Leadership, Resilience, and Digital Transformation in Education under Conditions of Social Uncertainty

Monograph

Open Science Initiative

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Edited by Olena Semenikhina

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INTRODUCTION

Olena Semenikhina

Education in the first half of the twenty-first century is increasingly shaped by instability, accelerated change, and the erosion of once-stable institutional and professional routines. Social turbulence, war-related disruption, technological transformation, post-pandemic inequality, psychological overload, and the growing role of algorithmic systems have significantly complicated the conditions under which educational institutions operate and under which educators make decisions. Under such conditions, education cannot be understood solely as a sphere of knowledge transmission or organizational reproduction. It must also be viewed as a field of ethical choice, institutional adaptation, collective resilience, and responsible digital development. This monograph proceeds from the assumption that uncertainty is not a temporary disturbance external to education, but a constitutive condition that changes how leadership is exercised, how educational environments are sustained, and how professional responsibility is interpreted. Such a perspective resonates with the idea that uncertainty in education has epistemic, normative, and ontological dimensions, while contemporary educational practice increasingly requires morally grounded, institutionally supported, and technologically informed decision-making.

This problem has acquired particular significance in the Ukrainian educational space, where systemic transformation intersects with wartime realities, forced mobility, psychological strain, institutional vulnerability, and the urgent need to maintain the continuity and quality of education under a compound crisis. At the same time, the issues discussed in this monograph are relevant beyond Ukraine. International scholarship also shows that education systems increasingly confront dilemmas related to

fairness, inclusion, resource allocation, school climate, psychological safety, digital governance, and the redesign of professional preparation in environments shaped by intelligent technologies. Recent work in pedagogical ethics emphasizes the growing importance of institutional responsibility and reflective moral judgment in conditions of rapid change, while studies of educational well-being demonstrate that leadership, organizational culture, and support structures are becoming central to educational quality rather than peripheral. Likewise, research on digitally transformed learning and professional preparation shows that AI and data-driven systems are no longer merely technical tools but factors that are reshaping the meanings of expertise, judgment, and accountability.

The title of the monograph, *Leadership, Resilience, and the Digital Development of Education under Conditions of Social Uncertainty*, reflects a deliberate effort to bring together three analytical lines that are often studied separately. The first concerns leadership, understood not only as formal administration but also as the capacity to organize collective action, sustain dialogue, make justified decisions, and create conditions in which others can act productively and responsibly. The second concerns resilience, interpreted not as a narrow psychological trait, but as the capacity of individuals, teams, and institutions to preserve meaningful and ethically responsible action under stress, volatility, and incomplete certainty. The third concerns digital development, understood not as the mere spread of technologies, but as a deeper reconfiguration of educational environments, professional roles, assessment practices, communication systems, and the relationship between human judgment and intelligent tools. Across the monograph, these three dimensions are treated as mutually constitutive. Leadership without resilience becomes fragile; resilience without ethical and organizational grounding becomes reactive; digital development without reflective leadership risks deepening inequality, opacity, and institutional instability.

The central problem addressed in this monograph arises from a growing contradiction. On the one hand, education is increasingly expected to ensure continuity, fairness, inclusion, quality, psychological support, and readiness for digital

transformation. On the other hand, the actual conditions of educational activity are marked by resource scarcity, moral ambiguity, emotional overload, organizational fragmentation, and rapidly changing technological infrastructures. This contradiction can be observed at multiple levels. At the normative level, institutions must balance justice, efficiency, inclusion, and procedural legitimacy. At the managerial level, they must respond to risk while preserving the continuity of educational processes. At the organizational level, they must sustain well-being, trust, and professional cooperation. At the interpersonal level, they must support psychologically safe, partnership-based interactions among educators, learners, parents, and communities. At the professional level, they must prepare future specialists for environments in which data, automation, and AI increasingly shape evaluation and action. The present monograph examines these levels not as isolated domains but as interconnected dimensions of one broad educational challenge.

The aim of the monograph is to develop an integrated scholarly understanding of how educational leadership, institutional resilience, and digital transformation can be interpreted and advanced under conditions of social uncertainty. More specifically, the monograph seeks to clarify the ethical, strategic, organizational, psychological, and professional dimensions of educational action in unstable conditions; to identify the managerial and pedagogical mechanisms that support continuity, justice, safety, and well-being; and to demonstrate how digitally mediated environments require new forms of leadership, teamwork, partnership, and professional preparation. The monograph also aims to bridge the gap between conceptual reflection and implementation-oriented thinking by combining theoretical analysis with empirical evidence, practical models, and case-based interpretations. This applied orientation is especially important because several chapters explicitly show that institutions need not only abstract recognition of contemporary challenges but also frameworks for action, including protocols, support models, role structures, and pedagogical tools that can guide decision-making in uncertain circumstances.

Methodologically, the monograph brings together different but compatible research traditions. Its chapters employ

conceptual and normative analysis, interdisciplinary synthesis of pedagogical, psychological, and managerial scholarship, comparative approaches, qualitative and quantitative empirical methods, case analysis, document analysis, and review-based systematization. Such methodological pluralism is not accidental. It corresponds to the complexity of the subject itself. Educational uncertainty cannot be adequately understood through a single method, as it simultaneously affects values, decisions, organizational mechanisms, team interactions, emotional climates, and technological infrastructures. The ethical dimension requires conceptual precision and normative reasoning. The strategic and managerial dimensions call for risk management and continuity planning models. The organizational and psychological dimension requires attention to school climate, support culture, burnout prevention, and professional well-being. The digital dimension requires analysis of technologically mediated professional practice and the changing boundaries of human and algorithmic expertise. By integrating these approaches, the monograph advances a multidimensional account of educational adaptation that avoids both purely abstract theorization and narrowly technical pragmatism.

The scientific contribution of the monograph lies in its attempt to treat social uncertainty not as a background variable but as a structuring condition of educational life. In this perspective, educational dilemmas are not exceptional episodes but a regular feature of pedagogical and institutional practice. Risk management is not a peripheral administrative task but a core component of educational continuity. Well-being is not a supplementary concern but a strategic condition of educational quality. Psychological safety is not merely a matter of individual comfort but a mediating organizational resource that shapes decision-making, trust, and professional resilience. Partnership is not an optional extension of educational activity but an institutional mechanism through which universities and schools strengthen their social function and connect educational work to broader community needs. Digital development is not reducible to technological modernization but demands new forms of interpretive caution, ethical awareness, data literacy, and responsible leadership. By placing these propositions in a common analytical framework, the monograph contributes to a more

coherent understanding of contemporary education as a morally, organizationally, and technologically complex field.

The practical significance of the monograph follows directly from this integrative orientation. Its materials may be useful for educational leaders, school and university administrators, teacher educators, researchers, policymakers, and practicing educators. The chapters offer conceptual tools for analyzing dilemmas, management models for continuity planning, approaches to supporting teacher and student well-being, frameworks for strengthening psychological safety and support culture, arguments for rethinking partnership with stakeholders and parents, and perspectives for redesigning educational programs under the pressure of digital transformation. Several chapters explicitly generate implementation-oriented outcomes, including structured decision-making protocols, trigger-based response logic, strategic well-being models, role-sensitive views of leadership, and recommendations for preparing specialists to act responsibly in data-rich, technologically unstable environments. In this sense, the monograph is intended not only to interpret educational change but also to support more reflective and resilient practice.

The monograph's internal architecture reflects this logic. **Part I, Ethical, Strategic, and Institutional Dimensions of Educational Leadership under Uncertainty**, establishes the broadest analytical frame. The first chapter addresses ethical dilemmas under uncertainty and examines the fairness of decisions, inclusion, and resource priorities as interdependent components of contemporary pedagogical ethics. The second chapter moves to the strategic and managerial level by analyzing risk management and the continuity of the educational process through scenario planning and response triggers. The third chapter broadens the institutional lens by examining the partnership between higher education institutions and stakeholders under martial law and in the context of post-war recovery, thereby foregrounding the social role of educational institutions and their embeddedness in wider community processes. Together, these chapters define the normative and institutional foundations of educational leadership in uncertain conditions.

Part II, Well-Being, Safety, and Resilience in Educational Communities, turns to the internal sustainability of educational environments. The fourth chapter examines the well-being of children and teachers as a strategic condition for maintaining educational quality and institutional stability, emphasizing the role of educational leadership, organizational culture, and social and emotional learning. The fifth chapter develops this line through a more focused analysis of psychological safety in teaching teams within inclusive primary education, showing how support culture, facilitative leadership, and organizational resources reduce burnout and strengthen professional resilience. This part demonstrates that educational quality in unstable conditions depends not only on formal organization or technical continuity but also on the emotional, relational, and cultural conditions under which educational work is carried out.

Part III, Teacher Leadership and Digital Transformation in Educational Practice, focuses on professional interaction and future-oriented change. The sixth chapter examines the leadership role of primary school teachers in building partnerships with parents under social challenges, showing that educational leadership increasingly includes facilitation, emotional intelligence, and community stabilization. The seventh chapter shifts attention to teamwork in digital educational environments and argues that digital competence must be understood together with facilitative and organizational leadership in collaborative professional settings. The eighth chapter extends the discussion into a specialized but analytically revealing case by examining artificial intelligence in esports as an indicator of digital transformation in physical culture education. This final chapter broadens the monograph's argument by showing that the future of education is increasingly shaped by data-intensive, AI-mediated, and ethically sensitive environments that demand new forms of adaptive judgment and professional preparation.

Taken together, the chapters of this monograph support a common conclusion. Education under conditions of social uncertainty cannot be sustained by administrative control alone, technological innovation alone, or individual teacher commitment

alone. It requires ethically informed leadership, resilient institutions, psychologically sustainable professional communities, partnership-based environments, and a reflective approach to digital development. It also requires a shift in how educational problems are framed. What may appear at first as separate issues, fairness, continuity, partnership, well-being, psychological safety, teamwork, and AI, in fact, belong to one shared field of educational transformation. The purpose of this monograph is to make that shared field more visible and conceptually coherent, while also contributing to the search for responsible, practically grounded responses to the challenges it poses.

Part 1

ETHICAL, STRATEGIC, AND INSTITUTIONAL DIMENSIONS OF EDUCATIONAL LEADERSHIP UNDER UNCERTAINTY

Chapter 1. ETHICAL DILEMMAS UNDER UNCERTAINTY: FAIRNESS OF DECISIONS, INCLUSION, AND RESOURCE PRIORITIES IN EDUCATION

Nina Tverezovska, Daria Suprun, Iryna Demchenko, Tetiana Hryhorenko, Viktor Sydorko

***Abstract**. The study addresses ethical dilemmas in education under conditions of uncertainty, with a particular focus on justice, inclusion, and the allocation of limited resources. A mixed-methods design was employed, combining conceptual and comparative normative analysis, case analysis, semi-structured interviews, focus groups, questionnaires, observation, thematic analysis, and statistical processing of quantitative data. It was identified that educational uncertainty is not situational but ontological, manifesting through epistemic, normative, and ontological dimensions that structure the emergence of pedagogical dilemmas. It was established that ethical dilemmas constitute an everyday reality for educators rather than exceptional episodes, and that their specificity is determined primarily by the nature of pedagogical relationships and the forms of responsibility characteristic of different educational sectors. It was found that, in general, secondary education dilemmas of holistic responsibility for child development prevail; in professional pre-higher education, dilemmas arise at the boundary between educational and quasi-professional responsibility; and in higher education, dilemmas of dual loyalty between scholarly and pedagogical roles become more salient. The influence of institutional culture, ethics training, teaching experience, and support resources on the quality of dilemma processing, the level of moral distress, and confidence in decision-making was assessed. Regular patterns of decreasing moral distress and a complex dynamic in which such decreases may reflect both professional adaptation and, in some cases, a risk of reduced moral sensitivity (moral anesthesia) were characterized. It was established that institutional culture is the strongest predictor of morally responsible decision-making and that no individual preparation can compensate for a toxic organizational environment. It was clarified that inclusive education remains a normatively justified ideal, yet its implementation generates dilemmas related to competing rights, cultural diversity, and resource scarcity. The impact of wartime conditions, digitalization, and algorithmic risks on the intensification of ethical tensions in*

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education was also evaluated. It was concluded that further research should focus on longitudinal, comparative, and cross-level studies of pedagogical wisdom, moral distress, and institutional conditions of ethical decision-making.

***Keywords**: ethical dilemmas in education; pedagogical ethics; uncertainty; inclusive education; resource allocation; moral distress; pedagogical wisdom.*

Introduction

The field of education belongs to those spheres of social life in which fundamental values collide most sharply: equality and freedom, efficiency and justice, individual development and social well-being. These collisions are not accidental; rather, they are rooted in the very nature of pedagogical activity, which unfolds under conditions of fundamental uncertainty. No educational process takes place in a vacuum of stable conditions: teachers make decisions about children whose futures are unpredictable; administrators allocate resources without precise knowledge of their effects; and education policymakers establish standards for societies undergoing constant transformation.

Uncertainty in education is not a temporary condition that can be overcome through the accumulation of knowledge or the refinement of methodology. It is an inherent ontological characteristic of education itself. As Dewey (1916, p. 89) notes, education is "a reconstruction or reorganization of experience which adds to the meaning of experience and increases the ability to direct the course of subsequent experience." Embedded in this definition is a recognition of the openness of the future: neither "added meaning" nor "subsequent experience" can be fully predetermined.

It is precisely in this context that ethical dilemmas acquire particular urgency. If uncertainty is a constant, then the question of how to make morally justified decisions despite incomplete information becomes central to pedagogical ethics. This chapter is devoted to three interrelated dimensions of this issue: the fairness of educational decisions under conditions of uncertainty, inclusion as both a normative ideal and a practical challenge, and the allocation of limited resources among competing educational needs. These dimensions are considered interdependent components of a single moral challenge confronting contemporary

education. In addition, recent studies highlight the growing prevalence of moral distress among educators working in complex, crisis-affected environments (Ballangrud et al., 2025; PMC, 2025). The chapter aims to provide practically applicable frameworks for educators and institutional leaders through theoretical analysis.

The relevance of this study is determined by several interrelated factors shaping the current state of educational theory and practice. Rapid social transformations, technological shifts, and globalization processes have significantly complicated the conditions under which educational systems operate. The accelerating pace of change means that educators and educational leaders are increasingly required to make decisions in situations for which no established experience or unambiguous normative guidance exists. Under such conditions, the study of the mechanisms of moral judgment becomes especially important.

The intensification of social inequality in education in the post-pandemic context has brought renewed attention to the distribution of educational resources, the priorities for supporting vulnerable student groups, and the mechanisms of compensatory educational policy. According to UNICEF (2021), the COVID-19 pandemic resulted in learning losses that disproportionately affected children from low-income families and students with special educational needs, making the issue of fairness in resource allocation especially acute.

The implementation of the principles of inclusive education in Ukraine and in most countries worldwide, in accordance with international commitments under the UN Convention on the Rights of Persons with Disabilities and the UN Sustainable Development Goals, encounters serious practical dilemmas that require theoretical reflection. The transition from the declarative recognition of inclusion to its actual implementation reveals contradictions that cannot be resolved at the level of administrative regulation without deeper ethical analysis.

Fourth, the digitalization of education and the spread of algorithmic decision-support systems have opened new dimensions of longstanding problems of fairness and bias, requiring reflection within the framework of pedagogical ethics. Algorithmic bias, the digital divide, and risks to student

confidentiality are new manifestations of old problems of inequality and dignity, all of which call for renewed normative analysis. These concerns are increasingly discussed in recent research on AI ethics in education, which highlights risks of algorithmic bias, opacity, and accountability gaps (Education Sciences, 2025; Frontiers in Education, 2025).

Fifth, within Ukrainian academic discourse, the problem of pedagogical ethics under conditions of uncertainty remains insufficiently and unsystematically studied. The vast majority of domestic scholarship in pedagogical ethics focuses either on general principles of pedagogical morality or on particular applied issues, such as academic integrity or rules governing teachers' conduct, while leaving aside a systemic analysis of dilemmatic situations arising under conditions of fundamental uncertainty. Addressing this gap is a central task of this chapter.

Recent international research (2024–2026) has further expanded the understanding of ethical decision-making in education under conditions of uncertainty, particularly in relation to artificial intelligence, institutional ethics, and moral distress among educators (Ballangrud et al., 2025; Biesta, 2025; Fedotova, 2024; Frontiers in Education, 2025; MDPI Education Sciences, 2025; SAGE Journals, 2025). Contemporary studies emphasize the growing complexity of ethical challenges associated with algorithmic governance, data-driven decision-making, and crisis conditions in education systems. These works highlight the importance of integrating ethical reflection into both educational leadership and everyday pedagogical practice, as well as the need for institutional frameworks that support morally responsible decision-making in rapidly changing environments.

Taken together, these studies confirm the growing importance of integrating ethical reflection, institutional responsibility, and technologically informed decision-making in contemporary education.

The **aim** of the study was to develop an integrated theoretical framework for the analysis and morally grounded resolution of ethical dilemmas arising in educational practice and policy under conditions of uncertainty, with particular attention to the fairness of decisions, inclusion, and resource allocation.

The **methodological foundation** of the study is comprehensive and corresponds to the interdisciplinary nature of the issues addressed in pedagogical ethics. A variety of methods were employed in order to capture both the theoretical and empirical dimensions of the phenomenon under investigation.

Conceptual analysis was used to clarify the study's key concepts: uncertainty, ethical dilemma, justice, inclusion, and pedagogical wisdom. Clarifying these concepts was a necessary precondition for properly formulating research questions and avoiding the conceptual confusion that often arises in interdisciplinary inquiry.

Comparative normative analysis was used to systematically compare different ethical theories – consequentialism, deontology, theories of justice, the capability approach, and the ethics of care – in terms of their capacity to explain and guide the resolution of educational dilemmas. This method enabled the identification of both the heuristic potential and the limitations of each theoretical tradition.

Argumentative analysis was employed to assess the quality of normative arguments used in debates on educational justice, inclusion, and resource allocation. This method enabled identifying the logical structure of arguments, uncovering hidden premises, and evaluating their persuasiveness.

The *method of thought experiments*, within the tradition developed by Rawls (veil of ignorance) and by other analytic philosophers, was used to test normative principles in hypothetical yet pedagogically productive situations. This method proved particularly effective for revealing implicit value assumptions and demonstrating the practical implications of theoretical positions.

Case analysis enabled concrete application of theoretical arguments through reference to real or realistic educational situations. Cases were selected according to criteria of typicality, by reproducing common classes of dilemmatic situations; diversity, by encompassing the micro-, meso-, and macro-levels of education; and heuristic value, by illuminating normatively significant questions.

Semi-structured interviews were the primary method for collecting data in the empirical part of the study. The choice of a semi-structured format was determined, on the one hand, by the need to ensure comparability of responses through common thematic blocks and, on the other hand, by the need to give respondents sufficient freedom to articulate individual positions and reveal the specific features of particular situations. The interview guide covered the following thematic blocks: 1) descriptions of concrete dilemmatic situations from personal experience; 2) strategies for addressing uncertainty and making decisions; 3) support resources and institutional conditions; and 4) respondents' assessment of their own preparedness to deal with ethical dilemmas.

Questionnaires were used to collect quantitative data on the frequency with which educators encountered different types of dilemmas, their subjective confidence in their own decisions, and their perceptions of institutional support. The questionnaire was developed on the basis of a preliminary qualitative pilot study and included self-assessment scales of moral distress adapted from medical practice (Corley et al., 2001), as well as scales of perceived organizational justice (Colquitt, 2001).

Focus groups were used to investigate educators' collective perceptions of "right" and "wrong" strategies for resolving dilemmas, as well as to identify informal norms and cultural expectations regulating behavior in dilemmatic situations. Focus groups are particularly effective for studying social norms because participants interact with one another and jointly construct meanings.

Observation (in the sample of school practices), was used during the pilot phase of the research to document real situations in which educators encountered dilemmas and the strategies they used to address them in natural settings. Observation made it possible to reduce the gap between declared and actual practices, a phenomenon well known in sociological research as the attitude-behavior gap.

Thematic analysis, following the methodology of Braun and Clarke (2006), was applied to qualitative data, namely interview and focus-group transcripts. Coding was conducted in two stages: first, inductively, through open coding closely grounded in the text; and then, deductively, by testing for correspondence with theoretical categories. The analysis was carried out using MAXQDA qualitative data analysis software.

The *statistical analysis* of quantitative questionnaire data included descriptive statistics, correlation analysis to identify relationships between the level of moral distress and institutional factors, and analysis of variance (ANOVA) to compare groups of educators with different lengths of service, types of institution, and experience working with inclusive students. Data were processed in the R environment.

The *triangulation* of methods and data sources was a fundamental methodological decision that ensured the validity of the conclusions. Combining qualitative and quantitative methods (methodological triangulation) and comparing data from teachers, administrators, and students (source triangulation) enabled cross-checking of the findings and reduced the influence of the specific limitations of any single method.

The *scientific novelty* of the research findings lies in the following. For the first time in Ukrainian pedagogical scholarship, a systematic analysis of ethical dilemmas in education has been conducted through the lens of fundamental uncertainty, identifying three qualitatively distinct dimensions of educational uncertainty – epistemic, normative, and ontological – and corresponding strategies for addressing them. This distinction is conceptually productive and opens up new analytical possibilities for pedagogical theory. An original typology of educational dilemmas has been developed based on the levels of the educational system (micro-, meso-, and macro-levels) and the nature of the conflicting values (equality vs. freedom, efficiency vs. justice, and individual good vs. public interest). Unlike existing approaches that consider dilemmas either in a purely abstract manner, at the level of theoretical principles, or in a purely casuistic way, at the level of isolated examples, the proposed typology combines theoretical systematicity with practical orientation. The concept of pedagogical wisdom (*phronesis*) has

also been proposed and substantiated as a practical virtue that enables educators to orient themselves morally in situations of uncertainty. Unlike approaches that reduce pedagogical competence to technical skills, the concept of pedagogical wisdom emphasizes an irreducible practical rationality that develops through experience, reflection, and participation in moral communities. The understanding of inclusive education has been further refined through a distinction between its normative foundations, which remain relatively stable, and the practical dilemmas of implementation, which are contextually variable. This distinction helps avoid two symmetrical errors: reducing support for inclusion to the defense of an abstract principle without accounting for practical difficulties, and rejecting the principle of inclusion on the basis of practical obstacles. The application of the capability approach developed by Nussbaum and Sen to problems of educational justice under conditions of resource scarcity has also been further advanced (Nussbaum, 2011; Sen, 1999). In particular, criteria for prioritizing educational investment have been developed that synthesize arguments for efficiency associated with the Heckman curve (Heckman & Masterov, 2007) and for justice associated with the Rawlsian difference principle (Rawls, 1971).

Based on an empirical study, the strategies used by practicing educators to address dilemmatic situations under conditions of uncertainty were identified and systematized, and institutional factors that facilitate or hinder morally responsible decision-making were determined. These findings help bridge the existing gap between normative pedagogical theory and educational practice.

The practical significance of the research findings is multi-level and concerns various actors within the educational system

For practicing educators, the study offers conceptual tools for identifying and analyzing dilemmatic situations, including a typology of dilemmas and criteria for distinguishing genuine dilemmas from merely «difficult decisions»; normative guidelines for making morally justified decisions under conditions of

uncertainty; and strategies of self-care and preservation of moral resilience under conditions of sustained moral distress. The chapter's materials may be used to develop workshops for educators on pedagogical ethics and decision-making.

For administrators of educational institutions, the study provides an analysis of the structural conditions that facilitate or hinder morally responsible decision-making; recommendations for fostering a school culture that supports reflective practice and collective engagement with difficult situations; and practical guidance for developing internal procedures for conflict resolution that are normatively transparent and ensure procedural justice.

For education policymakers, the study offers a normative framework for evaluating policy decisions concerning inclusion, resource allocation, and equal access to quality education; an analysis of the mechanisms of systemic responsibility and their possible distortions; and concrete recommendations for designing more equitable systems of educational funding and support for inclusion.

For systems of teacher education and professional development, the chapter's materials may serve as a basis for instructional modules in pedagogical ethics that emphasize not the memorization of ready-made rules, but the development of the capacity for moral judgment under conditions of uncertainty. The cases and analytical methods described here may be used in teacher education as instructional resources.

For the scholarly pedagogical community, the study provides a conceptual framework for further research in pedagogical ethics; a methodological toolkit, including adapted scales of moral distress and organizational justice and interview and focus-group protocols; and an empirical basis for comparative studies of how educators address dilemmatic situations in different institutional contexts.

In addition to the conceptual contributions, the study provides concrete implementation-oriented tools for educational practice. In particular, it proposes: structured decision-making protocols for handling ethical dilemmas under uncertainty (including stakeholder mapping, risk assessment, and justification procedures); institutional guidelines for organizing ethics

reflection groups and collegial consultations within educational institutions; practical frameworks for balancing inclusion and resource allocation in conditions of scarcity; models of integrating ethical reflection into everyday pedagogical routines rather than treating it as an exceptional activity.

These tools may be directly implemented at the institutional level through internal regulations, professional development programs, and leadership practices.

Research Results

The concept of uncertainty has several fundamentally different interpretations in scholarly discourse, and these are conceptualized differently within pedagogical ethics. In his classic work *Risk, Uncertainty and Profit*, Knight (1921) distinguished between risk as a measurable probability of adverse outcomes and uncertainty proper as a condition in which no objective probabilistic estimate is possible. This distinction is of fundamental importance for educational practice: a substantial part of what occurs in the educational process belongs precisely to Knightian uncertainty rather than to risk.

Simon (1955) introduced the concept of bounded rationality, which describes the cognitive limitations of decision-making: the human mind is unable to process all available information and therefore inevitably simplifies reality through heuristics and simplified models. In the educational context, this means that the ideal of the "rational educator" who makes decisions on the basis of complete information is a theoretical fiction. The real educator always acts on the basis of partial knowledge.

In poststructuralist pedagogical theory, uncertainty is conceptualized in a more radical way. Derrida (1978) and his followers argued that any educational situation is fundamentally unstable and that the meanings of pedagogical actions are never definitively fixed. From this perspective, attempts to fully «overcome» uncertainty through standardization and control are not only practically impossible but also ethically problematic, because they deny the autonomy and uniqueness of each learner.

For the purposes of this analysis, it is useful to distinguish three dimensions of educational uncertainty. First, epistemic uncertainty refers to a lack of knowledge about relevant facts, such as a student's individual abilities, the effectiveness of teaching methods, or future social needs. Second, normative uncertainty denotes the absence of consensus regarding which values and goals should be prioritized in education. Third, ontological uncertainty refers to the fundamental unpredictability of the future in which students will live and act. Each of these dimensions generates specific ethical challenges.

Contemporary pedagogical ethics draws on several competing normative traditions, each of which offers its own approach to resolving dilemmas under conditions of uncertainty. Understanding these traditions is a necessary precondition for the analysis of specific educational problems. Contemporary discussions also stress the limits of purely evidence-based approaches and the need for value-sensitive decision-making under uncertainty (Biesta, 2025).

Consequentialism, especially in its utilitarian form, evaluates decisions by their consequences and requires the maximization of overall welfare. In education, this logic is reflected in approaches oriented toward measurable educational outcomes, the economic efficiency of investment in human capital, and responsiveness to labor market demand. Critics of consequentialism point out that under conditions of uncertainty, the assessment of consequences becomes highly problematic: we do not know what actually produces particular educational outcomes, let alone how to predict the long-term social consequences of educational decisions (Sen, 1999).

The deontological tradition, represented above all by Kantian ethics, insists that some actions are morally obligatory or prohibited regardless of their consequences. The Kantian requirement to treat each person as an end rather than merely as a means has obvious significance for education: a student cannot be reduced to "human capital" or a statistical indicator. This tradition is especially important for protecting the rights of students and teachers in situations where systemic logic may disregard them.

Rawls's theory of justice offers a procedural approach to distributive problems that is particularly important for education. The Rawlsian difference principle requires that inequalities be justified only if they are to the greatest benefit of the least advantaged members of society (Rawls, 1971). The veil of ignorance as a methodological device, namely, the idea of choosing an educational system without knowing one's own position within it, is especially productive for the analysis of educational justice (Rawls, 1971). Nussbaum and Sen developed the capability approach, which shifts attention away from the equal distribution of resources toward the real opportunities available to individuals (Nussbaum, 1995; Sen, 1999).

The ethics of care, developed by Gilligan (1982) and Noddings (1984), offers an alternative focus: not abstract principles of justice, but concrete relationships of care between educator and student. From this perspective, the moral task of education lies not in the uniform application of rules, but in responsive attentiveness to each child's unique needs. This tradition is especially important for criticizing bureaucratic systems of educational administration that efface individuality.

None of these traditions is sufficient on its own. A comprehensive analysis of educational dilemmas requires their synthesis, in which they function as complementary perspectives rather than competing doctrines. This synthetic approach underlies the analysis developed in the following sections.

A dilemma in the strict sense is a situation of choice between two or more possible courses of action, each of which is undesirable to some extent or associated with moral costs. It is fundamentally important to distinguish a dilemma from a "difficult decision": in a difficult decision, the correct answer exists but is hard to find or implement; in a genuine dilemma, any choice leads to some form of moral loss.

In educational practice, dilemmas arise at several levels. At the *micro-level,* teachers face dilemmas in concrete pedagogical situations: how to respond to a disruptive student without neglecting the needs of the rest of the class; how to balance the demands of standardized assessment with a particular student's real needs. At the *meso-level,* there are dilemmas of school

administration: how to distribute limited resources among competing needs; how to ensure inclusion without lowering the quality for other students. At the *macro-level,* there are dilemmas in educational policy: which model of equality to implement and how to balance school autonomy with maintaining common standards.

Uncertainty complicates dilemmas in a distinctive way. When the probable consequences of each available course of action are unknown, it becomes impossible even to measure the "moral costs" associated with each option. This gives rise to the phenomenon of double uncertainty: uncertainty about facts is compounded by uncertainty about normative criteria. It is precisely within this space of double uncertainty that most real educational dilemmas arise.

Justice is perhaps the most frequently invoked and, at the same time, the most contested concept in pedagogical ethics. Different theorists attribute markedly different meanings to it, and this diversity is not merely academic; it reflects real value conflicts within society.

Equality as sameness is the most intuitive understanding: every student should receive the same educational resources, the same amount of teacher attention, and the same opportunities. This conception appeals to the basic principle of impartiality and can be easily operationalized through standards and regulations. Yet it conceals a fundamental problem: identical treatment of different individuals is not neutral; it systematically reproduces and deepens inequality when those individuals start from unequal positions.

Equity, by contrast, presupposes that different students should receive different resources according to their needs precisely as much as is required to achieve relevant educational goals. This approach underlies compensatory educational policy: additional funding for schools in deprived areas, support for students with special educational needs, and programs for gifted learners. The difficulty lies in the fact that the very definition of "needs" is normatively charged and often reflects underlying power relations.

The *capability approach*, developed by Sen (1999) and Nussbaum (1995), reconceptualizes justice as the provision of a real space of opportunities for each individual. Nussbaum identifies ten "central capabilities," among which education that develops the capacity for critical thinking occupies an important place (Nussbaum, 1995, pp. 33–34). This conception is particularly useful for the analysis of inclusive education: the issue is not merely access to schooling, but whether that schooling genuinely enables the development of each child's potential.

Critical pedagogy, especially in the legacy of Freire (1970), insists that genuine justice is impossible without transforming the power relations reproduced through education. Freire's metaphor of "banking education," in which students are treated as passive "accounts" into which knowledge is deposited, suggests that even well-intentioned efforts at fair resource distribution remain confined within a system that is itself unjust (Freire, 1970).

If substantive justice, that is, a just outcome, is extraordinarily difficult to achieve under conditions of uncertainty, procedural justice – the justice of the decision-making process – assumes particular importance. Research by Tyler (1990) in psychology and the social sciences convincingly shows that people evaluate outcomes far more positively when they perceive the process by which those outcomes were reached as fair, even when they remain dissatisfied with the outcomes themselves.

The principles of procedural justice in education include several *key elements*. The first is *representation*: everyone affected by a decision should have an opportunity to be heard during decision-making. The second is *justification*: decisions should be accompanied by explanations intelligible to those whom they affect. The third is *consistency*: similar situations should be resolved according to similar principles. The fourth is *contestability*: mechanisms should exist for reviewing decisions that may prove unjust.

An important instrument for securing procedural justice is the deliberative approach to educational policy, developed within the tradition of deliberative democratic theory (Gutmann & Thompson, 1996). The essence of this approach lies in the idea that educational decisions should be made through open and

reasoned dialogue among all stakeholders: teachers, parents, students, administrators, scholars, and community representatives. Such an approach does not guarantee the "right" decision, but it does ensure that different perspectives and values are taken into account.

Another important procedural instrument is Rawls's concept of reflective equilibrium, a method of reconciling general principles with particular judgments through their mutual adjustment (Rawls, 1971). In the pedagogical context, this means an ongoing dialogue between general normative principles, such as the claim that every child has a right to quality education, and concrete practical decisions. Such dialogue is never definitively complete; it is an inherent feature of morally responsible educational practice.

Any decision made under conditions of uncertainty entails the risk of error. Pedagogical practice and educational policy generate norms regarding which mistakes are more acceptable than others. This is a deeply ethical issue: the distribution of the risk of error is simultaneously a distribution of power and vulnerability.

In medical bioethics, the principle *primum non nocere* – "first, do no harm" – is well known. An analogous principle may be formulated for pedagogical practice: in situations of uncertainty, preference should be given to those decisions that minimize the risk of harm, especially for students belonging to the most vulnerable groups. This precautionary principle takes different forms in educational practice: careful assessment before assigning a diagnosis of "learning difficulties," consultation with specialists before excluding a student, and caution in adopting new pedagogical methods.

At the same time, excessive caution has moral costs of its own. When fear of making a mistake paralyzes pedagogical action, students who require timely intervention suffer. A child with dyslexia who does not receive specialized support in time because of concerns about "misdiagnosis" incurs real educational losses as a result of such caution. The precautionary principle must therefore be balanced by a principle of active responsibility: not

only avoiding harm, but actively promoting the well-being of those who require support.

Particularly important is the question of who bears the consequences of erroneous decisions. In actual educational practice, such consequences are often distributed highly unevenly: systemic errors in educational policy, such as inadequate funding for schools in poor areas, fall first and foremost on the most vulnerable students. Meanwhile, those who made those decisions rarely bear corresponding costs. This asymmetry of risk constitutes a significant dimension of educational injustice.

Pedagogical assessment is one of the clearest illustrations of the problem of justice under conditions of uncertainty. It combines all three dimensions of uncertainty: epistemic, because we do not know exactly what is being measured; normative, because there is no consensus on what ought to be measured; and ontological, because we do not know how assessed knowledge will be used in the future.

Standardized testing is one response to a particular aspect of this uncertainty: it seeks to minimize evaluator subjectivity and ensure the comparability of results. Yet it also generates other forms of injustice: a systematic advantage for students familiar with the testing format; the marginalization of important competencies that do not lend themselves to standardized measurement; and curriculum narrowing, as teachers are compelled to focus on "teaching to the test."

Alternative approaches to assessment – such as portfolios, project-based learning, and authentic assessment – have their own justice-related problems. Their subjectivity makes them more vulnerable to evaluator bias, and their resource intensity means the quality of assessment varies with available resources. No approach to assessment is free from moral compromise.

One of the most thoroughly studied manifestations of injustice in assessment is assessment bias. Meta-analytic research by Gershenson et al. (2016) demonstrates that teachers' evaluations vary systematically by students' race, socioeconomic status, and gender, even after controlling for students' knowledge levels. This phenomenon illustrates how subjective uncertainty –

"How am I evaluating this student?" – is transformed into systemic injustice through the influence of social stereotypes on pedagogical judgment.

The principle of inclusive education – the education of children with diverse needs and abilities within a shared educational environment – has become an international norm through the UNESCO Salamanca Statement (1994) and the United Nations Convention on the Rights of Persons with Disabilities (2006). Article 24 of the Convention proclaims the right of every person with a disability to "inclusive education at all levels" and obliges states to provide "reasonable accommodation of individual requirements."

The normative justification of inclusion rests on several arguments. First, there is the human rights argument: every child has an inalienable right to education in a non-exclusionary environment, and segregation constitutes a form of discrimination regardless of its "benevolent" motives. Second, there is the dignity argument: full participation in social institutions is a constitutive element of human dignity, and education is central among such institutions. Third, there is the social cohesion argument: educating students with different abilities and needs together is a condition for the development of a solidaristic society prepared to embrace diversity.

The evidence base summarized by Hehir et al. (2016) indicates that well-implemented inclusion produces positive outcomes both for students with special educational needs and for the rest of the class. Their meta-analysis showed that students with disabilities in inclusive classrooms demonstrate stronger academic and social outcomes than students in segregated settings. For other students, inclusive education fosters empathy, cooperation skills, and readiness to work in diverse environments.

However, the normative appeal of inclusion does not eliminate the real dilemmas that arise in practice. Some of these dilemmas result from insufficient resources, which is a problem of implementation rather than of principle; others are more fundamental and concern the principle itself. Recent studies confirm that many of these dilemmas are intensified under

conditions of limited resources and institutional instability (Oberg, 2025).

One of the most debated dilemmas of inclusive education concerns the distribution of teacher attention and resources among students with different needs. Critics of inclusion, such as Kauffman & Badar (2014), argue that the need to adapt teaching for students with substantial special needs inevitably diverts resources from the rest of the class. Supporters counter that this problem is largely an artifact of insufficient funding and inadequate staff preparation rather than a principled limitation of inclusion.

A deeper dilemma concerns the compatibility of different models of "special needs". A child with severe behavioral disorders who systematically disrupts the learning process places the educator in a position of having to choose between that child's right to inclusive education and the rights of other students to learn in a safe and stable environment. There is no principled resolution to this dilemma; rather, it requires the situational balancing of competing rights.

Another dilemma arises from different models of understanding disability and special needs. The medical model treats special needs as characteristics of the individual requiring "correction" or "compensation." The social model, by contrast, understands disability as the result of social barriers and calls for their removal rather than the "treatment" of the individual. As Oliver (1990) argues, these models have significantly different implications for educational practice: the former leads to specialized support, whereas the latter leads to the transformation of the educational environment. In practice, however, the two often need to be integrated.

Questions of identity and culture constitute another source of normative tensions in inclusive education. Deaf communities frequently criticize the audist view of deafness as a "hearing impairment," insisting instead, as Lane (1992) argues, that Deafness should be understood as a cultural identity rather than a pathology. This position calls into question the very aim of inclusive education when it is oriented toward "fitting" the child into mainstream culture. Similar tensions arise around education

for children with autism, particularly in debates between "therapeutic" and "neurodiversity" approaches.

The concept of inclusion is gradually expanding to encompass not only children with special educational needs associated with disability, but also students marginalized on other grounds, including ethnicity, language, socioeconomic status, gender identity, sexual orientation, and religious belief. This expansion is normatively justified, yet it also generates additional complexities.

Multicultural education, which seeks to incorporate the experiences, knowledge, and perspectives of different cultural groups into the learning process, encounters the dilemma of cultural relativism. If the equal value of different cultures is recognized, how should one respond to cultural practices that conflict with liberal values such as gender equality, human rights, and scientific knowledge? According to May & Sleeter (2010), the answer varies substantially across approaches to multicultural education, from "critical multiculturalism," which advocates transforming unjust cultural practices, to more conservative forms that emphasize equal respect for cultural traditions.

Education in minority languages is a specific instance of this broader dilemma. On the one hand, instruction in one's native language supports more effective learning and contributes to the preservation of linguistic and cultural identity. On the other hand, equal access to the state language, and through it to broader social opportunities, is a condition of social integration and mobility. These aims are not mutually exclusive, but they require careful balancing under conditions of limited resources.

Questions related to gender identity and sexual orientation among students are particularly complex under conditions of uncertainty. Educational systems must protect the dignity and safety of students who identify as LGBTQ+, while at the same time taking into account the religious and cultural convictions of some families and communities. The absence of scientific and social consensus on a number of related issues, such as medical intervention in cases of gender dysphoria in children, complicates the formulation of unambiguous educational recommendations.

Research on effective inclusive education practices identifies a set of institutional conditions without which the proclaimed principle remains empty rhetoric. First, adequate resources are essential: support systems such as teacher assistants, psychologists, speech therapists, and social workers; accessible educational environments; and adaptive learning materials. Second, Forlin (2010) shows that one of the most common reasons for teachers' resistance to inclusion is a sense of unpreparedness and lack of competence, which makes specialized teacher preparation especially important.

Third, a positive school culture is essential, that is, a climate in which diversity is perceived as a resource rather than as a problem. This requires deliberate efforts to build a community of mutual respect and mutual support. Fourth, active partnership with families is crucial: parents of children with special needs possess critically important knowledge about their children, and their genuine involvement, rather than merely formal "information sharing", is a condition of effective inclusive practice.

Fifth, system flexibility is required: standardized curricula and rigid assessment systems often function as structural barriers to inclusion. Universal Design for Learning, developed in the United States, offers principles for designing flexible learning environments that enable different students to achieve common educational goals through different pathways (CAST, 2018). This approach is an important response to the tension between standards and individualization.

The allocation of limited resources is the central practical manifestation of most educational dilemmas. Resources in education include not only financial means, but also teachers' time, administrative attention, physical space, educational materials, and access to specialists. All of these resources are scarce, and no real educational system can satisfy all the needs of all participants at the highest possible level.

Scarcity generates competing demands that are normatively incommensurable: how can one compare the needs of a child with a severe disability requiring extremely costly specialized support with the needs of a class of ordinary students for high-quality general education? How can investment in gifted students be

balanced with support for those who are falling behind? These questions have no purely "technical" answers; they are normative in their very nature. Contemporary analyses of educational systems under crisis conditions demonstrate that such trade-offs have become even more acute in recent years (Constantin et al., 2025).

In public choice theory, education is regarded as a public good characterized by a distinctive combination of properties: it is partly rivalrous, because the time a teacher spends on one student is unavailable to another, and partly non-rivalrous, because knowledge acquired by one student does not reduce the knowledge available to others. This hybrid nature complicates the application of both market logics, which assume full rivalry, and purely public logics, which assume full non-rivalry.

Inequality in educational funding is one of the most thoroughly documented forms of structural injustice. In many countries, school funding depends heavily on the local tax base, leading to systematic inequality between schools in wealthy and poor areas. Research by Condron & Roscigno (2003) convincingly demonstrates that financial inequality reproduces and deepens social inequality. Attempts to overcome this inequality through redistributive mechanisms, such as federal or nationwide funding, often encounter resistance grounded in principles of local self-government and autonomy.

Philosophers and economists of education have proposed several competing criteria for the fair distribution of educational resources. The principle of equal expenditure per pupil is the simplest and most readily operationalized: every student has a right to equal funding. Yet, as already noted, equal expenditure does not guarantee equal opportunities when students begin from unequal starting positions.

The principle of compensatory distribution presupposes that students with greater needs or more adverse circumstances should receive more resources. This principle is implemented through targeted programs: financial subsidies for schools in poor areas, special funding for students with special needs, and early childhood development programs. Barnett's (1995) research on the Head Start program in the United States shows that early

investment in children from disadvantaged social backgrounds has positive long-term effects.

The principle of equal outcomes is the most demanding: educational resources should be distributed so that all students attain a minimum level of achievement. This approach underlies minimum competency education and the concept of leveling up, that is, raising the lowest-performing students to the average level rather than merely providing an ordinary level of resources. Critics argue that this approach may impose a "ceiling" on more capable students.

The adequacy approach, widely used in American legal thought on educational finance, holds that every student is entitled not to "equal" but to adequate funding – that is, funding sufficient to attain a certain minimum level of education (Minorini & Sugarman, 1999). This conception is more flexible, but also more indeterminate, because it shifts the problem to the question of what counts as "adequate."

The most acute dilemmas of resource allocation arise under conditions of genuine scarcity, when even the basic needs of all students cannot be met. Such situations are characteristic of educational systems in low-income countries, post-conflict societies, and particular schools experiencing deep deprivation.

Medical bioethics has developed several principles of prioritization under conditions of scarce resources, especially in the context of triage during emergencies. Some of these principles can be adapted for education. The principle of greatest benefit gives priority to those who will benefit most from a given resource. The principle of priority to the most vulnerable gives precedence to those in the worst position. The principle of most urgent needs takes time into account: some educational needs have a "window" beyond which meeting them becomes far less effective, as in the case of early language support.

Especially complex is the problem of prioritization between "ordinary" students and students with extremely costly special needs. When educating one student with a severe disability costs as much as educating an entire class, a dilemma arises: how should one balance the rights of the individual against the interests of the group? Case law in a number of countries has

established that the right to reasonable accommodation for students with disabilities is not unlimited and must take overall systemic resources into account; however, "reasonableness" remains an indeterminate criterion subject to situational evaluation.

Decisions regarding the allocation of educational resources also have an important temporal dimension that often remains overlooked. Investments that appear "costly" in the short term may yield substantial long-term benefits, and vice versa. Heckman & Masterov (2007) demonstrated through the Heckman curve that the highest returns on educational investment are achieved in early childhood rather than at the university level. From the standpoint of long-term efficiency, limited resources should therefore be directed primarily toward early development rather than higher education.

Yet this logic of "efficiency" encounters normative limits, because it risks reducing education to a purely instrumental matter – an investment in "human capital" – while neglecting its intrinsic value. Learning at any age has value in itself, regardless of its "rate of return"; an exclusive concentration on early childhood may therefore lead to neglect of the needs of students in later age groups.

Intergenerational justice introduces another temporal dimension into resource allocation. Decisions made today about the educational system will have consequences for future generations. A decline in the quality of education for the present generation of students will have systemic consequences for society twenty or thirty years from now. Conversely, strengthening educational institutions requires long-term and stable investments that compete with current needs.

The analysis of educational dilemmas at the level of theoretical principles is necessary but insufficient. Real decisions are made by concrete people in concrete situations, where general principles collide with unforeseen details. It is here that Aristotle's concept of practical wisdom (*phronesis*) comes to the fore: the capacity to act rightly in particular circumstances, which cannot be reduced to the application of general rules (Aristotle, 1999, 1140a24–b30).

Pedagogical wisdom is a form of practical virtue that enables educators to orient themselves in morally complex situations. It includes the capacity to notice morally relevant aspects of a situation, that is, a form of moral perception; the capacity to weigh competing considerations and determine which are most salient in a given context; and the capacity to act decisively when a decision is required, even in the absence of full certainty.

Unlike technical skills, pedagogical wisdom cannot be fully codified into rules and procedures. It develops through experience, reflection, and participation in moral communities – collectives in which complex situations are jointly interpreted. This means that the institutional conditions under which educators work are of fundamental importance for the formation and exercise of pedagogical wisdom: bureaucratized systems that demand strict adherence to procedure suppress the development of practical wisdom.

As Jameton (1984) argues, the continual encounter with irresolvable dilemmas and the need to make decisions under conditions of uncertainty are a significant source of moral distress, a psychological state that arises when a person knows what ought to be done morally, yet systemic or institutional constraints make it impossible to act accordingly. Moral distress is a well-documented phenomenon in medical practice, but its manifestations in educational work have been studied less extensively. Recent research in education confirms the relevance of this concept, showing that moral distress is widespread among teachers and strongly associated with institutional constraints and lack of support (Ballangrud et al., 2025; Constantin et al., 2025).

Teacher burnout is one of the most serious challenges facing contemporary education. Not all aspects of burnout are consequences of moral distress; however, the constant encounter with irresolvable moral conflicts is a significant contributing factor. An educator who is repeatedly forced to choose between the rights of one student and the needs of the rest of the class, or between the demands of the system and the well-being of a particular child, bears not only cognitive but also moral burdens.

Research in positive psychology points to several factors that support teachers' moral resilience. These include a sense of

autonomy and meaningfulness in work, support from colleagues and administrators, opportunities to participate in collective reflection on difficult situations, and a school culture that acknowledges the complexity of pedagogical work and does not demand "pseudo-certainty" from educators in situations where uncertainty is unavoidable.

Schön (1983) proposed the concept of reflection-in-action, a form of thinking that occurs directly in the course of practice and makes it possible to adjust one's actions in response to new information and context. Unlike the technical application of ready-made recipes, reflective practice presupposes continual reconsideration of both the situation and one's own actions.

In the context of educational dilemmas, reflective practice includes, among other things, continual re-examination of one's own biases and their influence on pedagogical decisions; a willingness to question one's initial judgments; participation in communities of inquiry in which educators jointly analyze complex situations; and the documentation of decisions and their consequences as a means of accumulating practical wisdom.

An important tool of reflective practice is ethics consultation, a mechanism widespread in medical ethics but much less developed in education. Educational ethics committees or ethics consultants may support teachers and administrators in dealing with especially complex dilemmas, not by imposing ready-made decisions, but by facilitating structured analysis of the situation and examination of available alternatives.

The digitalization of education has generated fundamentally new dimensions of ethical dilemmas that overlay traditional problems of justice and distribution. The use of algorithmic systems in education – from adaptive learning platforms to automated assessment and early identification systems for "at-risk students" – raises new questions of transparency, accountability, and fairness.

Algorithmic bias is one of the most thoroughly studied risks of digitalized education. Algorithms trained on data reflecting existing inequalities can reproduce and even intensify those inequalities. As Barocas&Selbst (2016) note, dropout prediction systems trained on data from schools where racial minorities

disproportionately left school may systematically flag students from such groups as "at risk," regardless of their individual characteristics. Recent empirical studies confirm that such biases are not merely theoretical risks but observable patterns in data-driven educational systems (Mirea, Palade, & Gaureanu, 2024).

Another specific problem is the digital divide: unequal access to technology that may deepen educational inequality. The COVID-19 pandemic demonstrated this problem with particular clarity: the shift to distance learning proved profoundly unjust for students who lacked reliable internet access or a quiet place to study. These "new" inequalities are, in fact, both a reflection and an intensification of "old" socioeconomic inequalities.

Questions of confidentiality and data collection constitute another dimension of digital pedagogical ethics. Contemporary learning platforms collect vast amounts of data about students, ranging from test scores to click patterns and attention spans. These data may be used to personalize learning, which has clear educational advantages, but also for surveillance, commercial purposes, and, in extreme cases, manipulation. Legal frameworks such as the GDPR in Europe and FERPA in the United States impose certain restrictions, yet their effectiveness remains contested.

Artificial intelligence systems open up significant possibilities for personalized learning, support for teachers in routine tasks, and the early identification of students who require additional assistance. At the same time, they also generate specific ethical risks that call for a carefully considered normative response. At the same time, contemporary research emphasizes the ethical ambiguity of AI integration, particularly regarding responsibility, transparency, and pedagogical autonomy (AlBlooshi, 2026; Ballangrud et.al., 2026).

One of the key questions concerns the distribution of responsibility between the human actor and the algorithm when the algorithm makes or recommends a decision. If an AI system recommends that a student be referred to a specialized educational institution, and a teacher or administrator follows this recommendation without critical reflection, who bears moral responsibility for that decision? As Pasquale (2015) argues, the

risk of authoritative algorithmic bias – that is, the uncritical acceptance of AI recommendations as though they possessed objective authority is both real and well documented.

The concept of "moral anesthesia" should therefore not be interpreted unambiguously as a negative outcome. In part, it may reflect a necessary professional adaptation that enables educators to function under conditions of sustained moral pressure. At the same time, there is a risk that such adaptation may, in some cases, lead to diminished moral responsiveness. This dual nature calls for more precise conceptual and empirical differentiation.

Pedagogical autonomy is another normatively important dimension. If algorithmic systems excessively constrain pedagogical freedom by imposing standardized methods and content, they undermine the very nature of the pedagogical vocation. Pedagogy is not only a technique, but also an art that presupposes responsive sensitivity to the unique needs of particular students. Systems that reduce pedagogical work to the execution of algorithmic prescriptions risk undermining precisely what makes pedagogy effective.

The preceding analysis has focused primarily on the micro-level, namely, the dilemmas of individual teachers and administrators. Yet most educational injustices are systemic in nature: they are reproduced through institutional structures, norms, and practices that exceed the capacities of individual actors. Individual reflection and moral virtue alone are therefore insufficient; systemic transformation is required.

Structural racism in education is one of the most thoroughly documented manifestations of systemic injustice. As Ladson-Billings (1995) argues, it is manifested not only in overt forms of discrimination but also in apparently neutral institutional practices that continually reproduce inequality, particularly through the allocation of resources on the basis of local taxation, disciplinary gaps in which students from racial minorities are more frequently subjected to severe sanctions, and lower academic expectations held by educators toward certain groups of students.

Another important conceptual tool is the notion of the hidden curriculum, introduced by Jackson (1968). Alongside the explicit content of education—knowledge and skills – schools transmit

implicit messages about power, hierarchy, acceptable behavior, and social roles. These implicit messages often carry class, gender, and cultural dimensions, reinforcing inequality by normalizing dominant cultural codes.

Educational policy confronts a distinctive form of uncertainty: decisions made at the systemic level affect millions of people and have long-term consequences, making exhaustive prediction impossible. This requires specific procedural standards to ensure the legitimacy and accountability of educational policy decisions.

In particular, the principle of epistemic humility in relation to educational reform presupposes that reformers should acknowledge the limits of their own knowledge and build feedback mechanisms that make it possible to identify and correct mistakes. Randomized controlled trials are widely used in evidence-based educational policy to justify reforms with scientific data. At the same time, Biesta (2007) notes that they have important limitations: they measure only short-term outcomes in particular conditions and are difficult to transfer to other contexts.

The inclusion of stakeholders in the development of educational policy is a procedural principle that partly compensates for policymakers' epistemic limitations. Teachers, parents, students, and community representatives all possess forms of practical knowledge absent from the offices of officials and university campuses. Mechanisms of such inclusion – from public consultations to advisory councils – are important elements of a just educational system, although their effectiveness depends on genuine, rather than merely formal, willingness to listen to voices from below.

Accountability systems are among the most controversial features of contemporary educational policy. On the one hand, they respond to an entirely legitimate social demand: if the state invests substantial resources in education, it has the right to require an account of how those resources are used. On the other hand, specific forms of accountability often generate serious distortions.

Standardized testing as an accountability instrument has been widely criticized for encouraging teaching to the test,

narrowing the curriculum, demotivating students and teachers, and inadequately capturing what genuinely matters in education. Research on the *No Child Left Behind* reforms in the United States shows that strong pressure on schools through standardized tests led to the manipulation of reporting and a focus on "borderline" students – those barely reaching the required threshold – while other students were neglected (Jennings & Rentner, 2006).

Alternative approaches to accountability include intelligent accountability, which, according to O'Neill (2002), relies on trust in educators and on demonstrating results through multiple forms of evidence rather than solely through numerical indicators. The Irish model of school inspection, the Finnish support system – in which accountability is built primarily on the development of teacher competence rather than on external control – and several other approaches demonstrate that accountability systems can exist without undermining educators' autonomy and motivation.

On the basis of the foregoing analysis, several principles may be formulated that together constitute an integrated normative framework for pedagogical practice under conditions of uncertainty. These principles are not "recipes" and therefore do not eliminate the need for situational judgment; rather, they serve as guidelines that structure morally responsible thinking.

A central guideline for morally balanced decision-making in education under conditions of uncertainty is the principle of prioritizing the minimization of harm to the vulnerable. When the consequences of a pedagogical or managerial decision cannot be fully foreseen, preference should be given to courses of action that reduce the risk of worsening the situation of students who are already in disadvantaged circumstances. The issue here is not passive avoidance of responsibility, but active protection of those whose capacity for self-protection is constrained by social, psychological, physical, or institutional factors. Such a logic of moral choice corresponds to the idea of supporting the least advantaged and to approaches that link justice not merely to formally equal treatment but to the real expansion of life opportunities.

Another key element is the principle of procedural fairness and reason-giving. In the absence of any guarantee of a perfectly just outcome, the fairness of the process within which a decision is made becomes especially important. A morally justified educational process presupposes taking into account the voices of all stakeholders, providing intelligible explanations of the grounds and motives of decisions, maintaining consistency in the application of norms and criteria, and remaining open to reconsideration in the event of error or well-founded objection. Procedural fairness is particularly important in educational settings, where every decision affects not only the experience of a particular student but also trust in the institution as a whole.

No less significant is the principle of recognition and respect for diversity. Educational reality is constituted by differences in abilities, needs, linguistic experience, cultural affiliation, social status, modes of perception, and developmental pace. Morally responsible education therefore cannot orient itself toward the image of an "average" or "normative" student as a universal model. Respect for diversity presupposes organizing educational space in such a way that plurality is not regarded as a deviation requiring additional "inclusion," but is built into the very approaches to teaching, assessment, communication, and support. Inclusiveness thus emerges not as a separate area of activity, but as a moral quality of the educational system as a whole.

The principle of reflective humility also requires special attention. In professional pedagogical practice, it is impossible to possess complete knowledge of all the consequences of one's actions, all the contexts of a student's life, or all the hidden factors shaping an educational situation. A morally mature stance therefore requires acknowledgment of the limits of one's own knowledge, readiness to refine earlier conclusions, willingness to revise decisions in light of new information, and sensitivity to indirect and delayed consequences. Such an orientation is not a sign of weakness, but of professional and moral maturity, because it prevents self-confident decision-making without adequate appreciation of complexity. Reflective humility supports responsible pedagogical action that combines decisiveness with readiness for self-correction.

This framework is completed by the principle of systemic responsibility. The moral quality of educational decisions depends not only on the personal virtues of teachers or administrators, but also on the character of the institutional environment in which professional activity unfolds. Inequality in access to resources, procedural formalism, bureaucratic pressure, and hidden mechanisms of exclusion or discrimination cannot be overcome solely through individual integrity. A morally responsible pedagogical stance therefore involves not only supporting individual students in difficult circumstances, but also participating in the transformation of structures that reproduce injustice. A professional community aware of its own systemic responsibility can become an agent of educational change aimed at creating a more just, responsive, and inclusive educational environment.

Pedagogical ethics is not only a normative framework for educators' actions; it must also address the question of how education prepares students for their own ethical dilemmas. In a world characterized by increasing complexity and uncertainty, one of the most important aims of education is the development of moral agency – the capacity to orient oneself in morally complex situations, make responsible decisions, and live with uncertainty.

Critical thinking, media literacy, and the capacity for anticipatory analysis are not merely cognitive achievements, but moral ones as well. They shape individuals capable of resisting manipulation and authoritarianism, critically evaluating their own convictions, and assuming responsibility for their judgments.

Empathy and moral imagination – the ability to understand the perspectives and experiences of people different from oneself – constitute an important dimension of moral education. As Noddings (1984) emphasizes, education should above all cultivate the human capacity to care for others. Nussbaum (1995), for her part, insists on the central role of literary imagination – the ability to identify with other human destinies through literature and other forms of narrative – in the formation of morally responsible citizens.

Moral resilience – the capacity to preserve one's moral orientation and to avoid moral burnout under difficult conditions – is another important aim of education. It is not stoicism or

indifference, but rather the ability to preserve moral sensitivity and the capacity for action even when the "right" answer is not self-evident.

The empirical study was conducted over the period 2022–2025 in three successive phases: 1) a pilot qualitative phase involving observation and pilot interviews (n = 18), which made it possible to refine the research instruments; 2) a main qualitative phase involving semi-structured interviews and focus groups; and 3) a quantitative phase involving questionnaire administration for the verification and generalization of qualitative data.

A fundamentally important feature of the study is its coverage of three levels of the educational system: institutions of general secondary education (GSE), including comprehensive schools, lyceums, gymnasiums, and special education institutions; institutions of professional pre-higher education (PPH), including colleges, technical schools, and vocational schools; and institutions of higher education (HEIs), including universities, academies, and institutes. This design was motivated by the need to identify both common and specific patterns in the emergence and handling of dilemmas across different levels of the educational system, where the age of learners, the character of pedagogical relationships, and institutional norms differ substantially.

The sample was constructed with attention to length of teaching experience (up to 5 years, 5–15 years, and more than 15 years) and occupational status (subject teachers, homeroom teachers, administrators, pedagogical staff, and academic staff). The overall sample structure included semi-structured interviews (n = 84: GSE = 36, PPH = 22, HEIs = 26), focus groups (9 groups, n = 68; three in each type of institution), and questionnaires (514 completed questionnaires: GSE = 218, PPH = 142, HEIs = 154). The geographical scope covered seven regions of Ukraine—Kyiv, Kharkiv, Lviv, Odesa, Dnipropetrovsk, Poltava, and Volyn – with equal representation of urban and regional centers. The structure of the sample by type of institution, respondent status, and length of service is presented in Table 1. The study was conducted in accordance with research ethics standards: all participants provided informed consent, data were anonymized, and transcripts were stored on secure servers.Table 1

Table 1

Structure of the research sample by type of educational institution

Indicator	*GSE*	*PPH*	*HEIs*	*Total*
Number of institutions	24	14	16	54
Questionnaires (n)	218	142	154	514
Interviews (n)	36	22	26	84
Focus groups (n)	3	3	3	9
Experience up to 5 years (%)	28%	31%	19%	26%
Experience 5–15 years (%)	41%	38%	44%	41%
Experience over 15 years (%)	31%	31%	37%	33%
Share with ethics course (%)	28%	33%	41%	33%

Source: Authors' own work.

The analysis of qualitative data revealed both common patterns, characteristic of all types of institutions, and substantial specificity at each level of the educational system. This specificity is determined by differences in learners' ages, the nature of pedagogical relationships, the degree of procedural formalization, and institutional requirements.

In general secondary education, the leading dilemmas concern students' unequal starting conditions, responsibility for the child's "holistic development" rather than merely the transmission of knowledge, interaction with families, and the protection of children from adverse circumstances. Educators in general secondary education describe the most intensive emotional bond with students and, correspondingly, the highest level of moral distress when outcomes are unfavorable. A characteristic quotation is: "You have known this child for many years, you know the family, and when you cannot help because of the system, it really hurts" (primary school teacher, 12 years of experience).

In institutions of professional pre-higher education, dilemmas at the boundary between pedagogical and quasi-professional responsibility clearly predominate: learners are both "students" and "future professionals," which creates specific tensions between educational support and the demands of actual competence. Educators in professional pre-higher education frequently describe dilemmas related to deciding whether to admit a learner to practicum or vocational training when they regard that

learner's competence as insufficient: "If I let this student through, they will end up in a real-life situation where people depend on them. If I do not let them through, I may destroy their career because of one failure" (college instructor, Nursing program).

In higher education institutions, the dominant dilemmas concern academic integrity, the balance between research and teaching functions, student autonomy, and institutional pressure. Especially characteristic is the much greater number of descriptions of dilemmas involving conflict between one's own scholarly convictions and the demands of administration or external stakeholders: «Science says one thing, but the administration wants us to teach students differently, so what am I supposed to do in front of the classroom?» (associate professor, Pedagogy program). Academic integrity is the most pronounced institution-specific issue in higher education: 78% of HEI instructors described dilemmas related to academic plagiarism and the choice of sanctions.

Quantitative analysis of questionnaire data enabled systematic assessment of the prevalence of different types of dilemmatic situations across the three types of institutions (Table 2).

Table 2

Prevalence of types of dilemmatic situations by type of institution (% of respondents who encountered a given type of dilemma "often" or "very often")

Type of dilemma	*GSE %*	*PPH %*	*HEIs %*	*Total %*
Distribution of attention and resources	91%	84%	67%	82%
Assessment and actual progress	83%	79%	71%	78%
Confidentiality/protection	74%	62%	45%	62%
Academic integrity	41%	68%	78%	59%
Cultural / value diversity	69%	57%	53%	61%
Systemic mismatch of requirements	62%	71%	74%	68%
Professional competence/admission to practice	18%	76%	49%	44%
Conflict between scholarly and administrative positions	12%	31%	68%	34%

Note. Values ≥ 70% are highlighted in bold as the most prevalent types of dilemmas in each group.

Source: Authors' own work.

As Table 2 shows, dilemmas concerning the distribution of attention and resources are most prevalent in general secondary education (91%) and professional pre-higher education (84%), whereas in higher education their frequency is noticeably lower (67%), which may be explained by the greater autonomy of higher education students. By contrast, dilemmas concerning a systemic mismatch of requirements are more prevalent in HEIs (74%) and PPH institutions (71%), where educators more often describe tensions between educational autonomy and bureaucratic regulation. Academic integrity is the dominant type of dilemma in HEIs (78%) and PPH institutions (68%), but occurs much less frequently in GSE (41%).

The comparative analysis of strategies for handling dilemmas revealed substantial differences among educators working in different types of institutions. These differences reflect not only educators' personal characteristics but also institutional culture and the nature of pedagogical relationships (Table 3, Fig.1).

Table 3

Prevalence of dilemma-processing strategies by type of institution (% of respondents who identified the strategy as «primary» or «frequently used»)

Strategy	*GSE %*	*PPH %*	*HEIs %*	*Total %*
Priority of relationships (ethics of care)	82%	71%	58%	72%
Procedural protection (rule adherence)	58%	61%	44%	54%
Collegial consultation	53%	49%	57%	53%
Harm minimization	49%	51%	43%	48%
Deferred decision	41%	37%	33%	38%
Systemic appeal / activism	19%	24%	31%	24%
Appeal to an external arbiter (ombudsperson, NPP)	8%	11%	22%	13%

Source: Authors' own work.

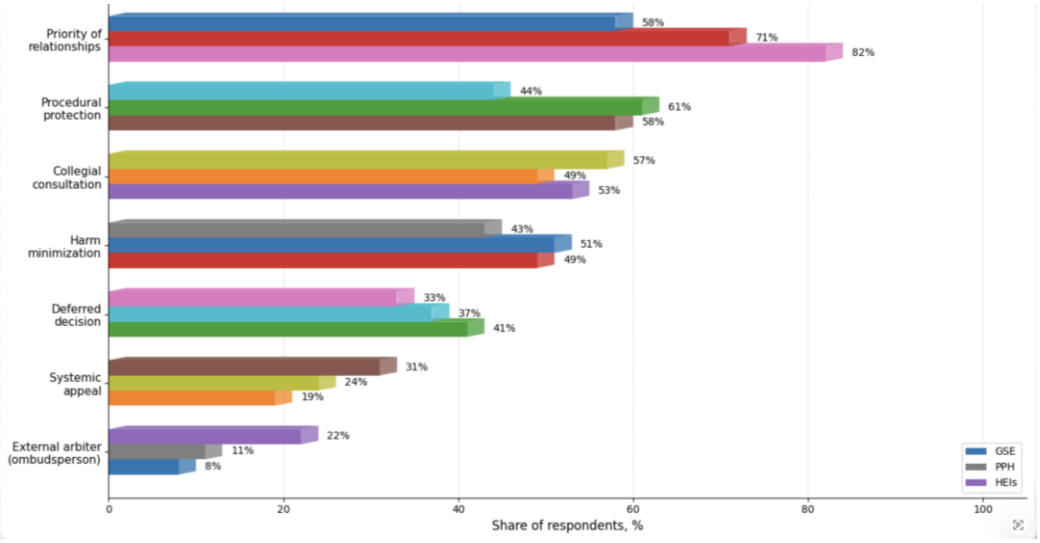

Figure 1

Prevalence of dilemma-processing strategies by type of educational institution

Source: Authors' own work.

The strategy of prioritizing relationships is dominant in general secondary education (82%), which corresponds to educators' emotional closeness to students. In higher education, its prevalence is substantially lower (58%), because relationships between instructors and students are less intensive and more formalized. By contrast, the strategy of systemic appeal is much more common among HEI instructors (31%) than among GSE educators (19%), which may be related to higher levels of self-efficacy and to the presence of institutional channels, such as academic councils and independent committees, for systemic change.

Appeal to an external arbiter, such as an equality commissioner, ombudsperson, or independent pedagogical board, is most common in higher education (22%), where such structures are better institutionalized, and least common in general secondary education (8%), where educators more often describe the absence of effective external mechanisms.

Regression analysis identified the key predictors of two dependent variables: the level of moral distress (measured by the Corley et al. scale) (Corley et al., 2001) and subjective confidence in decisions made (Table 4).

Table 4

Multiple regression results: predictors of moral distress and confidence in decisions (standardized β coefficients)

Predictor	*β (distress)*	*β (confidence)*	*p-value*	*Signi-ficance*
Supportive institutional culture	−0.48	+0.39	<0.001	***
Teaching experience	−0.31	+0.41	<0.001	***
Training in pedagogical ethics	−0.24	+0.33	<0.001	***
Availability of support resources	−0.22	+0.27	<0.001	***
Institution type (HEIs vs GSE)	+0.11	−0.08	<0.05	*
Institution type (PPH vs GSE)	+0.07	−0.05	0.12	n.s.
R^2 model	0.61	0.54	—	—

*Note. *** p < 0.001; ** p < 0.01; * p < 0.05; n.s. = not significant. β = standardized regression coefficient.*

Source: Authors' own work.

The results of the regression analysis confirm that institutional culture is the strongest predictor of both moral distress (β = −0.48) and decision confidence (β = +0.39). Training in pedagogical ethics has a significant independent effect on both variables, even after controlling for teaching experience and type of institution, indicating the educational component's autonomous role. The type of institution has a comparatively smaller effect: HEI instructors show somewhat higher distress (β = +0.11), which may be explained by the greater autonomy of their role and lower institutional support in comparison with GSE. The model explains 61% of the variance in moral distress and 54% of the variance in decision confidence (R^2 = 0.61 and 0.54, respectively).

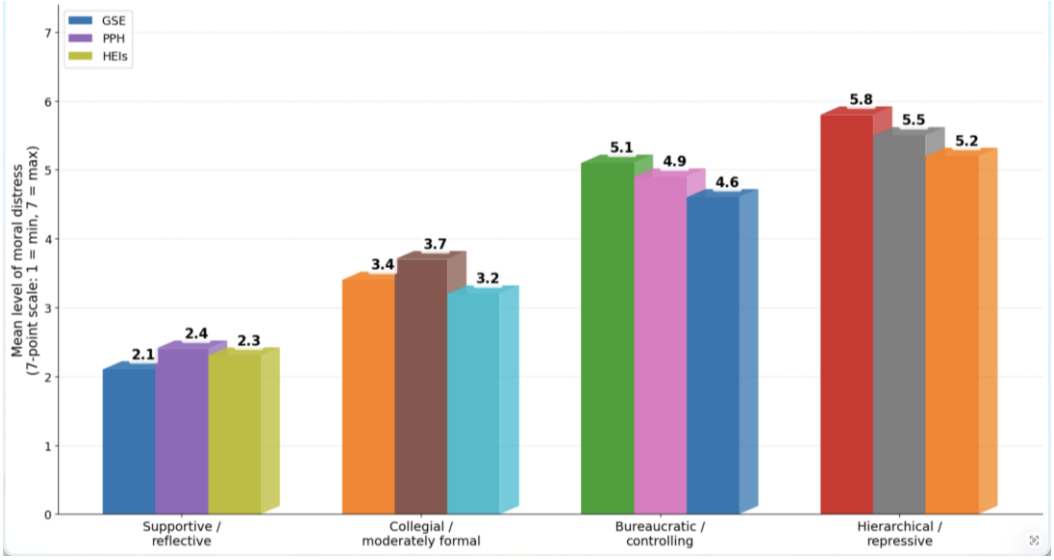

Figure 2

Level of moral distress (mean on a 7-point scale) by institutional culture and type of educational institution

Source: Authors' own work.

Of particular analytical interest is the non-linear relationship between teaching experience and the level of moral distress (Table 5).

Table 5.

Mean level of moral distress (7-point scale) and proportion of educators showing signs of moral anesthesia by years of service and type of institution

Years of service	*GSE distress*	*PPH distress*	*HEIs distress*	*Total distress*	*GSE ana-esthesia*	*HEIs ana-esthesia*
Up to 5	4.1	3.9	3.7	3.9	4%	3%
5–10	3.6	3.8	3.4	3.6	6%	5%
10–15	3.2	3.4	3.1	3.2	9%	8%
15–20	2.9	3.1	2.9	3.0	14%	11%
20–25	2.7	2.8	2.6	2.7	19%	16%
Over 25	2.4	2.5	2.3	2.4	31%	27%

Note. Moral anesthesia was operationalized as a combination of low distress (≤ 2.0) and low moral sensitivity based on qualitative assessment of interview transcripts.

Source: Authors' own work.

The data in Table 5 demonstrate a pronounced non-linear relationship: the level of moral distress gradually decreases with increasing years of service, from M = 3.9 among educators with up to 5 years of experience to M = 2.4 among those with more than 25 years. At the same time, the proportion of educators showing signs of moral anesthesia rises – from 4% among novices to 31% among the most experienced educators in general secondary education and 27% in higher education. This phenomenon is especially pronounced in general secondary education, where the emotional intensity of pedagogical relationships is greatest: prolonged immersion in complex situations without adequate support may lead to the exhaustion of moral sensitivity, even when outward functional effectiveness is preserved.

It is important to interpret the observed decrease in moral distress with caution. This tendency may indicate not only the development of professional competence, emotional regulation, and pedagogical maturity, but also, in certain cases, a reduction in sensitivity to morally significant aspects of situations. Distinguishing between adaptive professional resilience and problematic moral disengagement requires further qualitative and longitudinal analysis.

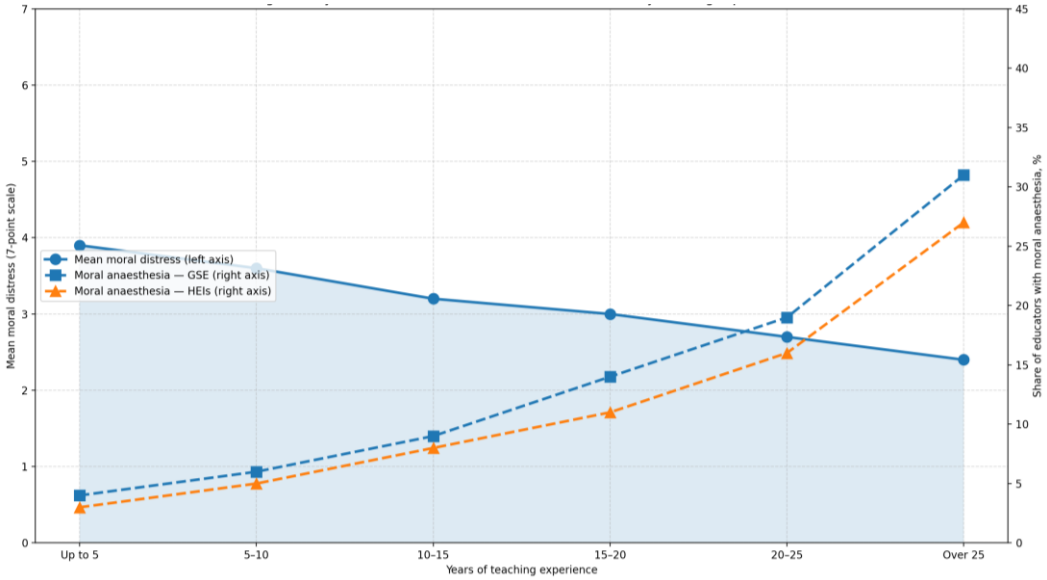

Figure 3

Dynamics of moral distress and moral anesthesia through teaching experience

Source: Authors' own work.

Comparison of data from the three types of educational institutions reveals several fundamentally important patterns that both confirm and refine the theoretical propositions while also bringing to light several unexpected and nuanced findings.

The findings confirm the proposition that dilemmatic situations are fundamentally pervasive in pedagogical practice and constitute not isolated cases, but an everyday reality for the vast majority of educators. More specifically, the nature of dilemmas is determined primarily by the character of pedagogical relationships and the nature of responsibility rather than by the formal level of education. In general secondary education, dilemmas are predominantly dilemmas of "holistic responsibility" for the child's development; in professional pre-higher education, they arise at the boundary between educational and quasi-professional responsibility; in higher education, they take the form of dilemmas of "dual loyalty" between scholarly and pedagogical roles. This conclusion points to the need to systematically prepare future educators to address dilemmas, rather than merely to master subject content and methodological skills. These differences have important implications for teacher education and suggest the need for substantially different thematic emphases in courses on pedagogical ethics for teachers in general secondary education and instructors in higher education. These findings align with recent international research emphasizing the central role of institutional conditions, ethical leadership, and systemic support in shaping educators' moral agency (Hill-Berry & Burris-Melville, 2025; Ballangrud et al., 2026).

The identified strategies for handling dilemmas correspond to different normative traditions: "priority of relationships" aligns with the ethics of care; "procedural protection" aligns with deontological approaches; and "harm minimization" aligns with consequentialism. This suggests that practicing educators intuitively draw on normative logics that best align with their personal orientation and institutional context, albeit without systematic theoretical reflection.

The data convincingly show that the quality of handling dilemmas is primarily a function not of educators' individual characteristics but of institutional conditions, specifically the institution's culture, the availability of support, and the presence

of space for collegial reflection. This has important implications for educational policy: strategies aimed solely at individually "upskilling" educators without transforming the institutional environment are insufficient.

Despite differences in the prevalence of particular types of dilemmas, institutional culture remains the strongest predictor of the quality of dilemma processing across all three types of institutions. This is a crucial conclusion: no system of teacher preparation can compensate for a toxic institutional environment. Systemic efforts to transform the organizational culture of educational institutions are a precondition for the effectiveness of any individually oriented intervention.

The phenomenon of "moral burnout" among experienced educators is a troubling signal that requires further investigation. It suggests that prolonged exposure to irresolvable dilemmas without adequate support may lead not only to burnout in the conventional sense of emotional exhaustion, but also to a specific form of "moral anesthesia," namely, a diminished sensitivity to the morally significant aspects of situations. Its increasing frequency with years of service points to the need not only for initial but also for continuous support for educators, in the form of regular reflection groups, individual counseling, and organizational mechanisms that sustain moral sensitivity throughout the entire career.

The considerably lower proportion of educators across all types of institutions who had undergone systematic training in pedagogical ethics (GSE = 28%, PPH = 33%, HEIs = 41%), combined with the independent positive effect of such training on the quality of handling dilemmas, points to a substantial gap in teacher education. This conclusion is especially important for the system of pedagogical education in Ukraine, where ethics courses often remain optional or are reduced to a mere declaratory presentation of principles, without fostering practical capacities for moral judgment.

The findings are broadly consistent with international studies that regard ethical dilemmas as an everyday rather than exceptional component of pedagogical practice. In particular, Shapira-Lishchinsky (2011) has shown that critical incidents in

teachers' work most often arise at points where care, justice, institutional norms, and professional responsibility collide; at the same time, educators frequently experience powerlessness and lack adequate tools for well-grounded moral choice. The high frequency of dilemmas documented in our study across GSE, PPH, and HEIs is therefore not anomalous but confirms an internationally documented feature of the profession.

The finding concerning the decisive role of institutional culture corresponds with the conclusions of Cherkowski, Walker, and Kutsyuruba (2015), who demonstrate that the moral agency of educational leaders and the quality of ethical decision-making depend not only on the personal virtues of the leader but also on whether the institution has created an atmosphere of trust, collegiality, and inclusive decision-making. In this sense, our conclusion that no amount of individual preparation can compensate for a toxic institutional environment is not only empirically confirmed but also theoretically consistent with the broader line of scholarship on moral agency in educational leadership (Ballangrud et al., 2025; Cherkowski et al., 2015).

At the same time, our data deepen the international literature by demonstrating differences among types of educational institutions. Whereas some international studies focus either on the school level or on institutional leadership, our study traces the specificity of dilemmas across three subsystems simultaneously. This helps explain why dilemmas of academic integrity and conflict between scholarly and administrative positions are more salient in higher education, while dilemmas of care, confidentiality, and the distribution of attention predominate in general secondary education. Such differentiation does not contradict international findings, but rather specifies them within a more complex institutional configuration (Roos & Bagger, 2024).

The findings relating to inclusion and resource scarcity also correspond with contemporary Ukrainian scholarship. Diachenko, Voroshchuk, Romanova, Shevtsova, & Tretiakova (2024) emphasize that the development of inclusive education in Ukraine is constrained not only by formal barriers but, above all, by a lack of trained personnel, support resources, and coherent intersectoral coordination. This conclusion helps explain why educators in our sample so often described dilemmas not as

conflicts of principles in themselves, but as conflicts of principles under conditions of insufficient time, lack of specialists, and weak procedural support.

The identified phenomenon of moral distress and its transformation into "moral anesthesia" among more experienced educators requires separate explanation. In Fedotova's (2022) theoretical work, moral distress is understood as a condition that arises when an internally accepted moral decision cannot be realized because of external constraints. In our study, this mechanism takes on a distinctly educational meaning: educators remain in situations for long periods in which they can clearly see the ethically preferable course of action, yet lack the resources, time, or institutional mandate to implement it. It is precisely the repetition of such situations that may explain the gradual decline in the intensity of distress with years of experience, not as a sign of healthy adaptation, but as a risk of the exhaustion of moral sensitivity.

The wartime context in Ukraine is another important factor in interpreting the findings. Shelestova's work on learning losses under wartime conditions and Nadyukova & Frenzel's (2025) study on stress and coping among Ukrainian teachers show that contemporary educators work under conditions of educational disruption, psychological overload, environmental instability, and widening inequality among students. The high levels of dilemmas concerning resource allocation, care for the vulnerable, and tensions between formal requirements and actual possibilities documented in our study should therefore be explained not only by the general complexity of the teaching profession, but also by the intensification of moral burdens under wartime conditions (Nadyukova & Frenzel, 2025; Shelestova, 2023).

At the same time, the analysis also indicates what is currently lacking in both domestic and international discourse. First, there is a shortage of comparative studies that simultaneously encompass GSE, PPH, and HEIs within a single analytical framework. Second, there is limited research capable of tracing the long-term dynamics of educators' moral distress and distinguishing professional maturity from moral exhaustion. Third, within the Ukrainian context, there is still insufficient empirical description of how war, digitalization, and inclusion policy together

reshape the structure of ethical dilemmas. Our study thus partly fills this gap while also opening up perspectives for further longitudinal and cross-level research.

The study has several limitations that should be considered when interpreting the findings. Although the sample is diverse, it is not representative in the strict statistical sense, since it was constructed through purposive rather than random sampling. The quantitative data should therefore be regarded as indicative rather than as grounds for strict generalization to the entire population of educators. Self-report data, including questionnaires and interview responses, may also be affected by social desirability bias: educators may describe themselves as acting in a more morally reflective manner than they actually do in practice. The observation phase partly mitigates this risk, but it covers only a limited number of participants and situations. The study was conducted under conditions of martial law in Ukraine (since 2022), which generated specific dilemmas for traumatized learners, internally displaced persons, and distance learning under conditions of danger, which may not be fully representative of peacetime conditions. The study captures educators' perceptions and self-assessments, but does not evaluate the actual outcomes of their decisions. It therefore remains an open question whether subjectively "correct" or confident decisions are in fact more just or more effective for students. Further research may include triangulated analysis comparing educators', pupils', parents', and students' judgments of the same situations. Overall, the results support the growing consensus in international scholarship that ethical decision-making in education cannot be reduced to individual competence alone but requires systemic, institutional, and technological awareness (Biesta, 2025; Xu et.al., 2025; AlBlooshi, 2026).

Conclusions

The analysis undertaken here leads to several fundamental conclusions. Uncertainty is an inherent ontological characteristic of educational activity rather than a temporary condition that can be overcome through the accumulation of knowledge. Distinguishing among epistemic, normative, and ontological

uncertainty enables more precise analysis of the nature of specific educational dilemmas and the corresponding strategies for addressing them. Justice in education is a polysemous concept that encompasses fundamentally different understandings – equality, equity, adequacy, and equality of opportunity. None of these is sufficient in isolation; genuine educational justice requires their synthesis, with procedural justice given priority in conditions where substantive justice of outcome is unattainable.

Inclusive education is a normatively justified ideal grounded in arguments from human rights, human dignity, and social cohesion. At the same time, its implementation generates real dilemmas – above all in the distribution of teacher attention, the compatibility of different models of special needs, and cultural diversity – which require situational balancing rather than the mechanical application of principles.

The distribution of educational resources is the clearest manifestation of systemic educational injustice. Systemic mechanisms of unequal funding, which sustain and reproduce social inequality through educational inequality, are a problem that exceeds the capacities of individual actors and requires systemic responses. At the same time, the temporal dimension of distribution remains important: the evidence supporting the prioritization of investment in early development and in the most vulnerable students is both compelling and normatively significant.

The educator's role as a moral subject is central to the entire analysis. Pedagogical wisdom, as a practical virtue that enables orientation in complex situations, cannot be reduced to technical skills and is a necessary condition of morally responsible educational practice. Reflective practice and participation in collective communities of inquiry are important mechanisms for developing and maintaining pedagogical wisdom.

The digitalization of education generates new dimensions of traditional dilemmas: algorithmic bias, the digital divide, and risks to confidentiality and pedagogical autonomy all require specific normative responses that are only beginning to take shape in pedagogical and legal thought.

The study's findings enable the formulation of an integrated normative framework for pedagogical practice under conditions of uncertainty, a framework that combines prioritizing the minimization of harm to the vulnerable, procedural fairness, respect for diversity, reflective humility, and systemic responsibility. No theoretical framework can eliminate dilemmas altogether. It can, however, provide guidelines for morally responsible thought and action in a complex educational world. Promising directions for further research include: 1) longitudinal investigation tracing the development of pedagogical wisdom and moral distress across the career span; 2) comparative international research into the specificity of dilemmas across different educational systems; 3) the development and evaluation of programs designed to prepare educators to deal with dilemmatic situations; and 4) triangulated analysis of the judgments of educators, learners, and parents/employers regarding the same dilemmatic situations.

References

AlBlooshi S. (2026). Artificial intelligence in higher education, opportunities, and challenges: a review. Front. Educ. 10:1683968. https://doi.org/10.3389/feduc.2025.1683968

Aristotle. (1999). *Nicomachean Ethics* (T. Irwin, Trans.). Hackett Publishing.

Ballangrud, B. O. B., Vennebo, K. F., & Aas, M. (2025). Ethical challenges in leading school development: The role of ethical reasoning. *Educational Research*. https://doi.org/10.1080/00131881.2025.2583499

Barnett, W. S. (1995). Long-term effects of early childhood programs on cognitive and school outcomes. *The Future of Children, 5*(3), 25–50.

Barocas, S., & Selbst, A. D. (2016). Big data's disparate impact. *California Law Review, 104*, 671–732.

Biesta, G. (2025). Educational decision-making in an age of uncertainty: Beyond evidence-based simplifications. *Educational Theory*. Advance online publication. https://journals.sagepub.com/doi/10.1177/01614681251385794

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

CAST. (2018). *Universal Design for Learning guidelines version 2.2*. CAST.

Cherkowski, S. L., Walker, K. D., & Kutsyuruba, B. (2015). Principals' moral agency and ethical decision-making: Towards transformational ethics. *International Journal of Education Policy & Leadership, 10*(5).

Colquitt, J. A. (2001). On the dimensionality of organizational justice: A construct validation of a measure. *Journal of Applied Psychology, 86*(3), 386–400.

Condron, D. J., & Roscigno, V. J. (2003). Disparities within: Unequal spending and achievement in an urban school district. *Sociology of Education, 76*(1), 18–36.

Constantin, G.-D., Hoinoiu, B., Veja, I., Mazilescu, C.-A., Hoinoiu, T., Luca, R. E., Munteanu, I. R., & Oancea, R. (2025). Moral Distress in Ethical Dilemmas: A Comparative Study of Medical Students and Physicians. *Healthcare*, *13*(19), 2547. https://doi.org/10.3390/healthcare13192547

Corley, M. C., Elswick, R. K., Gorman, M., & Clor, T. (2001). Development and evaluation of a moral distress scale. *Journal of Advanced Nursing, 33*(2), 250–256. https://doi.org/10.1046/j.1365-2648.2001.01658.x

Derrida, J. (1978). *Writing and difference* (A. Bass, Trans.). University of Chicago Press.

Dewey, J. (1916). *Democracy and education*. Macmillan.

Diachenko, M., Voroshchuk, O., Romanova, T., Shevtsova, N., & Tretiakova, T. (2024). Inclusive education in Ukraine: Achievements, challenges, prospects. *Revista Eduweb, 18*(4), 35–48. https://doi.org/10.46502/issn.1856-7576/2024.18.04.3

European Agency for Special Needs and Inclusive Education. (2021). *Key principles – Supporting policy development and implementation for inclusive education: Policy brief*. https://www.european-agency.org/sites/default/files/KeyPrinciples-policybrief-EN.pdf

Fedotova, T. V. (2022). Moralnyi dystres i moralna travma osobystosti: Teoretychnyi dyskurs problemy [Moral distress and moral trauma of personality: Theoretical discourse of the problem]. *Naukovi perspektyvy, 12*(30), 529–543. https://doi.org/10.52058/2708-7530-2022-12(30)-529-543

Forlin, C. (Ed.). (2010). *Teacher education for inclusion: Changing paradigms and innovative approaches*. Routledge.

Freire, P. (1970). *Pedagogy of the oppressed* (M. B. Ramos, Trans.). Herder and Herder.

Gershenson, S., Holt, S. B., & Papageorge, N. W. (2016). Who believes in me? The effect of student-teacher demographic match on teacher expectations. *Economics of Education Review, 52*, 209–224.

Gilligan, C. (1982). *In a different voice: Psychological theory and women's development*. Harvard University Press.

Gutmann, A., & Thompson, D. (1996). *Democracy and disagreement*. Harvard University Press.

Heckman, J. J., & Masterov, D. V. (2007). The productivity argument for investing in young children. *Review of Agricultural Economics, 29*(3), 446–493.

Hehir, T., Grindal, T., Freeman, B., Lamoreau, R., Borquaye, Y., & Burke, S. (2016). *A summary of the evidence on inclusive education*. Abt Associates. https://alana.org.br/wp-content/uploads/2016/12/A Summary of the evidence on inclusive education.pdf

Hill-Berry, N. P., & Burris-Melville, T. S. (2025). When the going gets tough: Educational leadership and resilience in times of crises. *Power and Education*, *17*(2), 216-240. https://doi.org/10.1177/17577438241297242

Jackson, P. W. (1968). *Life in classrooms*. Holt, Rinehart and Winston.

Jameton, A. (1984). *Nursing practice: The ethical issues*. Prentice-Hall.

Jennings, J., & Rentner, D. S. (2006). Ten big effects of the No Child Left Behind Act on public schools. *Phi Delta Kappan, 88*(2), 110–113.

Kaplan N, Zerach G, Levi-Belz Y. (2025) The contribution of moral injury to Israeli teachers' mental health difficulties: the mediating role of shame and guilt. *Psychological Therapy and Psychosomatics*. Volume 16. https://doi.org/10.3389/fpsyt.2025.1634795

Karakuş, N., Gedik, K., & Kazazoğlu, S. (2025). Ethical decision-making in education: A comparative study of teachers and artificial intelligence in ethical dilemmas. *Behavioral Sciences, 15*(4), Article 469. https://doi.org/10.3390/bs15040469

Kauffman, J. M., & Badar, J. (2014). Better, earlier, more intensive intervention is the route to full inclusion. *Remedial and Special Education, 35*(6), 357–366.

Knight, F. H. (1921). *Risk, uncertainty and profit*. Houghton Mifflin.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465–491.

Lane, H. (1992). *The mask of benevolence: Disabling the Deaf community*. Alfred A. Knopf.

Linnik, O., Bozhynskyi, V., Hrynevych, L., Kryzhanovska, V., Nikolaiev, Ye., & Riy, G. (2024). *Education during war: The Ukrainian schools' experience. Analytical report*. Kunsht NGO; OsvitAnalytics Think Tank of Grinchenko University. https://www.skeptic.in.ua/wp-content/uploads/2024-Education-during-War-Ukrainian-Schools-Experience-EN.pdf

May, S., & Sleeter, C. E. (Eds.). (2010). *Critical multiculturalism: Theory and praxis*. Routledge.

Minorini, P. A., & Sugarman, S. D. (1999). Educational adequacy and the courts: The promise and problems of moving to a new paradigm. In H. F. Ladd, R. Chalk, & J. S. Hansen (Eds.), *Equity and adequacy in education finance: Issues and perspectives* (pp. 175–208). National Academy Press. https://doi.org/10.17226/6166

Mirea, N., Palade, M., & Gaureanu, A. (2024). STEM Education, Artificial Intelligence, and Ethical Challenges. *MakeLearn 2024: Artificial Intelligence for Human-Technologies-Economy Sustainable Development*. https://ideas.repec.org//h/tkp/mklp24/38.html

Muringa, T. P. (2025). Exploring ethical dilemmas and institutional challenges in AI adoption: A study of South African universities. *Frontiers in Education, 10*, Article 1628019. https://doi.org/10.3389/feduc.2025.1628019

Nadyukova, I., & Frenzel, A. C. (2025). Ukrainian teachers' stress and coping during the war: Results from a mixed methods study. *Teaching and Teacher Education, 157*, 104941. https://doi.org/10.1016/j.tate.2025.104941

Noddings, N. (1984). *Caring: A feminine approach to ethics and moral education*. University of California Press.

Nussbaum, M. C. (1995). *Poetic justice: The literary imagination and public life*. Beacon Press.

Nussbaum, M. C. (2011). *Creating capabilities: The human development approach*. Harvard University Press.

O'Neill, O. (2002). *A question of trust*. Cambridge University Press.

Oberg, G. (2025). Moral injury in teaching: the systemic roots of ethical conflict and emotional burnout in education. *Educational Review*, 1–24. https://doi.org/10.1080/00131911.2025.2504523

OECD. (2023). *Equity and inclusion in education: Finding strength through diversity*. OECD Publishing. https://doi.org/10.1787/e9072e21-en

Oliver, M. (1990). *The politics of disablement*. Macmillan.

Pasquale, F. (2015). *The black box society: The secret algorithms that control money and information*. Harvard University Press.

Rawls, J. (1971). *A theory of justice*. Harvard University Press.

Roos, H., & Bagger, A. (2024). Ethical dilemmas and professional judgment as a pathway to inclusion and equity in mathematics teaching. *ZDM – Mathematics Education, 56*, 435–446. https://doi.org/10.1007/s11858-023-01540-0

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.

Sen, A. (1999). *Development as freedom*. Anchor Books.

Shapira-Lishchinsky, O. (2011). Teachers' critical incidents: Ethical dilemmas in teaching practice. *Teaching and Teacher Education, 27*(3), 648–656. https://doi.org/10.1016/j.tate.2010.11.003

Shelestova, L. V. (2023). Navchalni vtraty uchniv v umovakh viiny: Sutnist, diahnostyka ta shliakhy podolannia [Students' learning losses under wartime conditions: Essence, diagnosis, and ways of overcoming]. *Pedahohichni innovatsii: Idei, realii, perspektyvy, 1*(30), 62–72. https://doi.org/10.32405/2413-4139-2023-1(30)-62-72

Simon, H. A. (1955). A behavioral model of rational choice. *The Quarterly Journal of Economics, 69*(1), 99–118.

Tyler, T. R. (1990). *Why people obey the law*. Yale University Press.

UNESCO. (1994). *The Salamanca statement and framework for action on special needs education*. UNESCO.

UNESCO. (2023). *Guidance for generative AI in education and research*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000386693

UNICEF. (2021, March 2). *COVID-19 and school closures: One year of education disruption*. https://data.unicef.org/wp-content/uploads/2021/03/COVID19-and-school-closures-report.pdf

United Nations. (2006). *Convention on the rights of persons with disabilities*. https://www.un.org/disabilities/documents/convention/convoptprot-e.pdf

Webster, D., & Geron, T. (2025). Impacts to Teachers' Process of Ethical Decision-Making: How the Online Classroom Changes Phronesis. *Teachers College Record: The Voice of Scholarship in Education*, *127*(8), 51-71. https://doi.org/10.1177/01614681251385794

World Health Organization. (2023). *Considerations for implementing and adjusting public health and social measures in the context of COVID-19* (WHO/2019-nCoV/Adjusting_PH_measures/2023.1). https://iris.who.int/bitstream/handle/10665/366669/WHO-2019-nCoV-Adjusting-PH-measures-2023.1-eng.pdf?sequence=1

Xu, X., Meng, F., & Gou, Y. (2025). From Theoretical Navigation to Intelligent Prevention: Constructing a Full-Cycle AI Ethics Education System in High.er Education. *Education Sciences*, *15*(9), 1199. https://doi.org/10.3390/educsci15091199

Chapter 2. RISK MANAGEMENT AND CONTINUITY OF THE EDUCATIONAL PROCESS THROUGH SCENARIO PLANNING AND RESPONSE TRIGGERS

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***Abstract**. The study addresses the problem of ensuring the continuity of the educational process in higher education institutions (HEIs) under conditions of a compound crisis – specifically, the simultaneous occurrence of a pandemic and an armed conflict, as experienced in Ukraine during 2020–2025. The primary objective was to develop and experimentally verify an integrated risk management model based on scenario planning and a trigger-response system designed to maintain educational continuity regardless of the nature or scale of the crisis. A mixed-methods research design was employed, combining a quasi-experimental pedagogical intervention with quantitative surveys, semi-structured interviews, focus groups, document analysis, and structured observation; the study was conducted at the National University of Life and Environmental Sciences of Ukraine with a total sample of 535 participants, including academic staff, administrative personnel, and students. Diagnostic findings revealed a critically low baseline level of institutional readiness (Overall Readiness Index M = 2.39 out of 5.00), with 84.3% of respondents confirming the absence of a documented Business Continuity Plan. A four-level color-coded trigger-response system (green/yellow/orange/red) and four scenario protocols were introduced in the experimental group during the formative stage (2021–2023) and applied in real crisis events, including large-scale power outages, cyberattacks, and active hostilities near Kyiv. Control-stage measurements (2024–2025) demonstrated statistically significant improvements across all indicators in the experimental group compared to the control group ($p < .001$), with very large effect sizes (Cohen's $d = 1.67–2.21$); the Overall Readiness Index rose from 2.41 to 4.12 (+71.0%), while the mean crisis response time decreased from 18.3 to 3.7 hours (−79.8%). The study identified two novel phenomena specific to prolonged crisis contexts: trigger fatigue (declining protocol adherence after repeated activations) and readiness asymmetry (higher compliance among administrative staff than among academic staff and*

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students). The proposed Educational Business Continuity Planning (EdBCP) model advances existing scholarship by integrating bidirectional trigger transitions – covering not only escalation but also structured de-escalation – and by providing an empirically validated operational toolkit applicable to HEIs operating in high-risk environments..

***Keywords**: risk management in higher education; educational continuity; scenario planning; trigger-response system; emergency remote teaching; business continuity planning; crisis management; armed conflict and education; pandemic resilience; EdBCP.*

Introduction

Rapid changes in the global security and epidemiological environment during 2020–2025 have posed unprecedented challenges to the higher education system. The COVID-19 pandemic, which spread worldwide in 2020, disrupted higher education institutions (HEIs) across more than 180 countries, forcing them to rapidly transition to distance learning without adequate regulatory, technical, and methodological support. According to international research, the quality of the educational process significantly declined in the majority of HEIs (Marinoni et al., 2020).

In Ukraine, the situation was further exacerbated by the outbreak of the full-scale armed conflict in February 2022, which led to a fundamental transformation of the conditions for educational activities: partial destruction of university infrastructure, mass displacement of participants in the educational process, and the need to ensure the safety of students and academic staff under conditions of constant threat (UNESCO & IIEP, 2023). The psychological consequences of these crises for participants in the educational process are substantial: studies indicate a sharp increase in anxiety, post-traumatic stress, and emotional burnout (Bihun et al., 2022).

These circumstances revealed a systemic unpreparedness of most HEIs to manage risks under emergency conditions, manifested in the absence of clear response protocols, documented business continuity plans for the educational process, and defined criteria and mechanisms for transitioning between different modes of instruction. Strategic risk management is an integral component of organizational management (Kaplan &

Mikes, 2012; Weick & Sutcliffe, 2007). In most cases, responses to crisis events were reactive rather than preventive, significantly reducing the quality of education and academic integrity (Hodges et al., 2020; Crawford et al., 2020). Education in emergency contexts requires fundamentally different approaches compared to conventional distance learning (Education Cannot Wait, 2020).

Given the prolonged nature of martial law and the persistence of various threats (security, technological, and epidemiological), the development of systemic mechanisms for risk management and the continuity of the educational process is becoming strategically important for Ukrainian HEIs. Particular attention should be paid to an approach based on scenario planning and the use of response triggers tools that enable advance preparation for different crisis scenarios and establish clear conditions and sequences of managerial actions (Schwartz, 1991; van der Heijden, 1996).

The issue of risk management in higher education has received considerable attention in the international academic literature. The theoretical foundations of risk management in educational organizations have been explored by Levine and Van Pelt (2021), who conceptualize the university as an institution with heightened vulnerability to external shocks and identify the key components of HEI resilience. Tierney (2006) thoroughly examined issues of trust and academic culture, which influence universities' capacity for adaptation. Trow (2007) analyzed the transformation of higher education from an elite to a mass model, along with the associated challenges.

A systemic approach to ensuring organizational continuity (Business Continuity Management, BCM) in non-profit organizations, including educational institutions, was developed in the work of Smith and Elliott (2006), who adapted classical BCM tools to the specific context of the public sector; the prerequisites of this approach for organizations with global missions were analyzed by Bikson et al. (2003). Unpredictable events as a challenge to organizational resilience were comprehensively examined by Weick and Sutcliffe (2007).

The concept of scenario planning as a tool of strategic management under conditions of uncertainty has been

comprehensively developed by Schwartz (1991) and van der Heijden (1996). In particular, Schwartz developed a methodology for constructing alternative future scenarios by identifying key driving forces and uncertainties. Further developing Shell's approach to scenario planning, van der Heijden demonstrated its effectiveness for institutional strategic management. The application of the scenario-based approach in higher education was examined by Rowley and Sherman (2001), who developed scenario matrices for universities under conditions of changing funding structures and demographic fluctuations.

Numerous publications have addressed the impact of the COVID-19 pandemic on the higher education system. In particular, Hodges et al. (2020) distinguished between planned distance learning and the forced transition to online formats (Emergency Remote Teaching), emphasizing the fundamental differences in quality and preparedness. Crawford et al. (2020) conducted a comparative analysis of university response strategies across 20 countries and found that institutions with pre-established continuity plans demonstrated significantly higher academic performance outcomes. The expansion of blended learning as a flexible response strategy has been explored by Dziuban et al. (2018) and Garrison and Vaughan (2008). The impact of the pandemic on Malaysian HEIs was studied by Nordin and Nordin (2020), who identified similar patterns of systemic unpreparedness. The global dimensions of the pandemic's impact on higher education have been documented by the OECD (2020a; 2020b). WHO recommendations on emergency response include principles applicable to the management of educational organizations (WHO, 2017; WHO, 2021; WHO, 2023).

In the context of armed conflicts and their impact on education systems, it is important to highlight the study by UNESCO and IIEP (2023), which summarizes the experience of ensuring educational continuity under wartime conditions in Syria, Iraq, Afghanistan, and other countries. In particular, it was found that the key factors for maintaining the educational process include decentralization of managerial decision-making, multi-channel delivery of education, and pre-developed protocols for transitioning between formats.

Hryniuk et al. (2021) comprehensively examined issues in higher education under quarantine conditions. Education management in crisis contexts was studied by Luhovyi and Talanova (2021), who analyzed the adaptive capacity of Ukrainian universities amid European integration and wartime challenges. The digitalization of the educational process and distance learning were explored by Tverezovska et al. (2022), Shyshkina (2020), Bykov and Spirin (2019), and Bykov (2008), who focused on models of organizational systems of open education. Subota et al. (2022) investigated information technologies as a means of overcoming socio-cultural barriers in education. Educational systems in EU countries were analyzed in a comparative context by Sysoieva and Krystopchuk (2012). Managerial aspects of ensuring the quality of education under emergency conditions were addressed in the works of Kalashnykova (2022) and Reheilo (2023). However, the integrated combination of risk management, scenario planning, and response trigger systems to ensure the continuity of the educational process remains insufficiently explored in national research.

Despite the substantial body of scholarly work on related issues, a number of questions remain insufficiently developed. First, there is no integrated model for managing risks to the continuity of the educational process in HEIs that combines scenario planning with an operational trigger system for transitions between different modes of instruction. Second, existing approaches to Business Continuity Management (BCM) have been developed primarily for business organizations and require substantial adaptation to the specific context of higher education institutions, particularly under martial law (Smith & Elliott, 2006; Hodges et al., 2020). Third, there is a lack of empirical studies on the effectiveness of trigger-based response systems under conditions of chronic crisis, which has been characteristic of Ukraine throughout 2022–2024. Fourth, scientifically grounded criteria and threshold values for activating managerial decisions regarding changes in the format of the educational process have not yet been developed.

Given these gaps, it is necessary to systematize the risks threatening the continuity of the educational process in HEIs under conditions of pandemic and martial law; to develop a conceptual

model for ensuring the continuity of the educational process (EdBCP) based on scenario planning; to substantiate a system of response triggers as a mechanism for transitioning between scenarios; to experimentally verify the effectiveness of the proposed model on the basis of higher education institutions; and to conduct a comparative analysis of the obtained results against international and national experience.

The aim of this study is to develop and experimentally validate a model for managing risks to the continuity of the educational process in higher education institutions, based on scenario planning and a system of response triggers under emergency conditions (using the National University of Life and Environmental Sciences of Ukraine as a case study for the period 2020–2025).

Research results

The study was conducted at the National University of Life and Environmental Sciences of Ukraine (NUBiP of Ukraine) from 2020 to 2025. NUBiP of Ukraine is one of the largest agrarian universities in the country, with an extensive structure of faculties, institutes, and affiliated units, which results in increased organizational complexity in managing the educational process under crisis conditions. The university operated under both types of crises examined in this study: the transition to distance learning due to the COVID-19 pandemic (2020–2021) and the adaptation of the educational process to the conditions of martial law (2022–2025).

Three participant groups were involved in the study: academic staff, administrative personnel, and students. The sample was formed using a stratified sampling approach, accounting for faculty affiliation, position level, and mode of study. The total sample size was 535 individuals, of whom 265 were assigned to the experimental group and 270 to the control group. A detailed distribution of participants by category is presented in Table 1.

The inclusion criteria for the sample were as follows: for academic staff – at least one year of teaching experience under

distance or blended learning conditions; for administrative personnel – direct involvement in managerial decision-making related to the organization of the educational process; for students – enrollment in full-time or part-time higher education programs throughout the entire study period or a substantial part of it. The exclusion criteria included: lack of consent to participate in the study and incomplete completion of data collection instruments (omission of more than 15% of questionnaire items).

Table 1
Distribution of study participants by categories and groups

Category of participants	*Experimental group (n)*	*Control group (n)*	*Total (n)*
Academic staff	60	61	121
Administrative personnel	23	23	46
Students	182	186	368
Total	**265**	**270**	**535**

Source: compiled by the authors.

A mixed-methods research design was employed, specifically an explanatory sequential design, in which quantitative data were collected and analyzed at the first stage, followed by qualitative methods at the second stage for in-depth interpretation of the results (Creswell & Plano Clark, 2018). The choice of the mixed design was substantiated in accordance with the methodological principles outlined by Tashakkori and Teddlie (2010) and Johnson and Onwuegbuzie (2004). The study comprised three consecutive stages: diagnostic (2020–2021), formative (2022–2023), and control (2024–2025).

At the diagnostic stage, the baseline level of HEIs' readiness for risk management and ensuring the continuity of the educational process was assessed. During the formative stage, the author's model of scenario planning with a system of response triggers was implemented in the experimental group, while the control group continued to operate within existing institutional approaches without targeted intervention. At the control stage, indicators were repeatedly measured in both groups to evaluate the effectiveness of the implemented model.

A combination of mutually complementary methods was used to gather empirical data, ensuring data triangulation and

enhancing the reliability and validity of the findings. During the diagnostic and control phases, questionnaire surveys, semi-structured interviews, focus groups, document analysis, and structured observation were applied. In the formative phase, a pedagogical experiment was conducted that involved implementing the author-developed model of scenario planning and a system of response triggers.

The author-developed questionnaire on HEIs' readiness for managing risks to the continuity of the educational process was designed based on a theoretical model and included 42 items grouped into five thematic blocks: 1) institutional readiness for crisis situations; 2) availability and quality of continuity plans; 3) technological support for distance learning; 4) communication and coordination under crisis conditions; and 5) psychological readiness of participants in the educational process. Responses were recorded using a five-point Likert scale (1 – «strongly disagree» to 5 – «strongly agree»). The reliability of the instrument was assessed using Cronbach's alpha coefficient (α = 0.87), indicating a high level of internal consistency.

Semi-structured individual interviews were conducted with representatives of administrative personnel (n = 18) and academic staff (n = 24). Each interview lasted 45–60 minutes. In addition, four focus groups were conducted with students (8–10 participants in each group). All interviews and focus groups were audio-recorded with participants' consent, transcribed, and subjected to thematic analysis (Braun & Clarke, 2006). The qualitative research methodology was grounded in the principles outlined by Bryman (2016) and Charmaz (2014).

Document analysis covered the university's internal regulatory framework for the period 2020–2025, including the rector's orders on organizing the educational process under emergency conditions, minutes of academic council meetings, operational plans for transitioning between learning formats, and reports on the implementation of educational programs. The documents were analyzed using an author-developed content analysis matrix comprising 18 categories.

Structured observation was conducted by monitoring real managerial decisions during crisis events (air raid alerts, power

outages, and cyberattacks on the university's information systems). The recorded parameters included response time, compliance with protocols, and communication quality between units.

Quantitative data were processed using IBM SPSS Statistics 27.0 (Field, 2018). Descriptive statistics included the calculation of means (M), standard deviations (SD), and 95% confidence intervals (CI). The normality of data distribution was tested using the Kolmogorov–Smirnov test. Comparisons between the experimental and control groups were performed using the independent-samples t-test (for normally distributed data) or the Mann–Whitney U test (for non-normally distributed data). Within-group comparisons before and after the intervention were conducted using the paired samples t-test or the Wilcoxon signed-rank test, respectively. The level of statistical significance was set at $p < 0.05$. Effect size was assessed using Cohen's d (Cohen, 1988), and meta-analytical standards proposed by Hattie (2009) were used to interpret intervention effects. The overall methodology for evaluation in mixed-methods educational research is described by Mertens (2015).

Qualitative data were analyzed using thematic analysis following the procedure of Braun and Clarke (2006), ensuring intercoder reliability (Cohen's kappa $\kappa > 0.75$).

The study was conducted in accordance with the internal regulations of the National University of Life and Environmental Sciences of Ukraine and generally accepted ethical principles for research involving human participants. Prior to data collection, all potential participants were informed about the purpose, objectives, and procedures of the study, the voluntary nature of participation, and their right to refuse or withdraw consent at any stage, without providing reasons or consequences.

Participation in the study was entirely voluntary. Written or electronic informed consent was obtained from each participant for participation in the study and for the processing of anonymized data for scientific purposes. Respondents' anonymity was ensured through the assignment of coded identifiers; personal data were neither recorded nor stored. The confidentiality of information

obtained during interviews and focus groups was guaranteed by not disclosing personalized statements in publications.

Additional consent procedures were applied for participants involved in the pedagogical experiment. Academic staff and administrative personnel engaged in the formative stage were separately informed about the nature of the experimental intervention, the implementation of a scenario planning model, and a system of response triggers, and its distinction from routine professional activities. Students involved in observation and survey procedures within the experiment were provided with explanations regarding the educational and research context of their participation. For students who had not reached the age of majority at the start of the study, consent was obtained from parents or legal guardians. No academic advantages or negative consequences were associated with participation or refusal to participate in the experiment.

The study's results were not used to evaluate the participants' academic performance or professional activity. Data collection and storage were carried out in accordance with the academic integrity requirements of the National University of Life and Environmental Sciences of Ukraine and the provisions of the Law of Ukraine "On Personal Data Protection."

Risk management in higher education primarily involves the clear identification and systematization of threats that may disrupt the normal functioning of the educational process. Within this study, an author-developed classification of risks to the continuity of the educational process in HEIs was proposed, based on the synthesis of four conceptual sources: the international standard ISO 22301:2019 (Business Continuity Management Systems), FEMA methodological guidelines on emergency management (FEMA, 2021), UNESCO guidelines on education in emergencies (UNESCO & IIEP, 2023), as well as the author's own conceptualization that takes into account the specific context of Ukraine during 2020–2025.

ISO 22301:2019 defines continuity as the ability of an organization to continue delivering products and services at an acceptable predefined level following a disruptive incident. Adapting this approach to the educational domain requires

reinterpreting the concept of "services" as the educational process and the "acceptable level" as the minimum sufficient conditions for teaching and assessment. FEMA distinguishes four phases of emergency management-mitigation, preparedness, response, and recovery – which in this study are used as a framework for describing HEI action protocols at each trigger level. UNESCO emphasizes the need to ensure accessibility, quality, and the protection of participants in the educational process, even in the context of humanitarian crises.

Based on these sources, six groups of risks to the continuity of the educational process in HEIs were identified (Table 2).

Table 2

Classification of risks to the continuity of the educational process in HEIs

Risk group	*Type of risk*	*Characteristics*	*Source of classification*
Epidemi-ological	Pandemic/mass disease outbreak	sudden large-scale disruption of the educational process, transition to distance learning formats	WHO; UNESCO, 2023
Military-security	Armed conflict, occupation, shelling	threat to the physical safety of participants in the educational process, destruction of infrastructure	FEMA, 2021; author's classification
Technological	Power outages, cyberattacks, and it system failures	disruption of the technological infrastructure of distance learning	ISO 22301: 2019
Organizational-managerial	Lack of BCP plans, staff unpreparedness	institutional inability to respond to crises in a timely manner	ISO 22301: 2019; author's classification
Socio-psychological	Stress, burnout, mass displacement	decreased learning motivation, academic disengagement, dropouts	UNESCO, 2023; author's classification
Regulatory-legal	Changes in le–gislation under emergency conditions	inconsistency of educational programs and procedures with new legal requirements	author's classification

Note: ES – emergency situation; BCP – Business Continuity Plan. Compiled by the authors based on ISO 22301:2019; FEMA, 2021; UNESCO & IIEP, 2023.

Source: compiled by the authors.

The period 2020–2025 is characterized by Ukrainian HEIs by a unique combination of simultaneously operating risks from different groups, which significantly distinguishes this context from most international counterparts. While the pandemic crisis of 2020–2021 affected universities worldwide, the combination of military-security, technological, and socio-psychological risks that emerged after February 2022 is specific to the Ukrainian context and has no direct parallels in contemporary academic literature.

An analysis of documents from the National University of Life and Environmental Sciences of Ukraine for 2020–2025 indicates that the university faced all six identified risk groups during the study period. In particular, more than 1,400 air raid alerts were recorded between 2022 and 2024, requiring the immediate interruption of classes; large-scale forced displacement of students and academic staff was observed (according to various estimates, up to 30–35% of the cohort relocated abroad or to safer regions); the university experienced several cyberattacks on its information infrastructure; and a significant increase in обращения to psychological support services was documented due to emotional burnout and stress. The role of digital technologies in ensuring the educational process under crisis conditions has been examined by Dede (2010) and Albion et al. (2015). Similar patterns of vulnerability in educational systems across countries have been reported by Gritsenchuk and Malytska (2021) and Sysoieva and Krystopchuk (2012).

The concept of Business Continuity Management (BCM) has traditionally been developed for commercial organizations and aimed at minimizing losses from operational disruptions. The foundations of this approach were analyzed by Bikson et al. (2003). However, its adaptation to the educational sector is a relatively new research direction that has been intensively developing following the COVID-19 pandemic. Smith and Elliott (2006) were among the first to propose a BCM model for public organizations, although the educational dimension in their concept remained peripheral. A more targeted approach was proposed by Rowley and Sherman (2001), who defined strategic resilience as a university's ability to maintain its mission and core functions under conditions of turbulence.

Within the framework of this study, the concept of "educational process continuity" (Educational Business Continuity Planning, EdBCP) is proposed as the systemic capacity of HEIs to ensure the implementation of educational programs at a minimally acceptable level of quality and accessibility, regardless of the nature and scale of a crisis situation. The key distinction between EdBCP and classical BCM lies in prioritizing educational outcomes and participants' well-being in the educational process over the organization's financial and operational performance.

The author's EdBCP concept предусматривает a three-level architecture of continuity management that corresponds to the hierarchical structure of HEIs. Each level is characterized by a specific management objective, a set of measures, and a defined set of responsible actors (Table 3). The coordination of actions across all three levels is a necessary condition for the effective functioning of the EdBCP system.

Table 3
Three-level architecture of EdBCP in a higher education institution

EdBCP level	*Management object*	*Key measures*	*Responsible actors*
Institutional	HEI as an organization	development and updating of BCP, allocation of resources, coordination of units	rectorate, academic council
Program	educational programs and curricula	adaptation of programs to learning formats, adjustment of timelines, assessment	deans, departments
Instructional	individual courses and classes	selection of teaching forms and methods, ensuring feedback with students	academic staff

Note: EdBCP – Educational Business Continuity Planning; academic staff – teaching and research personnel. Compiled by the authors

Source: compiled by the authors.

The institutional level defines the overall strategy and the provision of resources for continuity. The program level ensures that educational programs adapt to changing conditions without compromising their integrity or accreditation requirements. The instructional level implements direct interaction with students

under crisis conditions. The experience of the National University of Life and Environmental Sciences of Ukraine indicates that the program level is the most vulnerable under crisis conditions, primarily due to the insufficient flexibility of regulatory requirements regarding the content and timelines of educational programs.

Scenario planning as a tool of strategic management under conditions of uncertainty gained widespread recognition following the seminal works of Schwartz (1991) and van der Heijden (1996). The core idea of this approach is to abandon attempts to predict a single "most likely" future and instead develop several alternative scenarios that cover a range of possible developments. Preparing for multiple scenarios simultaneously enhances organizational flexibility and reduces the risk of being caught unprepared by crisis situations (van der Heijden, 1996).

In the field of higher education, scenario planning was primarily used for long-term strategic planning prior to the pandemic, addressing demographic changes, labor market transformation, and digitalization (Rowley & Sherman, 2001; Bykov & Spirin, 2019; Bykov, 2008). After 2020, it gained new significance as a tool for operational crisis management. Crawford et al. (2020) demonstrated that universities with pre-developed scenario plans for transitioning to distance learning experienced significantly shorter periods of "transition chaos" compared to those that responded situationally. Flipped and hybrid learning as elements of flexible response strategies have been explored by Zainuddin et al. (2019) and Anderson and Dron (2011).

The author's model of scenario planning for HEIs synthesizes the approaches of Schwartz (1991), van der Heijden (1996), and the FEMA methodology (2021), and includes five stages: 1) identification of driving forces and key uncertainties; 2) definition of the axes of the scenario space; 3) development of four baseline scenarios; 4) formulation of action protocols for each scenario; and 5) establishment of triggers for transitions between scenarios.

The concept of a «response trigger» is derived from emergency management methodology (FEMA, 2021) and adapted to the specific context of educational management. In this study, a response trigger is defined as a pre-established condition or set

of conditions, the attainment of which automatically or directive-based initiates the transition of an HEI to a corresponding mode of functioning of the educational process. Unlike situational managerial decisions, triggers ensure predictability, speed, and coordination in responding to crisis events.

The developed authorial system includes four trigger levels corresponding to four baseline crisis development scenarios. Each level is identified by a color code, which simplifies communication among university units under heightened stress. The characteristics of these levels are presented in Table 4.

Table 4

HEI response trigger system for crisis situations

Level	*Name*	*Activation conditions*	*Mode of educational process*	*Response time*
1	Green (normal operation)	no threats; stable functioning	face-to-face and/or blended learning in full capacity	–
2	Yellow (heightened readiness)	isolated incidents; warnings of potential threats; local disruptions	blended learning with a transition to distance components; backup communication channels	24–48 hours
3	Orange (partial crisis)	regular security threats; mass power outages; up to 30% of staff unavailable	full transition to asynchronous distance learning; simplified assessment procedures	4–12 hours
4	Red (full crisis)	active hostilities in immediate proximity; complete loss of infrastructure; evacuation	suspension or minimization of the educational process; activation of safety protocols	immediate

Note: Response time refers to the maximum allowable interval between the identification of a trigger condition and the initiation of the transition to the corresponding mode. Compiled by the authors based on FEMA (2021) and ISO 22301:2019

Source: compiled by the authors.

The four baseline scenarios of the author's model form a matrix that encompasses the entire spectrum of possible states of the educational environment, from normal operation to full crisis. The scenario matrix was constructed along two axes of uncertainty identified based on the analysis of the risk landscape of the National University of Life and Environmental Sciences of Ukraine: (1) the level of physical safety of participants in the educational process and (2) the level of availability of technological infrastructure for learning. The characteristics of the scenarios and the corresponding management priorities are presented in Table 5.

Table 5

Scenario matrix of educational process continuity

Scenario	*Trigger level*	*Situation characteristics*	*Management priorities*
C-1: "Stability"	green	normal functioning of the HEI; minimal risks	development; quality; innovation
C-2: "Adaptation"	yellow	limited threats; partial disruptions; need for flexibility	flexibility; communication; resource reallocation
C-3: "Crisis management"	orange	systemic disruptions; large-scale threats to safety or infrastructure	safety; continuity; loss minimization
C-4: "Recovery"	transition from red	completion of the acute phase of the crisis; gradual normalization	recovery; reintegration; psychological support

Note: C – scenario. Transitions between scenarios are carried out according to the trigger system (Table 5). Compiled by the authors

Source: compiled by the authors

For each scenario, a detailed action protocol was developed, covering three dimensions of management: organizational (distribution of responsibilities and activation of backup structures), technological (list of tools and platforms and backup communication channels), and pedagogical (adaptation of teaching, control, and assessment formats). In particular, scenario C-3 ("Crisis management") предусматривает a full transition to asynchronous learning using Moodle as the primary platform, with email and messaging applications as backup communication channels, and the introduction of a simplified cumulative assessment system without mandatory synchronous examinations.

A key feature of the proposed model is the bidirectionality of trigger transitions: the system provides not only an algorithm for shifting to a more restrictive mode in the event of deterioration, but also a clear protocol for a gradual return to normal functioning upon stabilization. This distinguishes the proposed approach from most reactive crisis management models, which are focused solely on response rather than recovery.

The diagnostic stage of the study covered 2020, the period coinciding with the onset of the COVID-19 pandemic, which marked the first large-scale stress test for the higher education system in Ukraine. This made it possible to capture the baseline level of HEIs' readiness for risk management directly under real crisis conditions rather than in routine settings, thereby significantly enhancing the ecological validity of the diagnostic data. Surveys, interviews, and document analysis were conducted in parallel in both the experimental and control groups to ensure the comparability of baseline indicators.

The survey results using the author-developed questionnaire on HEIs' readiness to manage risks to the continuity of the educational process (n = 535) indicated an overall low level of institutional readiness across most measured constructs. The mean values of the five questionnaire blocks and the overall readiness index (ORI) for the total sample at the beginning of the diagnostic stage are presented in Table 6.

The lowest scores were recorded for the block «Availability and quality of continuity plans» (M = 1.87; SD = 0.74), corresponding to a critical level of readiness. Document analysis of the university confirmed these findings: as of early 2020, the National University of Life and Environmental Sciences of Ukraine lacked a documented educational continuity plan, clear protocols for transitioning between learning formats, and an approved system for distributing responsibilities under emergency conditions.

Table 6

Indicators of HEIs' readiness for risk management at the diagnostic stage (2020, n = 535)

Readiness indicator	*M*	*SD*	*95% CI*	*Level*
Institutional readiness for crisis situations	2.41	0.68	[2.28; 2.54]	low
Availability and quality of continuity plans	1.87	0.74	[1.72; 2.02]	critical
Technological support for distance learning	2.93	0.81	[2.77; 3.09]	moderate
Communication and coordination under crisis conditions	2.18	0.72	[2.04; 2.32]	low
Psychological readiness of participants	2.56	0.79	[2.40; 2.72]	low
Overall readiness index (ORI)	2.39	0.55	[2.28; 2.50]	low

Note: M – mean; SD – standard deviation; CI – confidence interval; scale range: 1–5 (minimum–maximum level of readiness). No statistically significant differences were observed between the experimental and control groups at the diagnostic stage (p > 0.05). Compiled by the authors

Source: compiled by the authors.

The relatively higher level of technological support (M = 2.93) can be explained by the prior implementation of the Moodle learning management system; however, the actual competencies of academic staff in its effective use remained insufficient. Similar findings regarding ICT readiness among teaching staff have been reported in international studies (Albion et al., 2015; Anderson & Dron, 2011).

Thematic analysis of interview materials (n = 42) and focus groups (n = 4) enabled the identification of key vulnerabilities in the management system of the educational process under crisis conditions. The results of content analysis of university documents across 18 categories revealed the systemic nature of most gaps: they were not the result of isolated managerial shortcomings but rather reflected the absence of a comprehensive risk management culture within the organization. The summarized data on the identified vulnerabilities are presented in Table 7.

Table 7

Key vulnerabilities of the educational process management system (diagnostic stage, 2020)

Identified vulnerability	*Frequency of occurrence (% of respondents)*	*Priority of mitigation*
Lack of a documented BCP plan	84.3	critical (to be addressed at the beginning of the formative stage)
Absence of clear criteria for transitions between learning modes	79.1	critical
Insufficient preparedness of academic staff for distance learning	67.4	high
Lack of backup communication channels	61.8	high
Insufficient student awareness of actions in emergency situations	58.2	moderate
Lack of psychological support under crisis conditions	52.6	moderate

Note: Percentage of respondents who confirmed the presence of the respective vulnerability; n = 535. Compiled by the authors

Source: compiled by the authors

The data presented in Table 8 indicate that the most critical issues are systemic planning gaps: 84.3% of respondents confirmed the absence of a documented BCP, while 79.1% reported the lack of clear criteria for transitioning between learning modes. Qualitative interview data complement this picture: the majority of administrative staff noted that decisions on changes to learning formats during the pandemic were made in a "manual mode," without predefined criteria or procedures, resulting in significant delays and contradictory directives. Similar problems have also been documented in Ukrainian HEIs (Voliarska, 2020).

The formative stage spanned the years 2021–2023 and comprised four consecutive sub-stages of implementing the author's model in the experimental group.

At the first sub-stage, management staff were trained, the university's Business Continuity Plan (BCP) was developed, and trigger conditions were identified. At the second sub-stage, pilot testing of the system was conducted under pandemic restrictions, and the protocols were adjusted accordingly. At the third sub-stage, the model was applied in a full-scale invasion context. At the fourth sub-stage, the model was refined based on reflection outcomes, training for academic staff and students was expanded, and key procedures were integrated into the university's internal regulations.

Throughout this period, the control group continued to operate within the existing institutional frameworks without targeted intervention, creating the conditions for a natural quasi-experiment.

The response trigger system was officially implemented in the experimental group in September 2021, following the completion of sub-stage F-1. The implementation included three components: (1) approval of the regulatory document "Regulations on the Response Trigger System of NUBiP of Ukraine" at the level of the Academic Council; (2) technical configuration of automated notifications through the university's corporate management system; and (3) проведение practical training sessions for all categories of participants in the experimental group on actions required at each trigger level.

The first real test of the system occurred during the escalation of the pandemic situation in December 2021, when the level 2 (yellow) trigger was activated within 3.1 hours after receiving the official notification from the Ministry of Health of Ukraine regarding the introduction of new restrictions. In the control group, the transition to a blended learning format under similar conditions took an average of 22.4 hours. Following the full-scale invasion in February 2022, the trigger system underwent its most rigorous test: during 2022–2023, a total of 14 trigger activations were recorded, including 6 at level 3 (orange) and 2 at level 4 (red).

Training for managerial personnel was conducted in both face-to-face and дистанційні formats, totaling 32 academic hours. The training program covered the theoretical foundations of risk

management in education, practical exercises for each scenario, simulation-based trigger-activation exercises, and case analyses of international university practices. Based on pre- and post-training assessments of administrative staff ($n = 23$), a statistically significant increase in knowledge related to educational continuity management was observed: the mean score increased from 3.2 ± 0.6 to 4.7 ± 0.4 ($t(22) = 9.84$; $p < 0.001$; $d = 2.06$). For academic staff involved in the formative stage, separate methodological workshops were conducted on adapting teaching under different trigger levels (a total of 8 workshops, 187 participants). The use of ICT in education under crisis conditions has been explored by Tverezovska et al. (2022) and Subota et al. (2022).

The control stage began in 2024 and involved repeated measurement of the full set of indicators in both groups using the same instruments as at the diagnostic stage. This ensured the validity of comparisons between baseline and final values. The repeated survey was conducted in two rounds: the first at the beginning of 2024 (after completion of the active phase of the formative stage), and the second at the beginning of 2025 (to assess the stability of the intervention effects). No statistically significant differences were found in the indicators of the experimental group between the two rounds of control measurement ($p > 0.05$), indicating the stability of the achieved results.

The aggregated results of the comparison of key indicators between the experimental and control groups before and after the intervention are presented in Table 8. For all indicators, the independent samples Student's t-test was applied (after testing for normality using the Kolmogorov–Smirnov test). The level of statistical significance was set at $p < 0.05$; effect size was assessed using Cohen's d (small effect: $d \geq 0.2$; medium: $d \geq 0.5$; large: $d \geq 0.8$).

To assess the operational effectiveness of the response trigger system, an analysis was conducted of four real crisis events that occurred during the formative and control stages and involved both groups.

Table 8

Comparison of key indicators in the experimental and control groups before and after the intervention

Indicator	*EG before (M±SD)*	*EG after (M±SD)*	*CG before (M±SD)*	*CG after (M±SD)*	*p*	*Cohen's d*
Overall readiness index (1–5)	2.41± 0.55	4.12± 0.43	2.38± 0.57	2.74± 0.61	<0.001	1.84
Response time to trigger activation (hours)	18.3± 4.2	3.7± 1.1	17.9± 4.6	14.2± 3.8	<0.001	2.21
Quality of the educational process under crisis conditions (1–5)	2.18± 0.64	3.89± 0.51	2.21± 0.67	2.58± 0.72	<0.001	1.67
Coverage by BCP protocols (%)	–	87.4± 6.2	–	31.6± 9.8	<0.001	2.08
Participant satisfaction with the organization of learning under crisis conditions (1–5)	2.04± 0.71	3.96± 0.48	2.07± 0.69	2.43± 0.74	<0.001	1.93

Note: EG – experimental group (n = 265); CG – control group (n = 270); M – mean; SD – standard deviation; p – level of significance (independent samples t-test comparing EG after vs. CG after); d – Cohen's effect size. Compiled by the authors

Source: compiled by the authors

For each event, the following indicators were recorded: the time from the occurrence of the trigger condition to the initiation

of the transition to the corresponding learning mode, the percentage of participants who complied with the protocol, and the extent of educational process losses (number of classes not conducted or not compensated). The results are presented in Table 9.

Table 9

Effectiveness of the trigger system during real crisis events (2021–2025)

Crisis event	*Trigger level*	*Response time EG (hours)*	*Response time CG (hours)*	*Outcome for EG*
Mass power outage (Oct 2022)	3 (orange)	2.4	19.6	Transition to asynchronous learning; losses < 3% of classes
Cyberattack on Moodle (Oct 2023)	2 (yellow)	1.8	11.3	Activation of backup platform; disruption < 4 hours
Large-scale hostilities near Kyiv (Feb 2022)	4 (red)	0.7	–	Suspension of classes; activation of safety protocol
Pandemic escalation (Dec 2021)	2 (yellow)	3.1	22.4	Blended format; 96% of classes preserved

Note: EG – experimental group; CG – control group; (–) – data unavailable due to evacuation of part of the CG staff; asynchronous – asynchronous learning. Compiled by the authors

Source: compiled by the authors

The data in Table 9 demonstrate a consistent advantage for the experimental group in response time across all recorded crisis situations. The mean response time in the experimental group was 2.0 ± 1.0 hours compared to 15.8 ± 5.1 hours in the control group ($U = 0$; $p = 0.029$; $r = 0.89$). Qualitative analysis of observation materials indicates that the key factor contributing to faster response was not merely the existence of a trigger system, but rather the prior psychological and procedural preparedness of participants: they knew what actions to take and whom to contact even before receiving official instructions.

The study's quantitative results were synthesized by comparing the values of five key indicators between the experimental and control groups at the beginning of the diagnostic stage (2020) and at the end of the control stage (2025). The aggregated data, including the calculation of relative change (Δ) for each group, are presented in Table 10.

Table 10

Summary of research results: dynamics of key indicators in the experimental and control groups (2020–2025)

Indicator	*EG before*	*EG after*	*Δ EG (%)*	*CG before*	*CG after*	*Δ CG (%)*
Overall readiness index (1–5)	2.41	4.12	+71.0	2.38	2.74	+15.1
Response time (hours)	18.3	3.7	−79.8	17.9	14.2	−20.7
Quality of the educational process in crisis conditions (1–5)	2.18	3.89	+78.4	2.21	2.58	+16.7
Compliance with BCP protocols (%)	n/a	87.4	–	n/a	31.6	–
Satisfaction with the organization of learning in crisis conditions (1–5)	2.04	3.96	+94.1	2.07	2.43	+17.4

Note: EG – experimental group (n = 265); CG – control group (n = 270); Δ – relative change in the indicator; n/a – indicator not measured at the diagnostic stage due to the absence of BCP documentation. Compiled by the authors

Source: compiled by the authors

The data presented in Table 10 demonstrate statistically significant differences between the groups across all measured indicators ($p < 0.001$). The largest intervention effects were observed for response time to trigger activation ($d = 2.21$) and compliance with BCP protocols ($d = 2.08$), corresponding to a very large effect size according to Cohen's scale. The overall readiness index in the experimental group increased from 2.41 to 4.12 points (+71%), whereas in the control group it rose only from 2.38 to 2.74 (+15%), confirming the effectiveness of the targeted

implementation of the model rather than general adaptation to crisis conditions.

The data in Table 10 demonstrate significant differences in the dynamics of indicators between the experimental and control groups. In the experimental group, a more pronounced increase was observed across all measured constructs: the overall readiness index increased by 71.0%, the quality of the educational process under crisis conditions rose by 78.4%, and participants' satisfaction with the organization of learning during the crisis increased by 94.1%. In the control group, the growth in indicators was substantially lower, ranging from 15% to 21%. This may indicate adaptive changes occurring under prolonged crisis exposure even without specially organized institutional intervention.

Statistical analysis revealed significant differences between the groups on all indicators at the $p < 0.001$ level. At the same time, the interpretation of the obtained results requires caution, as the recorded effect sizes are exceptionally large for educational research. Cohen's d values ranging from 1.67 to 2.21 fall into the category of very large effects, whereas educational studies more commonly report moderate effect sizes ($d \approx 0.4–0.6$) (Hattie, 2009). Such a pronounced effect may be associated with the combined influence of several factors, including the low initial level of participants' readiness, high motivation under conditions of real threat, the specificity of the extreme educational environment, and the quasi-experimental design without randomization. Additionally, it should be noted that the control group was also operating under prolonged crisis pressure, which may have influenced the nature of the inter-group differences.

In view of the above, the obtained results should be considered as evidence supporting the promise of the proposed model; however, they require further verification in other samples and under more controlled conditions.

The level of BCP protocol compliance in the experimental group (87.4 ± 6.2%) was significantly higher than in the control group (31.6 ± 9.8%), indicating not only knowledge of the protocols but also their operational internalization. The average response time to a trigger event in the experimental group

decreased from 18.3 to 3.7 hours (−79.8%), which can be regarded as an indicator of high operational readiness. Nevertheless, this indicator also requires cautious interpretation, taking into account the specific institutional context of the study.

Thematic analysis of observation and interview materials at the control stage revealed three stable patterns of effective functioning of the trigger system. The first pattern, «proactive communication», was characterized by administrative representatives in the experimental group sending early warning messages to participants even before the official announcement of transition, based on their own monitoring of trigger indicators. The second pattern, «cascade notification», involved heads of departments acting as key nodes in transmitting information from administration to academic staff and students, significantly reducing response time. The third pattern, «reflective adjustment», involved short (15–20 minutes) analytical discussions with key participants after each trigger activation to refine and improve the protocols.

Two types of deviations from the expected behavior were also identified. The first, "trigger fatigue," was observed after the 8th–10th trigger activation, when some academic staff began to ignore certain protocol requirements, perceiving them as overly bureaucratic. This phenomenon corresponds to what is described in emergency management literature as "alarm fatigue" (FEMA, 2021) and should be taken into account when designing systems for prolonged crisis response. The second deviation, "readiness asymmetry," revealed that administrative personnel demonstrated a significantly higher level of protocol compliance (94.2%) than academic staff (86.7%) and, especially, students (79.3%), indicating the need for differentiated training approaches for different participant categories.

From a management perspective, the identified phenomena of "trigger fatigue" and "readiness asymmetry" hold broader implications for educational management than merely describing the local challenges of implementing the model. These phenomena indicate that institutional resilience develops unevenly, and crisis preparedness depends not only on the presence of formalized protocols but also on the extent to which these protocols are supported at the program and departmental management levels,

and perceived by faculty and students as meaningful and justified. In this sense, the middle management level is particularly important, as it ensures the translation of strategic decisions into the language of daily academic practices and coordinates adaptation at the level of educational programs and academic units (Tamir & Machovcová, 2025).

Contemporary research convincingly demonstrates that a crisis in higher education does not end with the immediate response stage but transitions into a phase of recovery, institutional learning, and resilience-building (Regehr & Rule, 2025). In this context, the proposed model should be viewed not only as a mechanism for emergency transition between learning modes but also as a framework that integrates short-term response with long-term adaptation, crisis leadership, and organizational recovery. This conclusion aligns with recent scholarship on educational leadership in crisis conditions (Hill-Berry & Burris-Melville, 2025), the conceptual expansion of the notion of resilience from continuity to adaptation and transformation (Bou Zeid & Abouchedid, 2025), as well as empirical findings on the resilience mechanisms of Ukrainian universities during wartime and the differences between institutions depending on their size, regional location, and resource capacity (Błaszczyk et al., 2025; Brintseva, 2026).

The findings of this study are in substantive dialogue with a number of Ukrainian scholarly works on education management under crisis conditions. Kalashnykova (2022) found that the quality of education in emergency situations tends to decline in the absence of systemic measures and identified academic staff unpreparedness and the lack of clear institutional regulations as key contributing factors. The results of the present study fully confirm this conclusion: in the control group, where no systemic measures were implemented, the quality of the educational process under crisis conditions increased by only 16.7% despite five years of adaptation. At the same time, this study proposes a concrete operational toolkit – the system of triggers and scenario-based protocols – which goes beyond purely diagnostic observations (Kalashnykova, 2022).

Luhovyi and Talanova (2021) substantiated the existence of adaptive potential in Ukrainian universities but noted its

underutilization at the systemic level. The present study empirically confirms this finding and, at the same time, demonstrates a mechanism for realizing such potential through the EdBCP model. Reheilo (2023) investigated quality management in higher education under martial law at NUBiP in Ukraine and identified significant gaps in institutional documentation, findings that align with this study's diagnostic findings (84.3% of respondents confirmed the absence of a BCP at the beginning of the study). Similar conclusions are also presented in the monograph by Hryniuk et al. (2021).

Thus, the readiness asymmetry across participant groups in the educational process has significant implications for educational leadership. It demonstrates that, even in the presence of formally agreed procedures, institutional resilience is not a linear characteristic of a university but rather consists of subsystems with varying levels of preparedness. For other universities, the practical value lies not so much in the specific protocols themselves as in the model's managerial logic, which integrates coordination, resource reservation, multi-level leadership, and flexible redistribution of responsibility under clearly defined trigger conditions.

Consequently, the findings of this study align with the conclusions of scholars regarding the importance of business continuity planning (Crawford et al., 2020), the qualitative losses associated with reactive response (Hodges et al., 2020), and the role of protocols and backup channels (UNESCO & IIEP, 2023). At the same time, the present research substantially contributes to the existing body of knowledge in several respects. It is among the first empirical studies to test the effectiveness of a scenario-trigger model of business continuity management directly under conditions of active armed conflict, rather than solely during a pandemic. The proposed four-level trigger system is significantly more operationally detailed compared to the two- or three-level models described in most international studies. Furthermore, the bidirectional nature of trigger transitions – not only "downward" toward crisis but also "upward" toward normalization – is an element with no direct analogs in the analyzed literature.

Certain discrepancies with the results of UNESCO and IIEP (2023) should be noted. While the aforementioned report

highlights decentralization as a critical success factor, the present study revealed that excessive decentralization in the absence of a well-defined trigger system may result in fragmented crisis responses. At the initial stage of the research, faculty members and university structural units often made inconsistent decisions regarding the mode of instruction.

Thus, it is not decentralization itself that is effective, but rather decentralization operating within clearly established trigger protocols. This finding may have important practical implications for international policy recommendations on education in emergency and crisis contexts.

The interpretation of the results requires consideration of several limitations. The study was conducted within a single university, limiting the external validity of the findings and warranting a cautious approach to generalizing the results. NUBiP of Ukraine is a large, multidisciplinary university with a complex organizational structure, significant human resources, and greater capacity to mobilize resources in crisis conditions than many other higher education institutions. Therefore, the direct transfer of the proposed model to small, relocated, pedagogical, artistic, or medical institutions may be methodologically inappropriate. The absence of randomization in group allocation (a quasi-experimental design) does not rule out the possibility that uncontrolled variables may influence differences between the experimental and control groups. The duration of the formative stage (2021–2023) and the control stage (2024–2025) complicates the unambiguous establishment of causal relationships between specific interventions and the observed outcomes. The self-report nature of the questionnaire may lead to the overestimation of certain indicators due to social desirability bias (Bryman, 2016). Consequently, the model should be viewed not as a universal solution applicable to all types of higher education institutions, but rather as a conceptually and empirically grounded framework that requires further adaptation to different organizational profiles and crisis contexts.

The scientific novelty of the obtained results is determined by several interrelated components. The study developed and empirically verified an integrated model for managing the continuity of the educational process in higher education

institutions, which combines scenario planning with an operational system of response triggers. The concept of EdBCP (Educational Business Continuity Planning) was proposed and tested as an independent theoretical construct adapted to the specific nature of educational organizations. Empirical data were collected on the functioning of the trigger response system under the combined impact of the pandemic and wartime crises, which expand existing understandings of institutional resilience mechanisms and the limits of university adaptation in prolonged crisis situations.

The practical value of the results lies in the potential for the adapted application of the developed model, trigger system, and scenario protocols by other higher education institutions in Ukraine and abroad operating under heightened risk conditions. The author-developed questionnaire on higher education institutions' readiness for risk management (42 items, α = 0.87) can be used for self-diagnosis of institutional readiness by universities of various profiles, taking into account their size, resource capacity, and organizational specificity. The research findings may serve as a basis for the Ministry of Education and Science of Ukraine to develop relevant regulatory documents on the implementation of business continuity plans in higher education institutions. However, the practical adoption of individual elements of the model should be carried out with due consideration of the local context.

Conclusions

A set of theoretical and practical tasks related to the development and experimental validation of a model for managing risks to the continuity of the educational process in higher education institutions, based on scenario planning and a system of response triggers, has been successfully addressed. Based on the obtained results, the following conclusions have been formulated.

The risks to the continuity of the educational process in HEIs under emergency conditions have been systematized into six groups. An author-developed classification is proposed, encompassing six categories of risk (epidemiological, military-security, technological, organizational-managerial, socio-

psychological, and regulatory-legal), synthesized from ISO 22301:2019, the FEMA methodology (2021), UNESCO & IIEP documents (2023), and the author's conceptualization. It has been established that the specificity of the Ukrainian context in 2020–2025 lies in the simultaneous occurrence of multiple risk groups, which significantly complicates management responses compared to single-factor crisis situations.

The concept of educational process continuity (Educational Business Continuity Planning, EdBCP) has been developed as the systemic capacity of HEIs to ensure the implementation of educational programs at a minimally acceptable level of quality and accessibility, regardless of the nature and scale of a crisis. A three-level architecture of EdBCP (institutional, program, and instructional levels) is proposed, mirroring the university's hierarchical structure and ensuring coordination of managerial actions across all levels of the organization.

An author-developed combined model of scenario planning for HEIs has been designed, synthesizing the approaches of Schwartz (1991), van der Heijden (1996), and FEMA methodology (2021). The model includes four baseline scenarios ("Stability," "Adaptation," "Crisis Management," and "Recovery") and introduces a fundamentally new feature, bidirectional trigger transitions, which provide clear protocols not only for escalation to more restrictive modes but also for gradual return to normal functioning.

A four-level response trigger system (green/yellow/orange/red) has been developed and implemented, establishing predefined conditions and time thresholds for transitions between educational process modes. The system ensures predictability, speed, and coordination of institutional responses to crisis events and differs from existing analogs by a higher level of operational detail and consideration of the specific features of educational organizations.

A pedagogical experiment was conducted at the National University of Life and Environmental Sciences of Ukraine (2020–2025, n = 535). The diagnostic stage (2020) revealed a critically low level of institutional readiness (overall readiness index ORI = 2.39 on a 1–5 scale; 84.3% of participants confirmed the absence

of a BCP). The formative stage (2021–2023) included four sub-stages of implementing the model in the experimental group (n = 265) under real crisis conditions, both pandemic and wartime.

The results of the control stage (2024–2025) demonstrated statistically significant differences between the experimental and control groups across all measured indicators ($p < 0.001$). The overall readiness index in the experimental group increased from 2.41 to 4.12 (+71.0%), whereas in the control group it rose only from 2.38 to 2.74 (+15.1%). The average response time to trigger events in the experimental group decreased from 18.3 to 3.7 hours (−79.8%). The effect sizes (Cohen's d = 1.67–2.21) correspond to the category of "very large," confirming the practical significance of the implemented model.

The results of the study are consistent with the findings of international scholars regarding the importance of continuity planning (Crawford et al., 2020; Smith & Elliott, 2006) and the quality losses associated with reactive responses (Hodges et al., 2020), while substantially extending them with empirical evidence on the effectiveness of a scenario–trigger model under conditions of an active armed conflict. It has been established that effective governance is not achieved through decentralization per se, but through decentralization within clearly defined trigger protocols, a conclusion that refines the recommendations of UNESCO & IIEP (2023).

Two specific effects of prolonged crisis response were identified: "trigger fatigue" (a decline in protocol compliance after the 8th–10th activation) and "readiness asymmetry" (a higher level of compliance among administrative personnel compared to academic staff and students), which should be taken into account when designing continuity management systems under chronic crisis conditions.

The obtained results confirm the research hypothesis: the targeted implementation of an integrated risk management model based on scenario planning and a system of response triggers ensures a statistically significant increase in the level of HEIs' readiness for crisis situations, as well as improvements in the speed and quality of response, compared to traditional reactive approaches.

References

Albion, P. R., Tondeur, J., Forkosh-Baruch, A., & Peeraer, J. (2015). Teachers' professional development for ICT integration: Towards a reciprocal relationship between research and practice. *Education and Information Technologies, 20*(4),655–673. https://doi.org/10.1007/s10639-015-9401-9

Anderson, T., & Dron, J. (2011). Three generations of distance education pedagogy. *The International Review of Research in Open and Distributed Learning, 12*(3), 80–97. https://doi.org/10.19173/irrodl.v12i3.890

Bihun, N., Tverezovska, N., Vdovichenko, O., Barinova, N., Kocharian, A., & Kazanzhy, M. (2022). Psychotherapy in dealing with crises in the COVID-19 pandemic. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 13*(2), 259–272. https://doi.org/10.18662/brain/13.2/342

Bikson, T. K., Treverton, G. F., Moini, J., & Lindstrom, G. (2003). *New challenges for international leadership: Lessons from organizations with global missions*. RAND Corporation.

Błaszczyk, M., Kovalisko, N., Pieńkowski, P., Pachkovskyy, Y., & Ryniejska-Kiełdanowicz, M. (2025). Coping with adversity: Mechanisms of resilience in Ukrainian universities during the Russian-Ukrainian War—a perspective from Lviv University students. *Higher Education*. https://doi.org/10.1007/s10734-025-01506-z

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brintseva, O. (2026). The Impact of War on Ukrainian Universities: A Difference-in-Differences Analysis and Post-War Recovery Strategies. *Higher Education Quarterly.* 80, no. 2, e70113. https://doi.org/10.1111/hequ.70113

Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.

Bykov, V., & Spirin, O. (2019). Tsyfrova transformatsiia vyshchoi osvity Ukrainy [Digital transformation of higher education in Ukraine]. *Informatsiini tekhnolohii i zasoby navchannia, 70*(2), 1–18. https://doi.org/10.33407/itlt.v70i2.2970

Bykov, V. Yu. (2008). *Modeli orhanizatsiinykh system vidkrytoi osvity* [Models of organizational systems of open education]. Atika.

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). SAGE Publications.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P. A., & Lam, S. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching, 3*(1), 1–20. https://doi.org/10.37074/jalt.2020.3.1.7

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Dede, C. (2010). Comparing frameworks for 21st century skills. In J. Bellanca & R. Brandt (Eds.), *21st century skills: Rethinking how students learn* (pp. 51–76). Solution Tree Press.

Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: The new normal and emerging technologies. *International Journal of Educational Technology in Higher Education, 15*, Article 3. https://doi.org/10.1186/s41239-017-0087-5

Education Cannot Wait. (2020, March 27). COVID-19 and education in emergencies. https://pmnch.who.int/resources/publications/m/item/covid-19-and-education-in-emergencies

Federal Emergency Management Agency. (2021). *Comprehensive preparedness guide 101: Developing and maintaining emergency operations plans* (3rd ed.). U.S. Department of Homeland Security. https://www.fema.gov/sites/default/files/documents/fema_cpg-101-v3-developing-maintaining-eops.pdf

Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). SAGE Publications.

Garrison, D. R., & Vaughan, N. D. (2008). *Blended learning in higher education: Framework, principles, and guidelines*. Jossey-Bass.

Gritsenchuk, O. O., & Malytska, I. D. (2021). Tsyfrovyi osvitnii prostir v umovakh pandemii: dosvid zarubizhnykh krain [Digital educational space during the pandemic: Experience of foreign countries]. *Kompiuter u shkoli ta simi*, (2), 14–22.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.

Hill-Berry, N. P., & Burris-Melville, T. S. (2025). When the going gets tough: Educational leadership and resilience in times of crises. *Power and Education*, *17*(2), 216-240. https://doi.org/10.1177/17577438241297242

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020, March 27). The difference between emergency remote teaching and online learning. *EDUCAUSE Review*. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Hryniuk, S. P., Zheludenko, M. O., Zaitseva, I. V., Zasluzhena, A. A., Kovtun, O. V., & Sultanova, L. Yu. (2021). *Vyshcha osvita v umovakh karantynnykh obmezhen ta sotsialnoho dystantsiuvannia* [Higher education under quarantine restrictions and social distancing] [Monograph]. Imeks-LTD. https://lib.iitta.gov.ua/id/eprint/729888/1/Монографія%202021.pdf

International Organization for Standardization. (2019). *ISO 22301:2019 Security and resilience – Business continuity management systems – Requirements*. ISO. https://www.iso.org/standard/75106.html

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14–26. https://doi.org/10.3102/0013189X033007014

Kalashnykova, S. A. (2022). Zabezpechennia yakosti vyshchoi osvity v umovakh kryzovykh sytuatsii [Quality assurance of higher education in crisis situations]. *Vyshcha osvita Ukrainy*, (1), 12–21.

Kaplan, R. S., & Mikes, A. (2012). Managing risks: A new framework. *Harvard Business Review, 90*(6), 48–60.

Levine, A., & Van Pelt, S. J. (2021). *The great upheaval: Higher education's past, imperfect future*. Johns Hopkins University Press.

Luhovyi, V. I., & Talanova, Zh. V. (2021). Adaptatsiinyi potentsial ukrainskykh universytetiv v umovakh yevrointehratsii [Adaptive potential of Ukrainian universities in the context of European integration]. *Pedahohika i psykholohiia*, (2), 5–18.

Marinoni, G., van't Land, H., & Jensen, T. (2020, May). *The impact of COVID-19 on higher education around the world: IAU Global Survey Report*. International Association of Universities. https://iau.global/s/iau_covid19_and_he_survey_report_final_may_2020.pdf

Mertens, D. M. (2015). *Research and evaluation in education and psychology* (4th ed.). SAGE Publications.

Nordin, N. B., & Nordin, N. B. (2020). Impact of pandemic COVID-19 to the online learning: Case of higher education institution in Malaysia. *Universal Journal of Educational Research, 8*(12A), 7607–7615. https://doi.org/10.13189/ujer.2020.082546

OECD. (2020). *Education at a glance 2020: OECD indicators*. OECD Publishing. https://doi.org/10.1787/69096873-en

OECD. (2020, March 30). *A framework to guide an education response to the COVID-19 pandemic of 2020* (OECD Policy Responses to Coronavirus [COVID-19]). OECD Publishing. https://doi.org/10.1787/6ae21003-en

Regehr, C., & Rule, N. O. (2025). From pandemic crisis to recovery and resilience: lessons from COVID-19 at a large urban research university. *Studies in Higher Education*, *50*(1), 200–215. https://doi.org/10.1080/03075079.2024.2332415

Reheiloo, I. Yu. (2023). Upravlinnia yakistiu osvity v umovakh voiennoho stanu [Quality management of education under martial law]. *Visnyk NUBiP Ukrainy*, (330), 45–57.

Rowley, D. J., & Sherman, H. (2001). *From strategy to change: Implementing the plan in higher education*. Jossey-Bass.

Schwartz, P. (1991). *The art of the long view: Planning for the future in an uncertain world*. Doubleday.

Shyshkina, M. P. (2020). Khmaro oriientovane navchalne seredovyshche zakladu osvity [Cloud-based learning environment of an educational institution]. *Kompiuter u shkoli ta simi*, (3), 3–10.

Shyshkina, M. P., & Popel, M. V. (2016). Khmaro oriientovane osvitnie seredovyshche navchalnoho zakladu: suchasnyi stan i perspektyvy rozvytku [Cloud-based educational environment of an educational institution: Current state and development prospects]. *Informatsiini tekhnolohii i zasoby navchannia, 55*(5), 58–76.

Smith, D., & Elliott, D. (Eds.). (2006). *Key readings in crisis management: Systems and structures for prevention and recovery*. Routledge.

Subota, L., Kravchuk, O., Davydova, Zh., & Tverezovska, N. (2022). Information technologies as a means of overcoming social-cultural barriers in the process of international students training. *Eduweb: Revista de Tecnología de Información y Comunicación en Educación, 16*(3), 55–66. https://doi.org/10.46502/issn.1856-7576/2022.16.03.4

Sysoieva, S. O., & Krystopchuk, T. Ye. (2012). *Osvitni systemy krain Yevropeiskoho Soiuzu: zahalna kharakterystyka* [Educational systems of the European Union countries: General characteristics]. Rivne.

Tamir, E., & Machovcová, K. (2025.) Fostering Resilience in Higher Education: Middle Management Strategies for Institutional Survival. *Higher Education Quarterly*. 79, no. 4: e70071. https://doi.org/10.1111/hequ.70071

Tashakkori, A., & Teddlie, C. (Eds.). (2010). *SAGE handbook of mixed methods in social and behavioral research* (2nd ed.). SAGE Publications.

Tierney, W. G. (2006). *Trust and the public good: Examining the cultural conditions of academic work*. Peter Lang: New York, Bern, Berlin, Bruxelles, Frankfurt am Main, Oxford, Wien, 2006. XII, 210 pp.

Trow, M. (2007). Reflections on the transition from elite to mass to universal access: Forms and phases of higher education in modern societies since WWII. In J. J. F. Forest & P. G. Altbach (Eds.), *International handbook of higher education* (pp. 243–280). Springer.

Tverezovska, N., Kubitskyi, S., Dlubovska, A., Ihnatenko, N., Bodnaruk, I., Lisovyi, V., & Kuchai, T. (2022). Management of the educational process using information technologies for high-quality training of specialists in higher education institutions. *International Journal of Computer Science and Network Security, 22*(9), 561–568. https://doi.org/10.22937/IJCSNS.2022.22.9.72

UNESCO & International Institute for Educational Planning. (2023). *Education in emergencies: Evidence for better practice*. UNESCO Publishing. https://doi.org/10.54675/YXQG5278

van der Heijden, K. (1996). *Scenarios: The art of strategic conversation*. John Wiley & Sons.

Voliarska, O. S. (2020). Upravlinnia osvitnymy orhanizatsiiamy v umovakh nevyznachenosti [Management of educational organizations in conditions of uncertainty]. *Pedahohika i psykholohiia*, (3), 22–31.

Weick, K. E., & Sutcliffe, K. M. (2007). *Managing the unexpected: Resilient performance in an age of uncertainty* (2nd ed.). Jossey-Bass.

World Health Organization. (2017). *WHO emergency response framework (ERF)*. World Health Organization. https://iris.who.int/handle/10665/258604

World Health Organization. (2021). *WHO guidance on preparing for national response to health emergencies*. World Health Organization. https://iris.who.int/handle/10665/350838

World Health Organization. (2023). *Considerations for implementing and adjusting public health and social measures in the context of COVID-19* (WHO/2019-nCoV/Adjusting_PH_measures/2023.1). World Health Organization. https://iris.who.int/bitstream/handle/10665/366669/WHO-2019-nCoV-Adjusting-PH-measures-2023.1-eng.pdf?sequence=1

Zainuddin, Z., Haruna, H., Li, X., Zhang, Y., & Chu, S. K. W. (2019). A systematic review of flipped classroom empirical evidence from different fields: What are the gaps and future trends? *On the Horizon, 27*(2), 72–86. https://doi.org/10.1108/OTH-09-2018-0027

Zeid, M. B., & Abouchedid, K. (2025). Reconceptualizing education system resilience through inclusive participation in conflict-affected societies. *International Journal of Educational Research*, *133*. https://doi.org/10.1016/j.ijer.2025.102751

Chapter 3. THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF PARTNERSHIP BETWEEN HIGHER EDUCATION INSTITUTIONS AND STAKEHOLDERS UNDER MARTIAL LAW AND IN THE CONTEXT OF POST-WAR RECOVERY

Nadiia Vasynova, Yaroslava Yurkiv, Viktoriia Volodavchyk, Olga Saienko, Serhii Sydorenko

***Abstract**. This study examines the partnership between higher education institutions and stakeholders in the context of universities' growing role in the socio-economic development of local communities. The aim of the research is to substantiate the theoretical and methodological foundations of such interaction, define the principles of networked partnership, and systematize approaches to assessing stakeholder engagement, taking into account the social dimension of cooperation. The study employs a range of research methods, including interdisciplinary analysis of academic sources, methods of analysis and synthesis, and elements of systemic and comparative approaches. The application of these methods enabled clarification of the key concepts, systematization of scholarly approaches to partnership interaction, and definition of the principles of cooperation between higher education institutions and stakeholders.*

Based on the generalization of theoretical analysis results, a methodological approach has been proposed for diagnosing the level of stakeholder engagement. It involves evaluating three interrelated dimensions of interaction: organizational, communicational, and social. Particular attention is devoted to the social dimension of partnership, which enables the assessment of the potential impact of university–stakeholder cooperation on community development.

The findings confirm that effective interaction between universities and stakeholders contributes to the development of partnership networks, strengthens universities' social role, and fosters the creation of innovative educational ecosystems. At the same time, it should be emphasized that the

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proposed approach serves as a conceptual foundation: it provides general methodological guidelines for evaluation and strategic planning but does not constitute a finalized, universal methodology. Its application requires adaptation to a particular university's values, the specifics of its activities, and the environment in which it operates.

The practical significance of the study lies in the possibility of applying this approach by higher education institutions to assess the effectiveness of stakeholder cooperation and to improve mechanisms of partnership interaction.

This study was conducted within the framework of the project "Institutionalization of Interaction Between Higher Education Institutions and Local Communities as a Factor in the Restoration and Preservation of Human Capital under Martial Law and During Post-War Reconstruction."

***Keywords**: higher education institutions; stakeholders; partnership; principles of networked partnership; network cooperation; stakeholder engagement; social dimension of interaction; local communities.*

Introduction

The contemporary development of the higher education system is characterized by the growing role of universities as key social institutions that influence not only educational processes but also regional socio-economic development, human capital formation, and social stability. In this context, the activities of higher education institutions are progressively extending beyond the traditional functions of teaching and research, acquiring the features of open systems that operate on the principles of partnership, networked interaction, and the integration of resources from various social institutions.

These processes are particularly significant in the context of ongoing socio-economic transformations, especially during the period of martial law in Ukraine. Under such conditions, universities are required to adapt to new operational realities, ensure the continuity of the educational process, support academic communities, and address the socio-economic challenges faced by local communities. In this regard, effective interaction among higher education institutions, stakeholders, government bodies, employers, civil society organizations, local communities, and international partners is a critical prerequisite for their strategic development and for strengthening universities' social role.

In contemporary academic discourse, universities are increasingly perceived as active agents of societal transformation, performing not only educational and research functions but also the so-called "third mission," which concerns their social impact on communities and societal development. The implementation of this mission involves establishing sustainable partnerships with stakeholders, developing networked forms of cooperation, and adhering to the principles of openness, shared responsibility, and the integration of knowledge and resources. In this context, universities function as platforms for interaction among diverse social actors, facilitating knowledge dissemination, fostering innovation, and contributing to the development of social capital. At the same time, the actual operations of higher education institutions show that engagement with stakeholders is often fragmented or merely formal, and is not always grounded in the systematic application of principles of partnership and networking. In many cases, cooperation is limited to isolated communication activities or to stakeholder representatives' participation in specific educational or research initiatives, while the strategic nature of partnerships, resource integration, and the joint creation of social value remain underdeveloped.

Furthermore, in scientific research and the management practices of higher education institutions, attention is largely focused on the organizational or communicative aspects of cooperation with stakeholders, while the social dimension of such interaction – in particular, its impact on the development of local communities, the formation of social capital, and the strengthening of universities' role in societal development – remains insufficiently explored. Approaches to determining the level of stakeholder engagement in the university's educational, scientific, and social processes, as well as to evaluating the outcomes of such interaction, are also underdeveloped.

Consequently, a pressing research issue is the lack of a comprehensive methodological approach to assessing stakeholder engagement in higher education institutions that accounts for the principles of networked collaboration and the social dimension of partnership interactions. This necessitates the development of a scientifically grounded set of tools that will allow for determining the level and effectiveness of universities' interaction with

stakeholders, evaluating their social outcomes, and fostering the formation of sustainable partnership networks between higher education institutions, communities, and other social institutions.

The aim of this study is to substantiate the theoretical and methodological foundations of partnership interaction between higher education institutions and stakeholders, to define the principles of networked partnership, and to generalize approaches to assessing the level of their engagement, taking into account the social dimension of interaction and its impact on the development of local communities.

To achieve this objective, the study employs a set of interrelated scientific research methods. First and foremost, the method of interdisciplinary analysis of scientific sources was used, which allowed us to determine the extent to which the issue of interaction between higher education institutions and stakeholders has been explored in Ukrainian and foreign scientific literature, as well as to identify the main approaches to understanding the partnership and network-based interaction of universities with stakeholders.

Methods of analysis and synthesis were applied to clarify the content of the study's conceptual framework, specifically the concepts of "stakeholders," "stakeholder engagement," and "network interaction," as well as to substantiate the main conceptual provisions regarding the social dimension of universities' interaction with stakeholders. The use of these methods enabled the systematization of scientific approaches and the formulation of a set of principles for the interaction of higher education institutions with stakeholders.

The study employs elements of both the systems and comparative approaches. The systems approach enabled us to examine the interaction between higher education institutions and stakeholders as a complex, multi-level system encompassing the organizational, communicative, and social aspects of cooperation and operating on the basis of specific principles of partnership and networking. This approach enabled the identification of the roles and place of various stakeholder groups in the university's activities and exploration of their interrelationships.

A comparative analysis was used to examine existing approaches to assessing stakeholder engagement and to identify effective practices for universities' interactions with stakeholders in educational, scientific, and social activities.

Based on a synthesis of the theoretical analysis and the application of the aforementioned methods, a methodological approach to diagnosing stakeholder engagement is proposed, which involves assessing three interrelated interaction dimensions: organizational, communicative, and social. This approach allows for a comprehensive assessment of the nature and level of stakeholder participation in university activities and determines the effectiveness of implementing the principles of partnership and network-based interaction between higher education institutions and stakeholders.

At the same time, it should be emphasized that the proposed approach represents a conceptual foundation. It provides general methodological guidelines for evaluation, but does not constitute a finalized universal methodology. Its application requires adaptation to a particular university's values, its specific activities, and the environment in which it operates.

The chapter also incorporates the authors' research results, obtained through analysis of the theoretical and practical foundations of higher education institutions' interactions with stakeholders and the implementation of the stakeholder approach in university management. These findings allow us to view the interaction of higher education institutions with stakeholders as an important prerequisite for their strategic development, the strengthening of partnerships, and the expansion of areas of cooperation with local communities, as reflected in the author's previous publications (Vasynova, 2022; Vasynova, 2023; Vasynova, 2023). The identified methodological approaches lay the groundwork for further substantiation of a system of principles governing the interaction of higher education institutions with stakeholders and the development of tools to assess the level of their engagement.

The interaction of higher education institutions with stakeholders has been the subject of numerous studies. Ukrainian scholars emphasize the role of stakeholders in transforming the

educational process and ensuring its quality (Hevko & Borysov, 2020; Kovalenko, 2021; Trunina & Bilyk, 2021; Shevchenko & Khytyko, 2020; Popadynets, 2018). Their works highlight the stakeholder approach as a condition for the strategic development of universities and as a tool for enhancing competitiveness (Tereshchenko, 2025; Serhiyenko, 2025; Kononova & Us, 2025). Special attention is paid to university–community interaction under wartime conditions (Vasynova, 2022).

In international research, the stakeholder concept is viewed as a component of institutional development and university interaction with the external environment. Foundational contributions were made by Fassin (2009), Etzkowitz & Leydesdorff (2000), and Agasisti et al. (2019), who developed theoretical models such as the "triple helix" and examined the role of universities in regional development. Nabaho et al. (2022) and Labe (2024) explore the "third mission" of universities, emphasizing community engagement and communication mechanisms. Gogiashvili (2022) emphasizes universities' social responsibility, while Dereso (2021) proposes a practical model integrating educational, research, and social activities.

Recent studies further expand this discourse. Spânu et al. (2024) analyze the implementation of the "third mission" through community engagement; Koekkoek et al. (2024) examine university–community interaction in the Netherlands; Hinterleitner et al. (2025/2026) provide a systematic review of the role of universities in regional sustainability transitions; and De Groot (2025) highlights multi-stakeholder networks in higher education.

Traditionally, universities have fulfilled two missions: educational and research. At the end of the 20th century, the concept of the "third mission" emerged, signifying the active participation of higher education institutions in the socio-economic development of society. Universities are now seen not only as centers of education and science but also as agents of social transformation, interacting with stakeholders and contributing to solving pressing issues of territorial development. This underscores the importance of studying the forms and levels of stakeholder engagement and defining the social dimension of such interaction (Farnell, 2020).

Despite a significant body of research expanding the scope of issues related to the interaction between higher education institutions and stakeholders, this issue is cross-cutting and remains key to the development of the higher education system. It encompasses all levels of university operations, ranging from strategic management to operational activities. Furthermore, it reflects the need for a constant search for new forms and methods of partnership in the context of contemporary socio-economic transformations.

Research Results

In the current context of higher education system transformation, the interaction of universities with various stakeholder groups and local communities is particularly significant. The state of war in Ukraine has radically changed the country's socio-economic and educational landscape. According to data from the Unified State Electronic Database on Education, provided by the State Enterprise "Inforesurs" of the Ministry of Education and Science of Ukraine, the number of students in higher education institutions in 2022–2024 shows a downward trend compared to the pre-war period (Main Department of Statistics, 2025). This is linked both to migration processes and to limited opportunities for young people to pursue education under martial law. As a result, Ukrainian educational institutions have faced several systemic challenges: staff shortages, declining student enrollment, financial constraints, and the need to seek alternative sources of support. Despite these challenges, universities continue to serve as key centers of social stability, integration of internally displaced persons, and local community development, highlighting the need to strengthen collaboration with stakeholders and partner networks. The importance of such collaboration is also confirmed by strategic documents in higher education.

The Strategy for the Development of Higher Education in Ukraine for 2022–2032 emphasizes the need for systematic collaboration among higher education institutions, employers, government bodies, and the public as key stakeholders (On Approval, 2022). At the same time, the Standards and Guidelines

for Quality Assurance in the European Higher Education Area (ESG-2015) emphasize the importance of actively involving internal and external stakeholders in educational processes. This approach contributes to improving the quality of education, ensuring its alignment with societal needs, and strengthening universities' role in supporting social cohesion, economic development, and innovation (Standards and Guidelines for Quality Assurance in the European Higher Education Area, 2015).

In these documents, stakeholders are viewed as a group of individuals and legal entities (staff, students, employers, partners, the state, the public) who influence the organization’s activities or are directly dependent on its outcomes. It should be noted that every year, communication with these stakeholder groups is increasingly viewed by higher education institutions as one of the priority management tasks, and under martial law, its significance grows substantially, as it is precisely such collaborative interaction that facilitates the consolidation of resources, a prompt response to societal needs, and the formation and retention of the student body. These transformations have led to the emergence of a new concept: “stakeholder management” (Stakeholder Management) – the management of relationships with interested groups (The Concept of Stakeholders, 2026).

In international academic discourse, stakeholders are understood to be groups of entities that have their own interests, expectations, and needs regarding an organization’s activities, and that are capable of influencing its operations or being influenced by it. Therefore, the concept of “stakeholders” is considered synonymous with the term “interested parties,” as it encompasses all participants who are directly or indirectly connected to the organization’s activities, are interested in its results, and can determine the direction of its development (What is Stakeholder Engagement, 2021). Consequently, stakeholders can play a significant role in achieving organizational success, particularly by helping to bridge existing “gaps” in the organization’s operations and development.

In the context of a higher education institution’s activities, this means the opportunity to reduce barriers and contradictions across its various work areas, namely educational, scientific, pedagogical, methodological, and administrative (The Concept of

Stakeholders, 2026). However, in our view, stakeholders should be seen not only as interested parties but primarily as partners of universities, since their support is key to realizing the higher education institution's mission and strategic vision. Under such conditions, the university's activities are based on the principles of partnership, which entail taking into account the interests of various stakeholder groups, aligning their expectations, and establishing a foundation for mutually beneficial cooperation.

University stakeholders are traditionally divided into two groups: external and internal. Based on an analysis of academic sources (Hevko & Borysov, 2020; Trunina & Bilyk, 2021; Vasiuk & Haievska, 2023; Vasynova, 2023), a systematization of stakeholders was carried out, which made it possible to identify key stakeholder groups that directly or indirectly influence the university's activities and the formation of its social dimension. The list includes stakeholder groups that participate in the implementation of the higher education institution's educational, scientific, and social functions or are interested in its results. A generalized structure of such groups is presented in Figure 1.

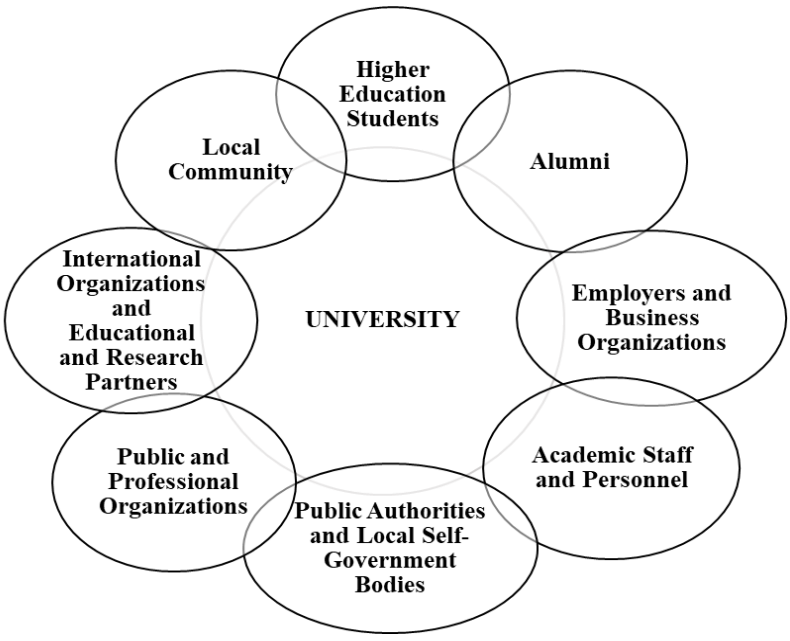

Figure 1

Key stakeholder groups of the university within the scope of the study

Source: Authors' own work based on (Hevko & Borysov, 2020; Trunina & Bilyk, 2021; Vasiuk & Haievska, 2023; Vasynova, 2023).

As shown in Fig. 1, the interactions of a higher education institution encompass a wide range of stakeholders, among whom students, academic and teaching staff, employers, state and local government bodies, civil society organizations, business entities, and local communities are traditionally distinguished. These groups form a network of partnerships that ensures the fulfillment of the university's educational, scientific, and social mission.

At the same time, during periods of military challenges, the stakeholder approach takes on new meaning, as it allows consideration not only of traditional stakeholder groups but also of new categories emerging from societal transformations. These include internally displaced persons, particularly students and academic staff; local communities hosting displaced educational institutions; and international donors and organizations supporting the restoration of educational infrastructure and the development of educational programs.

International organizations and institutions play a distinct role in the contemporary educational landscape, serving as key partners for universities in implementing international educational and research programs, fostering academic mobility, and strengthening the institutional capacity of higher education institutions.

Given the above, stakeholders should be identified based on a combination of two key characteristics:

– having a stake in the outcomes of the higher education institution's activities;

– having the potential to influence its management decisions, educational processes, and strategic development.

However, it should be emphasized that influence alone, without a corresponding interest, is not sufficient grounds for classifying an individual or organization as a stakeholder. This takes on particular significance in the context of a higher education institution's interaction with the local community, where the synergy of interests and influences facilitates joint activities to develop human capital, increase social engagement, and address local issues. It is precisely the alignment of positions and the coordination of stakeholders' efforts that create the conditions for

achieving tangible social impact and sustainable community development.

Within the scope of this study, the university's interaction with stakeholders is viewed as a process of creating a supportive environment that fosters the development of innovative and socially oriented activities at the higher education institution.

In today's context, such interaction is increasingly interpreted through the lens of network governance, which involves horizontal coordination and partnership-based cooperation among various social actors.

In this system, the university serves as a platform for integrating the resources, knowledge, and interests of various stakeholder groups, thereby fostering the development of partnership networks and the formation of innovative educational ecosystems (Joyce & Richard, 2020). Further development of this idea involves refining the mechanisms for implementing networked collaboration. In particular, a study by N. Vasyuk and L. Gaevska emphasizes that network governance involves establishing a system of institutional and organizational mechanisms that ensure effective interaction between government bodies and the public. In this context, the mechanism of network governance is viewed as a complex of legal, administrative, organizational, personnel, financial, and technical support for institutional activities, aimed at developing networked interaction among various participants in social processes (Vasyuk & Gaevska, 2023). In light of this, in higher education, network governance can be viewed as a model for organizing a university's interactions with stakeholders, grounded in the principles of partnership, openness, mutual responsibility, and joint decision-making. This approach contributes to strengthening universities as centers of social innovation, to the development of local communities, and to the formation of educational ecosystems within which educational, scientific, and social potential are integrated.

Reflection on the role and significance of stakeholders in organizational activities has served as the basis for the development of a number of contemporary theoretical approaches to managing stakeholder interactions. Among these, the

stakeholder approach, the concept of network governance, and the Triple Helix and Quadruple Helix models – which explain the mechanisms of partnership between universities, the state, business, and civil society – play a significant role (Freeman, 1984; Rhodes, 1996; Etzkowitz & Leydesdorff, 2000; Carayannis & Campbell, 2009).

Let us consider the main provisions of these approaches:

Stakeholder approach – managing interactions with stakeholders. The stakeholder approach is based on understanding an organization's activities as a system of interactions with various stakeholder groups that influence its functioning or are affected by its decisions (Freeman, 1984). In the context of higher education institutions, such stakeholders include students, employers, government agencies, local communities, civil society organizations, and international partners. Managing stakeholder engagement involves integrating their interests into the decision-making process, building partnerships, developing communication channels, and involving stakeholders in the implementation of the university's educational, research, and social initiatives.

Network governance – network management and horizontal coordination. The concept of network governance reflects a modern model of organizing interaction between different institutions, based on partnership, cooperation, and horizontal connections (Rhodes, 1996). Unlike traditional hierarchical management systems, network governance involves distributed responsibility, joint decision-making, and coordination among network participants. In higher education, this model facilitates the formation of partnership networks among universities, government agencies, businesses, and civil society organizations, enabling more effective implementation of educational, innovative, and social projects.

Triple Helix model – university–business–government interaction. The Triple Helix model describes an innovative system of cooperation between three key institutional sectors: universities, business, and government (Etzkowitz & Leydesdorff, 2000). In this model (Fig. 2), universities serve as centers for the generation of knowledge and innovation, business ensures their

practical implementation and commercialization, and the government establishes the regulatory and institutional conditions for the development of innovative activities (Wikipedia, 2026). The interaction among these sectors contributes to the formation of regional innovation ecosystems and strengthens universities' role in socio-economic development.

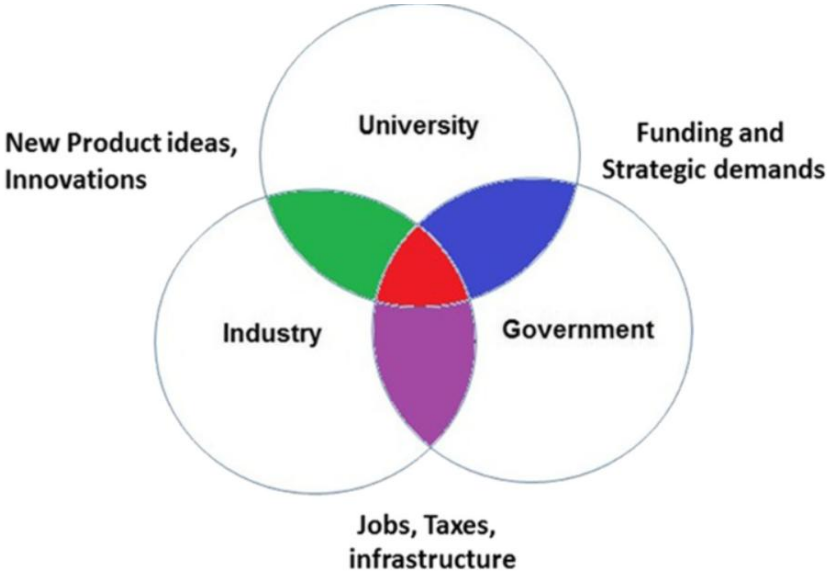

Figure 2
The Triple Helix Model

Source: Authors' own work based on (Wikipedia, 2026).

An innovative environment forms at the intersection of the three sectors, where knowledge, resources, and management mechanisms are integrated, leading to the creation of new products, infrastructure development, and economic growth.

The Quadruple Helix represents an expansion of this interaction to include the community and civil society. The Quadruple Helix model is an evolution of the Triple Helix concept and involves incorporating a fourth element – civil society and local communities into the system of innovative interaction (Carayannis & Campbell, 2009). This approach emphasizes the importance of engaging a broad range of social actors in shaping innovation policy, developing education, and generating knowledge. Within this model, universities are viewed not only as

educational and scientific institutions but also as active participants in socio-economic development, interacting with government agencies, business, and the community to create an innovation ecosystem (Fig. 3).

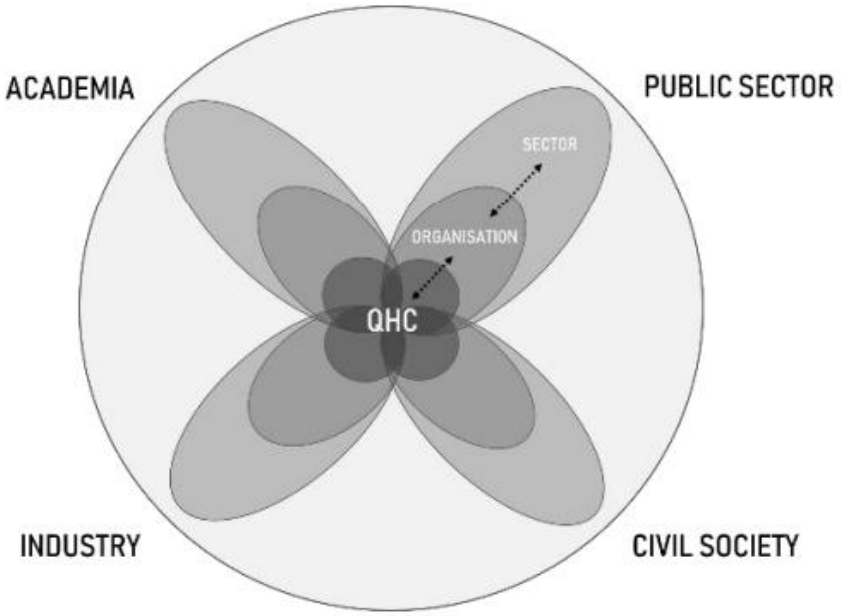

Figure 3

The Quadruple Helix model of interaction among key sectors of the innovation ecosystem

Source: Authors' own work based on (Carayannis, 2019).

The implementation of the Quadruple Helix model is based on a number of key principles, including:

- collaboration and co-creation – combining the efforts of various stakeholder groups to jointly solve complex socio-economic problems and stimulate innovation;

- open innovation – facilitating the exchange of ideas, experience, and resources among universities, businesses, government agencies, and civil society organizations;

- social responsibility – taking into account ethical aspects and principles of sustainable development, and orienting innovation activities toward the public good;

- knowledge sharing – disseminating knowledge, experience, and best practices across different sectors of society. The Quadruple Helix model expands upon the traditional concept of interaction between universities, business, and government by adding a fourth element: civil society. The intersection of these sectors forms a shared innovation space where knowledge generation, partnership development, and innovation creation occur.

Stakeholder approach, network governance, Triple Helix, and Quadruple Helix constitute interconnected conceptual frameworks that define contemporary approaches to managing organizational interaction with stakeholders. Their common methodological foundation lies in recognizing the multilevel structure of social relations, the necessity of horizontal coordination, and the integration of resources from different sectors to ensure innovative development.

Within these models, universities are considered key institutions that combine educational, scientific, and social functions, act as centers of knowledge generation and innovation, and establish partnership networks with governmental structures, business, and civil society. This perspective positions universities as systemic nodes in the innovation ecosystem, where knowledge, resources, and governance mechanisms are integrated to ensure sustainable socio-economic development.

In the context of the practical implementation of partnership interactions, it is important to adhere to general principles for engaging stakeholders in educational institutions' activities. According to W. Joyce & J. Richard, effective engagement with stakeholders should be based on a set of guiding principles that ensure the coherence of joint actions and contribute to the achievement of strategic goals for educational development (Joyce & Richard, 2020). In particular, the key principles of stakeholder engagement include:

1. Proactive communication by educational institutions with stakeholders. Faculty and administrators of educational institutions must provide stakeholders with the necessary information and analytical data to enable the formation of

productive partnerships aimed at improving the effectiveness of the educational process.

2. Alignment of partnership activities with educational goals. All interactions with stakeholders must be directly linked to achieving strategic goals for educational development and improving the quality of student training.

3. Joint and responsible participation of partners. Effective interaction requires the active participation of all parties in implementing joint initiatives, while each partnership participant's roles and responsibilities must be clearly defined.

4. Transparency of information exchange. Data on performance results and achievements must be open, reliable, and understandable to all participants in the partnership.

5. Shared values and a common vision of outcomes. All partnership participants must act in line with shared values, focusing on achieving the agreed-upon strategic outcomes.

6. Results-Orientation and Use of Evidence-Based Data. The implementation of partnership initiatives must be based on data analysis and aimed at achieving specific results, thereby enhancing the effectiveness of management decisions and the quality of educational processes.

These principles underscore the importance of systematic, transparent interaction between educational institutions and stakeholders, which aligns with contemporary approaches to developing partnership networks and network governance in education.

Implementing such approaches contributes to the formation of a community educational ecosystem that unites educational institutions at various levels, local governments, businesses, civil society organizations, and other social institutions around a common goal – the development of human capital and the provision of lifelong learning.

A synthesis of scholarly approaches to stakeholder engagement and an analysis of current trends in the development of partnership networks in higher education have enabled the formulation of a framework of principles for partnerships (Table 1)

Table 1

System of Principles of Network Partnership between Higher Education Institutions and Stakeholders

Principle	*Description of the Principle*	*Expected Outcomes*
Strategic Partnership	Establishing long-term mutually beneficial relationships between the university and key stakeholder groups	Development of sustainable partnership networks and strengthening of an innovative educational environment
Transparency and Openness	Ensuring access to information about the university's educational, research, and innovation activities	Increased trust, improved communication efficiency, and enhanced institutional accountability
Mutual Benefit	Orienting cooperation toward creating shared value for all partners involved	Sustainable and mutually beneficial partnership relationships
Adaptability	Ensuring universities' flexible response to changes in the labor market, society, and the economy	Greater relevance and responsiveness of educational programs
Integration of Knowledge and Resources	Combining the scientific potential of universities with the practical expertise of business and the institutional capacities of government	Development of innovative solutions and strengthening of knowledge transfer
Network Interaction	Building horizontal connections between universities, business, government, and civil society	Formation and development of innovative ecosystems
Social Orientation	Directing partnerships toward addressing societal challenges and supporting community development	Strengthening the social mission and societal impact of universities
Inclusiveness	Ensuring the participation of diverse stakeholder groups in university interaction processes, considering their needs, capacities, and sociocultural characteristics	Broader stakeholder engagement and increased equity and accessibility of partnership initiatives

Source: Authors' own work based on (Carayannis & Campbell, 2009; Carayannis & Campbell, 2019; Dereso, 2021; Labe, 2024; Etzkowitz & Leydesdorff, 2000, etc.).

between higher education institutions and stakeholders (Carayannis & Campbell, 2009; Carayannis & Campbell, 2019; Dereso, 2021; Labe, 2024; Etzkowitz & Leydesdorff, 2000, etc.), which takes into account the specific features of how universities operate in today's innovative and socially oriented educational environment.

The proposed framework of principles reflects the comprehensive nature of higher education institutions' interactions with stakeholders and guides universities toward developing long-term partnerships with various stakeholder groups. Its implementation helps strengthen universities' role as open social institutions that actively engage with business, government, and civil society.

These principles emphasize the importance of systematic, transparent, and mutually beneficial cooperation between universities and stakeholders, which aligns with contemporary approaches to developing partnership networks and network governance in education. The principle of inclusivity is particularly important, as it entails considering the diverse needs and capabilities of various stakeholder groups, including internally displaced persons, representatives of local communities, local government bodies, and the public sector.

The result is an open and inclusive system of partnership between the university and its stakeholders, which helps strengthen the social legitimacy of the higher education institution and enhances its ability to respond to contemporary societal challenges.

This results in a networked model of interaction, within which the university serves as a platform for pooling the knowledge, innovations, and management practices of various social actors. This approach creates the conditions for a community educational ecosystem that fosters human capital development, supports innovative activities, and promotes the socio-economic development of regions.

Such a system typically includes:

- institutions of preschool, general secondary, vocational, and higher education;

- local government bodies;
- businesses and employers;
- civil society organizations and cultural institutions;
- community residents who participate in lifelong learning.

Within such a system, the university serves as a vital hub that integrates educational, scientific, social, and innovative resources, fostering the formation of partnership networks among educational institutions, local government bodies, businesses, and civil society.

The practical implementation of these principles involves using a range of organizational, communication, and project-based collaboration tools. These include establishing advisory and expert councils with stakeholder representatives, concluding partnership agreements and memoranda of cooperation, involving representatives of communities, employers, and civil society organizations in the development, review, and updating of educational programs, and implementing joint educational, scientific, and socially oriented projects. An important role is played by the organization of public events, namely, roundtables, forums, strategic sessions, training sessions, and public discussions, which ensure open communication and foster trust among participants.

An additional tool for developing networked collaboration is the use of digital platforms and electronic communication resources, which expand professional contacts, maintain a constant dialogue with stakeholders, and enable prompt responses to the needs of the community and the labor market. The application of these tools and measures helps strengthen partnerships, improve the efficiency of intellectual, organizational, and social resources, and enhance universities' roles as active participants in the development of local communities and regional innovation ecosystems.

In the scientific literature, the key outcomes of such collaboration include the integration of knowledge with practical activities, the strengthening of collective action, and the

development of shared social responsibility (Joyce & Richard, 2020), specifically:

1. The combination of knowledge with practical activity involves integrating the scientific potential of universities with the practical experience of business and the managerial resources of state and public institutions. In today's environment, implementing educational and social initiatives requires an interdisciplinary approach and the integration of expertise at various levels, enabling the translation of strategic intentions into practical actions and ensuring the sustainable development of projects.

2. Strengthening collective action involves coordinating the efforts of various stakeholder groups to achieve common goals. Networked collaboration facilitates the consolidation of resources, the pooling of expert potential, and creates a foundation for implementing new partnership initiatives in the field of educational and innovative activities.

3. Fostering shared social responsibility involves developing partnerships between universities and stakeholders, which creates opportunities for jointly shaping social value. Such collaboration helps raise participants' social responsibility and increases universities' involvement in addressing pressing issues facing local communities.

In our view, the significance of these advantages lies in their reflecting the practical outcomes of effective interaction between higher education institutions and stakeholders and in demonstrating the potential of networked cooperation as a key factor in the development of modern universities. The implementation of such forms of interaction contributes not only to improving the effectiveness of universities' educational and scientific activities but also to strengthening their role as active participants in socio-economic transformations. In this context, the development of networked interaction has a broader impact on the functioning of higher education institutions and their participation in the socio-economic development of society.

A synthesis of research findings and an analysis of universities' partnership practices with stakeholders reveal additional benefits of networked collaboration, including:

– improved quality of educational programs through the involvement of employers and other stakeholders in shaping educational content;

– expanding opportunities for innovative activities and knowledge transfer;

– increasing universities' adaptability to changes in the external environment and labor market needs;

– strengthening universities' participation in the development of local communities;

– forming innovative ecosystems through collaboration between universities, business, the state, and civil society.

Thus, the implementation of partnership principles contributes to a comprehensive effect, manifested in the improvement of the quality of universities' educational and research activities, the development of an innovative environment, and the strengthening of their role in the socio-economic development of society. For the practical implementation of these approaches, it is advisable to use stakeholder relationship management tools, such as a stakeholder map.

It is worth noting that some of the advantages listed above are conceptually linked to the principles of partnership outlined in Table 1, as they reflect the practical outcomes of their implementation. In particular, the principle of integrating knowledge and resources manifests itself in the combination of scientific and practical experience, the principle of networked interaction – in the strengthening of collective action, and the principle of social orientation – in the formation of shared social responsibility. Together, this creates the conditions for the development of innovative educational ecosystems and the strengthening of universities' role in the development of local communities.

Implementing these approaches, particularly the principles of partnership, requires the use of appropriate tools for managing stakeholder relationships. In the practice of strategic and project management, various tools are used to plan and organize interactions with stakeholders. One such tool is the

Communication Matrix, which the International Institute of Business Analysis (IIBA) recommends using (Karlina, 2023). The Communication Matrix allows for structuring the stakeholder engagement process, identifying communication channels, responsible parties, and the frequency of information exchange (Table 2).

Table 2
Communication Matrix

Frequency	*Meeting/ Report Title*	*Purpose*	*Communication Method*	*Participants*	*Person in Charge*

Source: Authors' own work based on (Karlina, 2023).

Thus, the communication matrix facilitates planning stakeholder engagement, while the stakeholder map allows for the systematization and analysis of the participants in the partnership network.

Alongside communication planning tools, tools for identifying and systematizing stakeholders are of great importance. One such tool is the stakeholder map, which is used to identify, systematize, and analyze key stakeholder groups. In the practical activities of higher education institutions, a stakeholder map is developed to identify the main groups and institutions that can influence the university's performance or, conversely, be influenced by it.

This map allows you to organize information about stakeholders, identify their interests and levels of influence, and establish collaboration priorities. The process of creating a stakeholder map involves several sequential steps:

1. Identification – compiling a list of all groups, organizations, and institutions that are relevant to the company's operations.

2. Research – analyzing their interests, positions, and means of influence.

3. Visualization – creating a visual representation that illustrates the relationships between stakeholders and the organization's key objectives.

4. Prioritization – identifying the stakeholders who have the greatest impact on success and are most critical to addressing current issues (The Concept of Stakeholders, 2026). This process helps the organization understand whom to prioritize working with and how to build effective communication and partnerships.

In this context, there is a need not only to identify and group stakeholders but also to determine the actual level of their engagement in the university's educational, scientific, and social processes. That is why the next step in our research is to develop a methodology for analyzing stakeholder engagement, enabling us to move from conceptual analysis to the instrumental measurement of interaction effectiveness.

Experts emphasize the advisability of beginning the organization of the educational space (academic year) by assessing the level of stakeholder engagement in the educational process, thereby enabling the timely determination of interaction directions and increasing their effectiveness. Based on an analysis of Ukrainian and foreign scientific works (Popadynets, 2018; Popadynets, Andrusiv, Shtohryn & Galtsova, 2020; What is Stakeholder Engagement, 2021; The Concept of Stakeholders, 2026), a list of questions for diagnosing the level of stakeholder engagement in the university's activities was systematized and summarized:

1. Have the main stakeholder groups of the university been identified?

2. Has a stakeholder matrix (interests, needs, level of influence) been created, and is it periodically updated?

3. Are the specific characteristics of different groups taken into account when planning interactions?

4. Have responsible individuals or departments been designated for communication with stakeholders?

5. Have procedures been developed for involving stakeholders in educational, research, and social activities?

6. Are the results of interactions documented (meeting minutes, agreements, reports)?

7. Are their needs and expectations taken into account when making management decisions?

8. Are measures developed to respond to stakeholder inquiries?

9. Is the effectiveness of cooperation with stakeholders evaluated?

10. Has the frequency of reporting to stakeholders been established?

11. Is the level of their engagement monitored?

12. Is national and international experience in university-stakeholder engagement studied and taken into account?

13. Do stakeholders have access to up-to-date information about the university's activities, projects, and initiatives?

14. Is regular communication provided regarding performance results, social initiatives, and partnership projects?

15. Is the information transparent, understandable, and accessible to various groups?

16. Are consultations, meetings, and joint events held with stakeholders?

17. Have opportunities been created for stakeholders to participate in the implementation of joint projects?

18. Are there mechanisms for submitting proposals, comments, or initiatives from stakeholders?

19. The proposed approach is simple to apply and convenient for practical use. Assessment is carried out by recording a positive ("+") or negative ("–") response to each proposed question, enabling quick determination of which components of stakeholder engagement are implemented at the appropriate level and which require improvement.

To interpret the results, it is advisable to use the approach proposed in the study by I. Popadynets, U. Andrusiv, M. Shtohryn,

and O. Galtsova (Popadynets, Andrusiv, Shtohryn & Galtsova, 2020), where the level of stakeholder engagement is determined by the total score:

11–18 points – high level of engagement (stakeholders feel significantly involved in the activities of the university, institute, or department);

6–10 points – moderate level of engagement;

0–5 points – low level of engagement, indicating a predominantly formal nature of interaction.

Thus, the existing list of questions sufficiently reflects the organizational level of interaction (questions 1 through 12) and the communication level (questions 13 through 18). At the same time, it does not fully address the social dimension, particularly the potential impact of the university's stakeholder cooperation on local community development. This component is conceptually significant for achieving the objective of our study. Therefore, it is advisable to supplement the methodology with a separate set of questions to analyze stakeholders' social engagement and determine the potential impact of their interactions with the university on the development of the local community. Some of the key questions within this section could include the following:

1. Are stakeholders involved in the implementation of socially significant initiatives by the higher education institution aimed at the development of the local community?

2. Do community representatives participate in determining the priority areas for joint projects?

3. Do stakeholders' suggestions influence the content of educational programs, research, or social initiatives focused on community needs?

4. Does collaboration with stakeholders contribute to increasing the social engagement of young people and community residents?

When defining the set of issues, it is important to consider a university's values, the nature of its activities, and its operating environment; therefore, this set cannot be considered universal or exhaustive.

Thus, it is advisable to structurally divide the proposed methodology for assessing the level of stakeholder engagement in the activities of a higher education institution into three interrelated components:

1. Organizational block – covers issues related to stakeholder identification, the formation of a system of interaction, and the management of partnership relationships.

2. Communication block – reflects the characteristics of information exchange, the transparency of the university's activities, and the level of stakeholder involvement in joint events and consultations.

3. Social block – aimed at determining the impact of the university's interaction with stakeholders on the development of the local community, social initiatives, and the promotion of civic engagement.

With regard to the interpretation of results, the above-outlined approach should be taken into account, focusing on the number of questions identified in the questionnaire (analysis protocol). Each question serves as an indicator, which is assessed according to the principle "+" (practice is implemented) or "–" (practice is absent or implemented episodically) (see Table 3). The sum of positive responses constitutes a quantitative measure of stakeholder engagement, enabling the identification of strengths and weaknesses in cooperation and outlining directions for its improvement. The results obtained allow for a general picture of stakeholder involvement and for determining further steps to enhance collaboration mechanisms.

It should be emphasized that, in defining the set of questions, it is important to consider a particular university's values, the specifics of its activities, and the environment in which it operates. Therefore, the proposed list cannot be considered universal or exhaustive. It represents a conceptual framework that provides general methodological guidelines but requires adaptation to specific conditions and objectives.

Thus, the methodology combines a structured set of indicators, a simple evaluation system, and the ability to interpret results both at the general level and within individual blocks

(organizational, communicational, social). This ensures its practical applicability while leaving room for further development and refinement depending on the context.

Table 3

Level of stakeholder engagement in university activities

No. Item	*Self-assessment question*	*Block*	*Indicator*	*Stakeholder 1 +/ –*	*Stakeholder 2 +/ –*	*Stakeholder 3 +/ –*

Source: Authors' own work based on (Popadynets, Andrusiv, Shtohryn & Galtsova, 2020)

In our view, the proposed approach enables not only quantitative assessment of stakeholder cooperation, but also identification of problematic areas for further managerial response and improvement of partnership mechanisms. The methodology may be applied as a tool for the university's internal self-assessment, as well as an analytical basis during strategic planning of stakeholder relations. Its use contributes to the systematization of information on the nature of stakeholder interaction, the identification of strengths and weaknesses of cooperation, and the outlining of directions for further enhancement of partnership and network interaction mechanisms.

At the same time, it should be emphasized that the proposed toolkit serves as a framework or conceptual basis for evaluation. It provides general methodological guidelines but does not constitute a finalized or universal methodology. Its application requires adaptation to a particular university's values, the specifics of its activities, and the environment in which it operates.

It is important to note that the developed list of questions reflects the implementation of key principles of interaction between higher education institutions and stakeholders, in particular: strategic partnership, transparency and openness, mutual benefit, adaptability, integration of knowledge and resources, network interaction, and social orientation. Thus, the proposed system of questions can be viewed as a tool for

operationalizing these principles and for assessing the level of their practical implementation in the university's activities.

Conclusions

The study found that collaboration between higher education institutions and stakeholders is a key factor in their strategic development, enhancing competitiveness, and strengthening universities' social role. In the current context of higher education system transformation, particularly during a period of martial law, such interaction takes on special significance, as it helps consolidate resources, build partnership networks, and increase universities' involvement in addressing socially significant issues facing local communities.

Based on an analysis of scientific sources and contemporary theoretical approaches (stakeholder approach, network governance, the Triple Helix and Quadruple Helix models), the paper substantiates the rationale for considering the interaction between higher education institutions and stakeholders as a multi-level system of partnerships encompassing various stakeholder groups: students, employers, government bodies, civil society organizations, local communities, and international institutions.

A synthesis of scholarly approaches to stakeholder engagement and an analysis of current trends in the development of partnership networks in higher education have enabled the formulation of a system of principles for effective interaction between higher education institutions and stakeholders. Adherence to these principles ensures an open, collaborative, and mutually beneficial nature of cooperation, promotes the integration of knowledge and resources, fosters networked interaction, and strengthens the social orientation of universities' activities. As a result, sustainable partnerships are formed that support the development of innovative educational ecosystems and align the interests of key stakeholder groups with universities' educational, scientific, and social activities.

The study proposes a methodological approach to diagnosing the level of stakeholder engagement in higher education institutions' activities, which involves evaluating

interactions across three interrelated dimensions: organizational, communicational, and social. The organizational dimension reflects the presence of managerial mechanisms for stakeholder interaction; the communicational dimension indicates the level of openness and intensity of information exchange; and the social dimension highlights the potential impact of university–stakeholder cooperation on community development and civic engagement.

At the same time, it should be emphasized that this approach represents a conceptual foundation. It provides general methodological guidelines for evaluation but does not constitute a finalized or universal methodology. Its application requires adaptation to a particular university's values, the specifics of its activities, and the environment in which it operates.

The self-assessment procedure is based on the principles of strategic partnership, transparency and openness, mutual benefit, adaptability, integration of knowledge and resources, network interaction, and social orientation, which allows for the evaluation not only of the existence of interaction but also of its qualitative characteristics.

Supplementing existing approaches to assessing stakeholder engagement with a social set of questions expands the toolkit for analyzing universities' interactions with stakeholders and accounts for their contribution to the implementation of the university's social mission. The proposed methodology is flexible, easy to use, and can be applied both at the university level as a whole and to analyze the interactions of individual structural units or stakeholder groups.

The novelty of the proposed three-component approach lies in its expansion of the traditional framework for assessing stakeholder engagement by adding a social dimension alongside the organizational and communicational ones:

- the organizational dimension makes it possible to evaluate the presence of managerial mechanisms and procedures for stakeholder interaction;

- the communicational dimension captures the level of openness, transparency, and intensity of information flows;

- the social dimension introduces a new emphasis on the impact of university–stakeholder cooperation on community development and the formation of civic engagement.

Thus, the novelty consists in the creation of a framework model that integrates internal (organizational and communicational) and external (social) aspects of interaction. This enables not only the assessment of managerial and communicational practices but also the consideration of the broader societal effects of university–stakeholder partnerships. In this way, the proposed approach serves as a conceptual foundation for multidimensional diagnostics, combining managerial, informational, and social perspectives, which makes the evaluation more comprehensive and relevant to contemporary conditions.

Prospects for further research lie in developing a comprehensive set of tools for empirically measuring higher education institutions' interactions with stakeholders, particularly by creating matrix mapping models of stakeholders that account for the social dimension of partnership interactions and their impact on the development of local communities.

References

Agasisti, T., Barra, C., & Zotti, R. (2019). Research, knowledge transfer, and innovation: The effect of Italian universities' efficiency on local economic development 2006−2012. *Journal of Regional Science, 59*, 819–849.

Carayannis, E. G., & Campbell, D. F. J. (2009). 'Mode 3' and 'Quadruple Helix': Toward a 21st-century fractal innovation ecosystem. *International Journal of Technology Management*, 46(3–4), 201–234. https://doi.org/10.1504/IJTM.2009.023374

Carayannis, E. G., & Campbell, D. F. J. (Eds.). (2019). Quadruple Helix collaborations in practice: Stakeholder interaction, responsibility and governance. Springer Retrieved from https://riconfigure.eu/wp-content/uploads/2021/06/D6.4-Quadruple-Helix-Collaborations-in-Practice-1.pdf

De Groot, L. (2025). Multi-stakeholder networks in the higher education context. This source can strengthen the theoretical section on network partnership beyond formal stakeholder lists. ttps://doi.org/10.1080/1360080X.2025.2451445

Dereso, C. W. (2021). The role of community engagement in higher education: Convergence relating to knowledge growth – A practical model and guidelines. *Psychology and Education Journal*, 58(2), 6529–6534. https://doi.org/10.17762/pae.v58i2.3186

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From national systems and «Mode 2» to a Triple Helix of university–industry–government relations. *Research Policy, 29*(2), 109–123. https://doi.org/10.1016/S0048-7333(99)00055-4

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy*, 29(2), 109–123. https://doi.org/10.1016/S0048-7333(99)00055-4

Farnell, T. (2020). 'Community engagement in higher education: trends, practices and policies', NESET report, Luxembourg: Publications Office of the European Union. https://doi.org/10.2766/071482

Fassin, Y. (2009). The stakeholder model refined. *Journal of Business Ethics, 84*(1), 113–135. https://doi.org/10.1007/s10551-008-9677-4

Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Boston: Pitman. Retrieved from https://albimarketing.com/docs/Stakeholder_Approach_to_Strategic_Management.pdf

Gogiashvili, S. (2022). Stakeholders in higher education – Transforming for development and well-being. *Journal of Development Studies, 2*(1). https://doi.org/10.52340/jds.2021.06

Havrylychenko, Ye. V. (2014). Teoretyko-metodychni polozhennia ta osoblyvosti formuvannia steikkholderiv na pidpryiemstvakh zhytlovo-komunalnoho hospodarstva [Theoretical and methodological principles and features of stakeholder formation at housing and communal enterprises]. *Aktualni problemy ekonomiky, 8*, 127–135 [in Ukrainian]

Hevko, I., & Borysov, V. (2020). Vzaiemodiia steikkholderiv iz zakladamy vyshchoi osvity v umovakh optymizatsii osvitnoho protsesu [Stakeholder Interaction with Higher Education Institutions in the Context of Optimization of the Educational Process]. *Visnyk Cherkaskoho natsionalnoho universytetu imeni Bohdana Khmelnytskoho. Seriia «Pedahohichni nauky» – Bulletin of the Cherkasy Bohdan Khmelnytsky National University. Series «Pedagogical Sciences», 3,* 57–63. https://doi.org/10.31651/2524-2660-2020-3-57–63 [in Ukrainian]

Hinterleitner, I., Pflitsch, G., Penker, M., Sedlacek, S., & Radinger-Peer, V. (2026). Unveiling the role of higher education institutions in regional sustainability transitions: a systematic literature review and research agenda. *Sustain Sci, 21*, 381–400. https://doi.org/10.1007/s11625-025-01736-1

Holovne upravlinnia statystyky u Poltavskii oblasti. (2025). Informatsiia pidhotovlena na pidstavi danykh Yedynoi derzhavnoi elektronnoi bazy z pytan osvity [Information prepared on the basis of data from the Unified State Electronic Database on Education]. Retrieved from https://www.pl.ukrstat.gov.ua/main/stat_info/osv/osv4.htm [in Ukrainian]

IREG Guidelines for Stakeholders of Academic Rankings. Retrieved from https://ireg-observatory.org/en/

Joyce, W. A., & Richard, J. A. (2020). A conceptual analysis of stakeholder networking in higher education institutions. *International Journal of Social Science and Humanities Research*, 8(4), 203–206 Retrieved from https://www.academia.edu/44633141/A_Conceptual_Analysis_of_Stakeholder_Networking_in_Higher_Education_Institutions

Karlina, O. (2023). Pravylna komunikatsiia zi steikkholderamy – vazhlyva navychka biznes-analityka [Effective communication with stakeholders as an important skill of a business analyst]. *E5.* Retrieved from https://e5.ua/uk/blogpost-2/pravylna-komunikatsiya-zi-stejkholderamy-vazhlyva-navychka-biznes-analityka/

Koekkoek, A. et al. (2024). *University–community engagement in the Netherlands*. This is a useful source for understanding the drivers, institutional forms, and motivations behind university-community interactions https://doi.org/10.3389/feduc.2024.1005693

Kononova, N. V., & Us, M. I. (2025). STEEP+S-analiz yak instrument marketynhu vzaiemodii zakladiv vyshchoi osvity zi steikkholderamy v umovakh tsyfrovizatsii [STEEP+S analysis as a marketing tool of interaction between higher education institutions and stakeholders in digitalization]. *Marketing and Management of Innovations, 78*(2), 90–102. https://doi.org/10.32782/2524-0072/2025-78-90 [in Ukrainian]

Kovalenko, O. (2021). Poniattia «steikkholder» ta yikh rol u roboti suchasnoho universytetu [The concept of «stakeholder» and their role in the work of a modern university]. *Novi tekhnolohii navchannia, 95*, 98–105. https://doi.org/10.52256/2710-3560.95.2021.11 [in Ukrainian]

Labe, M. J. E. (2024). Stakeholders' engagement in the realization of vision and mission of educational institution: Basis for re-branding strategies. *International Journal of Management and Commerce Innovations, 12*, 136–141. https://doi.org/10.5281/zenodo.13078454

Labe, M. J. E. (2024). University–community engagement and the role of higher education institutions in local development. *Journal of Higher Education Outreach and Engagement*, 28(1), 45–60

Málovics, G. et al. (2025). *University–community engagement and sustainability transitions*. This article is well-suited to strengthening the argument about the university's social role, different models of institutionalization, and the tension between formal and genuinely effective forms of interaction https://doi.org/10.1016/j.ijme.2025.101228

Nabaho, L., Turyasingura, W., Twinomuhwezi, I., & Nabukenya, M. (2022). The Third Mission of Universities on the African Continent: Conceptualisation and Operationalisation. *Higher Learning Research Communications, 12* (1). https://doi.org/10.18870/hlrc.v12i1.1298

Nabaho, L., Turyasingura, W., Twinomuhwezi, I., & Nabukenya, M. (2022). The third mission of universities on the African continent: Conceptualisation and operationalisation. *Higher Learning Research Communications, 12*(1), 81–98. https://doi.org/10.18870/hlrc.v12i1.1298

Poniattia pro steikkholderiv [The concept of stakeholders]. (n.d.). Retrieved from https://hb.mdpu.org.ua/kafedra-ekologiyi-ta-zoologiyi/stejkholdery [in Ukrainian]

Popadynets, I., Andrusiv, U., Shtohryn, M & Galtsova, O. (2020). The effect of cooperation between universities and stakeholders: Evidence from Ukraine. *International Journal of Data and Network Science*, 4(2), 199–212. https://doi.org/10.5267/j.ijdns.2020.1.001

Popadynets, I. R. (2018). Diahnostuvannia steikkholderiv naftohazovykh pidpryiemst [Diagnostics of stakeholders of oil and gas enterprises]. *Ekonomichnyi prostir, 135*. https://doi.org/10.30838/P.ES.2224.290818.181.188 [in Ukrainian]

Pro skhvalennia Stratehii rozvytku vyshchoi osvity v Ukraini na 2022–2032 roky [On approval of the Strategy for the Development of Higher Education in Ukraine for 2022–2032]. (2022). Retrieved from https://mon.gov.ua/osvita-2/vishcha-osvita-ta-osvita-doroslikh/strategiya-rozvitku-vishchoi-osviti-v-ukraini-na-2022-2032-roki [in Ukrainian]

Rhodes, R. A. W. (1996). The new governance: Governing without government. *Political Studies*, 44(4), 652–667. https://doi.org/10.1111/j.1467-9248.1996.tb01747.x

Serhiienko, T. I. (2025). Steikkholdery osvitnoho protsesu: yak nalahodyty efektyvnyi dialoh u pidhotovtsi zdobuvachiv vyshchoi osvity [Stakeholders of the educational process: How to establish an effective dialogue in training higher education students]. *Higher Education Review, 1*(3), 45–56. https://doi.org/10.18372/2786-5487.1.20314 [in Ukrainian]

Shevchenko, N. O., & Khytko, M. Ya. (2020). Rol steikkholderiv u systemi zabezpechennia yakosti vyshchoi osvity [The role of stakeholders in the system of quality assurance in higher education]. In *Filosofiia i kultura v minlyvosti sohodennia* (pp. 60–66). Dnipro: NTU "DP". [in Ukrainian]

Spânu, P., Ulmeanu, M.-E., & Doicin, C.-V. (2024). Academic Third Mission through Community Engagement: An Empirical Study in European Universities. *Education Sciences, 14*(2), 141. https://doi.org/10.3390/educsci14020141

Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG). (2015). Retrieved from https://enqa.eu/wp-content/uploads/2015/11/ESG_2015.pdf [in Ukrainian]

Tereshchenko, A. A. (2025). Subiektnist steikkholderiv vyshchoi osvity: problemy habitualizatsii [Subjectivity of higher education stakeholders: Problems of habitualization]. *Journal of Social Sciences, 72*(1), 25–34. https://doi.org/10.32782/2663-5208.2025.72.1.3 [in Ukrainian]

Triple helix model of innovation (2026). In Wikipedia Retrieved from https://en.wikipedia.org/wiki/Triple_helix_model_of_innovation

Trunina, I., & Bilyk, M. (2021). Formuvannia konkurentnykh perevah zakladiv vyshchoi osvity [Formation of competitive advantages of higher education institutions]. *Visnyk KrNU imeni Mykhaila Ostrohradskoho, 2*(127). https://doi.org/10.30929/1995-0519.2021.2.36-40 [in Ukrainian]

Vasiuk, N., & Haievska, L. (2023). Mekhanizmy merezhevoho upravlinnia v diialnosti orhaniv publichnoi vlady: sutnist poniat [Mechanisms of network governance in the activities of public authorities: The essence of concepts]. *Public Administration Aspects*, 11(2), 17–23. DOI https://doi.org/10.15421/152314 [in Ukrainian]

Vasynova, N. (2023). Vzaiemodiia zakladu vyshchoi osvity iz steikkholderamy: dosvid ta napriamy rozvytku [Interaction of a higher education institution with stakeholders: Experience and directions of development]. *Aktualni pytannia humanitarnykh nauk, 59*(1), 251–255. DOI https://doi.org/10.24919/2308-4863/59-1-39 [in Ukrainian]

Vasynova, N. S. (2022). Steikkholderskyi pidkhid yak umova stratehichnoho rozvytku universytetu [Stakeholder approach as a condition for strategic development of a university]. *Aktualni pytannia humanitarnykh nauk, 57*(1), 250–254. DOI https://doi.org/10.24919/2308-4863/57-1-36 [in Ukrainian]

Vasynova, N. S. (2023). Steikkholderstvo yak osnova upravlinnia universytetom v umovakh yevrointehratsii [Stakeholderism as a basis for university management in the context of European integration]. *Osvita ta pedahohichna nauka, 2*(183), 3–12. DOI https://doi.org/10.12958/2227-2747-2023-2(183)-3-12 [in Ukrainian]

What is stakeholder engagement, and why is it important for strategic planning? (2021). Retrieved from https://www.smestrategy.net/blog/stakeholder-engagement-management-for-strategic-planning

Part II.

WELL-BEING, SAFETY, AND RESILIENCE IN EDUCATIONAL COMMUNITIES

Chapter 4. SUPPORTING THE WELL-BEING OF CHILDREN AND TEACHERS IN TIMES OF EDUCATIONAL UNCERTAINTY: MANAGEMENT STRATEGIES AND PRACTICAL TOOLS FOR SUSTAINING EDUCATIONAL QUALITY

Yuliia Shpaliarenko

Abstract. *This chapter examines the well-being of teachers and children as a condition for sustaining educational quality in times of educational uncertainty. The study is based on the premise that uncertainty in contemporary education should be understood not only as a situational disruption but as a broader condition that affects organizational stability, pedagogical interaction, emotional safety, and the capacity of educational institutions to maintain coherent and supportive learning environments. The chapter analyzes contemporary approaches to educational uncertainty, teacher well-being, student well-being, leadership, organizational culture, and practical strategies for support in educational settings. Particular attention is paid to the interdependence of teacher and student well-being and to the institutional mechanisms through which educational environments either buffer or intensify the effects of instability. The methodological design combines theoretical analysis and synthesis of current research with the interpretation of empirical data from a teacher survey and the analysis of educational practices. The empirical findings show that teachers' professional well-being is shaped primarily by administrative support, the psychological climate within the staff, and professional collaboration, whereas students' well-being depends above all on positive relationships with teachers, a supportive classroom atmosphere, and peer support. On this basis, the chapter substantiates an integrated model of well-being support that combines managerial, pedagogical, psychological, and social dimensions. It is argued that educational quality in uncertain conditions depends not only on instructional continuity and formal academic outcomes but also on institutions' ability to preserve trust, engagement, emotional safety, and professional sustainability. The chapter concludes that well-being should be treated as a strategic component of educational management and as one of the conditions that make humane, stable, and effective education possible.*

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Introduction

Contemporary educational systems increasingly function under conditions of instability, accelerated change, and growing institutional complexity. Educational institutions are expected to preserve the continuity and quality of the educational process while simultaneously responding to pressures that affect organizational routines, pedagogical interaction, and the psychological state of all participants in education. Under such conditions, educational quality can no longer be interpreted solely through academic outcomes, curriculum implementation, or formal indicators of institutional effectiveness. It also depends on whether the educational environment remains psychologically sustainable, socially supportive, and organizationally responsive for both teachers and children (Bozkurt et al., 2020; UNESCO, 2020).

Educational uncertainty should therefore be understood not as an isolated disruption, but as a broader and more durable condition of contemporary education. It emerges through the interaction of social transformation, technological shifts, resource limitations, changing policy expectations, and the need for rapid adaptation to unpredictable circumstances. The pandemic period made these processes especially visible, revealing how fragile educational continuity may become when schools are forced to reorganize learning conditions, communication practices, and support mechanisms within a very short time. In such situations, uncertainty affects not only the technical organization of teaching and learning but also trust, predictability, emotional safety, and the perceived stability of the educational environment (Bozkurt et al., 2020; Kim & Asbury, 2020).

This shift has intensified scholarly attention to the well-being of participants in the educational process. In current research, well-being is increasingly interpreted as a multidimensional construct that includes psychological, emotional, social, professional, and organizational dimensions of functioning within

educational settings. In relation to teachers, it encompasses professional resilience, emotional stability, perceived support, job satisfaction, and the capacity to sustain effective pedagogical work under pressure. In relation to children, it includes emotional safety, school connectedness, a sense of belonging, supportive interaction with teachers and peers, and engagement in learning. Such an understanding makes it possible to treat well-being not as an auxiliary matter of personal comfort, but as a systemic condition for the functioning and sustainability of the educational environment (Dreer, 2023; Gámez-Genovart et al., 2025; Kurrle et al., 2025).

The growing relevance of this issue is also linked to the fact that the relationship between well-being and educational quality has become increasingly evident in both empirical research and educational practice. Teachers' professional well-being is associated with instructional functioning, professional engagement, retention, and the quality of pedagogical interaction, whereas children's well-being influences motivation, self-regulation, participation, and learning engagement (Day & Gu, 2014; Dreer, 2023). When the educational environment fails to support these dimensions, the consequences extend beyond temporary emotional discomfort. They may include professional exhaustion, reduced job satisfaction, weakened classroom climate, lower student engagement, and a diminished institutional capacity to maintain quality under conditions of instability (Collie, 2021; Ozturk et al., 2024).

At the same time, contemporary scholarship shows that this field remains conceptually fragmented. Teacher well-being, student well-being, burnout, resilience, school connectedness, organizational climate, leadership, and social and emotional learning are often studied as related but analytically separate domains. As a result, the literature contains a substantial body of evidence, yet comparatively fewer integrative analyses explain how these dimensions function together as a coherent system for sustaining educational quality in times of uncertainty. This gap is especially significant for educational management, because the practical question is not merely whether well-being matters, but how educational institutions can organize conditions, relationships, and support mechanisms so that well-being

becomes an embedded component of educational quality rather than an isolated supportive initiative (Gámez-Genovart et al., 2025; Kurrle et al., 2025; Wu, 2025).

Another important aspect is that well-being in education is shaped not only by individual coping capacities but also by institutional arrangements. Leadership style, organizational culture, administrative support, professional collaboration, internal communication, and partnership-based interaction all influence whether educational institutions are able to create a stable and humane environment for teaching and learning. Research has shown that supportive leadership and positive organizational conditions are associated with lower emotional exhaustion, stronger professional functioning, and greater sustainability of pedagogical work (Collie, 2021; Day & Gu, 2014; OECD, 2019). In this regard, well-being should be located simultaneously in the psychological, pedagogical, and managerial dimensions of education. Such an approach allows it to be considered not merely a peripheral theme but a strategic resource for sustaining the educational process.

This perspective is equally relevant to children's well-being. Recent studies increasingly emphasize that the quality of students' educational experience depends not only on academic provision but also on whether the school environment fosters belonging, connectedness, emotional safety, and constructive relationships. Positive teacher-student relationships and whole-school conditions that support belonging strengthen resilience, improve engagement, and contribute to healthier patterns of participation in educational life (Allen et al., 2016; Baker et al., 2008; Wu, 2025). Likewise, universal school-based social and emotional learning programs have been shown to support both student development and the broader school climate, which reinforces the idea that well-being and educational quality should be approached as mutually connected rather than parallel goals (Cipriano et al., 2024; Jennings & Greenberg, 2009; Zins et al., 2004).

In this regard, particular attention should be paid to practical approaches that support well-being at different levels of educational functioning. Contemporary research points to the value of social and emotional learning, reflective practice, professional learning communities, emotionally supportive

pedagogical interaction, and institutional systems that combine psychological, pedagogical, and organizational measures. However, the effectiveness of such approaches depends on whether they are implemented as isolated interventions or as part of a coordinated institutional strategy. Sustainable improvement becomes possible only when support for well-being is integrated into the daily life of the educational institution, including teaching practice, professional development, school leadership, and internal support systems (Avola et al., 2025; Hargreaves & Fullan, 2012; OECD, 2021).

The purpose of this chapter is to analyze the relationships among educational uncertainty, the well-being of teachers and children, and the quality of education, and to systematize managerial, pedagogical, and psychological mechanisms for supporting well-being in educational institutions.

To achieve this purpose, the chapter addresses several interrelated objectives. First, it clarifies contemporary approaches to understanding educational uncertainty and well-being in the educational process. Second, it systematizes the main factors influencing the well-being of teachers and children in educational settings. Third, it examines the relationship between well-being, organizational conditions, and the quality of education. Fourth, it substantiates an integrated system of managerial and pedagogical tools that may support well-being in educational institutions under conditions of instability and change.

The chapter is based on a combination of theoretical and empirical analytical procedures. It includes the analysis and synthesis of contemporary scientific literature, the comparative generalization of theoretical approaches, the systematization of key factors shaping well-being in educational environments, and the interpretation of empirical data obtained through a survey of teachers and the analysis of educational practices aimed at fostering a supportive climate in educational institutions. This combination makes it possible to consider well-being not only as a theoretical category, but also as a practical domain of educational management and pedagogical action.

The chapter's structure follows this logic. It first reviews contemporary scholarship on educational uncertainty, teacher

well-being, student well-being, leadership, organizational culture, and supportive educational practices. It then presents the methodological foundations of the analysis and discusses the main results concerning the factors that shape well-being and their connection to educational quality. Particular attention is given to the role of educational leadership, professional support for teachers, positive teacher-student relationships, and the integration of social and emotional learning into a broader institutional system of support. The chapter concludes with a discussion of the findings and practical implications for creating educational environments that are not only effective but also psychologically sustainable and developmentally supportive.

Analysis of current research

Educational Uncertainty as a Contemporary Condition of the Educational Process

Educational uncertainty has become a stable feature of contemporary education rather than a temporary disruption. It emerges through the interaction of social change, technological transformation, institutional pressure, and the need for rapid adaptation to unstable conditions. In such circumstances, the educational process becomes more vulnerable to interruptions, weakened predictability, communication difficulties, and emotional strain. Research shows that uncertainty affects not only the organization of teaching and learning, but also the quality of relationships, the sense of safety within school life, and the capacity of educational institutions to maintain continuity and trust (Bozkurt et al., 2020; Kim & Asbury, 2020).

This means that educational quality in uncertain conditions cannot be interpreted only through academic outcomes or formal instructional continuity. It also depends on whether the school remains a supportive, coherent, and psychologically sustainable environment for teachers and children. In this perspective, educational uncertainty highlights the interdependence of organizational conditions, pedagogical interaction, and participants' well-being, making well-being one of the conditions through which educational quality is preserved (Day & Gu, 2014; OECD, 2019).

An important implication of this understanding is that educational uncertainty changes not only the operational conditions of schooling but also the criteria by which institutional effectiveness is judged. In stable contexts, effectiveness is often associated with continuity, predictability, and measurable outcomes. Under uncertain conditions, however, institutions are also evaluated by their ability to remain adaptive without fragmenting, and by their capacity to preserve supportive interactions while responding to change. This broader interpretation shifts attention from formal stability alone to the resilience of the educational environment as a whole. It also explains why uncertainty should be studied not merely as a disruptive factor, but as a condition that reveals the deeper dependence of educational quality on relationships, trust, and institutional support.

Teacher Well-Being: Stress, Burnout, Resilience, and Professional Agency

Teacher well-being is increasingly viewed as a multidimensional construct that includes emotional stability, job satisfaction, resilience, perceived support, and the capacity to sustain effective pedagogical work. Contemporary studies show that teachers' well-being is influenced not only by personal coping resources but also by organizational climate, leadership, workload, collegial relations, and access to professional development (Dreer, 2023; Gámez-Genovart et al., 2025; Ozturk et al., 2024).

Particular attention in the literature is given to stress and burnout as risks that weaken pedagogical effectiveness and professional retention. At the same time, resilience, emotional regulation, and professional agency are considered important protective resources. These resources, however, are not formed in isolation. They are strengthened or undermined by institutional conditions. Thus, teacher well-being should be treated not only as an issue of occupational health, but also as a dimension of educational quality and institutional sustainability (Beltman et al., 2011; Collie, 2021; Day & Gu, 2014).

This broader perspective also helps explain why teacher well-being has become increasingly relevant in discussions of educational sustainability. Teachers are not only transmitters of curriculum content; they are central actors in maintaining continuity, emotional stability, and pedagogical coherence within the educational process. When their professional well-being is undermined, the effects extend beyond individual distress and may alter the quality of communication, the responsiveness of instruction, and the overall school climate. For this reason, supporting teacher well-being should be understood as an investment in the institution's long-term capacity to function effectively under pressure rather than as a narrowly individualized form of professional assistance.

Student Well-Being: Belonging, Connectedness, Resilience, and Engagement

Student well-being is likewise interpreted as a multidimensional phenomenon that includes emotional safety, belonging, connectedness, supportive relationships, resilience, and engagement in learning. In recent research, the concepts of school connectedness and belonging have become especially important because they explain how learners experience school not only as an instructional setting, but also as a relational and social environment (Allen et al., 2016; Wu, 2025).

Studies show that student well-being is strongly influenced by teacher-student relationships, classroom climate, peer support, and opportunities for meaningful participation. Resilience is viewed not as a fixed individual trait, but as a dynamic process supported by predictable routines, supportive interaction, and inclusive school conditions. This means that student well-being is directly linked to learning engagement and should be considered one of the conditions through which educational quality is sustained (Cipriano et al., 2024; Jennings & Greenberg, 2009; Masten & Motti-Stefanidi, 2020).

This interpretation is especially important because it positions student well-being within the core logic of educational participation rather than at the margins of school life. A learner's ability to remain attentive, motivated, and involved in learning

depends to a considerable degree on whether the school environment is experienced as meaningful and emotionally secure. When belonging and connectedness are present, students are more likely to interpret challenges as manageable and to remain engaged even in unstable situations. When these conditions are weak, disengagement may emerge gradually and remain unnoticed until it affects both academic participation and broader developmental outcomes. Thus, student well-being should be treated as both an educational and a relational condition of successful schooling.

Leadership, Organizational Culture, and Support Systems in Educational Institutions

The well-being of teachers and children depends substantially on institutional conditions. Leadership, organizational culture, and support systems shape the environment in which pedagogical interaction occurs and therefore influence whether schools remain coherent and supportive under pressure. Research demonstrates that supportive leadership is associated with teacher satisfaction, lower emotional exhaustion, and a stronger school climate, while a constructive organizational culture strengthens trust, collegiality, and the stability of professional functioning (Collie, 2021; Day & Gu, 2014; Gámez-Genovart et al., 2025).

Institutional support systems, including professional collaboration, mentoring, counseling, and mechanisms of communication and feedback, are especially important in uncertain conditions. They allow schools not only to respond to difficulties, but also to create continuity and shared responsibility. Thus, leadership and organizational culture should be viewed as mediating mechanisms through which uncertainty is either buffered or intensified within the educational process.

What follows from this is that institutional support for well-being cannot be reduced to the presence of separate services or formal policies alone. Its effectiveness depends on whether leadership, culture, and support structures operate in a coordinated way and are visible in everyday school life. A school may formally possess support mechanisms, but if communication

remains weak, trust is limited, or staff do not perceive support as accessible, these mechanisms will have only a partial impact. By contrast, where institutional norms encourage dialogue, shared responsibility, and responsiveness, support becomes a lived feature of the educational environment. This is why leadership and organizational culture should be understood as the conditions through which supportive systems either gain practical force or remain merely declarative.

Practical Approaches to Supporting Well-Being in Educational Settings

Contemporary research highlights several practical approaches that help sustain well-being in educational institutions. Among the most significant are social and emotional learning, reflective practice, professional learning communities, psychologically supportive pedagogy, counseling support, and partnership with families and communities (Cipriano et al., 2024; Hargreaves & Fullan, 2012; OECD, 2019).

The effectiveness of these approaches depends on whether they are implemented as isolated interventions or as part of a coherent whole-school strategy. The literature suggests that well-being is best supported when pedagogical, psychological, and organizational practices are aligned and embedded in the institution's everyday life. Therefore, practical support for well-being should be interpreted as a systemic rather than fragmentary dimension of educational management.

Taken together, these approaches suggest that practical support for well-being should be interpreted as a continuous institutional process rather than as a set of occasional corrective actions. Their value lies not only in helping schools respond to already visible difficulties, but also in creating a climate in which emotional safety, collaboration, and supportive interaction become normal features of educational life. In this sense, practical approaches function most effectively when they reinforce one another: pedagogical practices support classroom climate, professional collaboration strengthens teacher resilience, and institutional coordination ensures that separate measures contribute to a broader whole-school logic. Such alignment makes

support for well-being more sustainable and more closely connected with the long-term quality of the educational process.

Methods and Analytical Design

This chapter is based on a combination of theoretical and empirical analytical procedures. The theoretical part includes the analysis and synthesis of contemporary scientific literature on educational uncertainty, teacher well-being, student well-being, leadership, organizational culture, and supportive educational practices. A comparative analysis was used to identify common and distinctive approaches to understanding well-being in educational settings, while systematization and generalization enabled the identification of the main factors influencing the quality and sustainability of the educational process.

The empirical component relies on data from a teacher survey and on the analysis of educational practices aimed at fostering a supportive psychological climate in educational institutions. The obtained data were used not for broad statistical generalization, but to identify dominant tendencies and practically significant relationships among organizational support, professional well-being, and the characteristics of the educational environment.

The analytical design of the chapter integrates three interrelated levels of interpretation: the conceptual level, which clarifies the theoretical meaning of educational uncertainty and well-being; the organizational level, which examines leadership, culture, and support systems; and the practical level, which systematizes concrete approaches to supporting the well-being of teachers and children in educational settings.

Results

Educational Uncertainty, Well-Being, and Quality of Education: A Conceptual Model

The analysis presented in the previous sections makes it possible to conceptualize the relationship between educational uncertainty, well-being, and quality of education as a dynamic and

interdependent system rather than a sequence of isolated influences. In this system, uncertainty functions not simply as an external challenge, but as a condition that changes the requirements placed on educational institutions, teachers, and children. It intensifies the need for adaptability, increases emotional and organizational strain, and makes the stability of the educational process more dependent on the relational and institutional resources available within the educational environment.

Within this framework, well-being should be treated as a mediating factor that links external instability to the internal capacity of the educational system to function effectively. Educational uncertainty does not influence educational quality only through logistical disruption or structural change. Its effects are mediated by how participants in the educational process experience uncertainty, how institutions organize support, and whether the educational environment preserves emotional safety, professional viability, and meaningful engagement in learning. In other words, uncertainty affects quality not directly, but through the conditions it creates for or against well-being.

The proposed conceptual model rests on three interconnected assumptions. First, educational uncertainty generates organizational, pedagogical, and psychological pressure within the educational environment. This pressure may take the form of disrupted routines, increased workload, reduced predictability, communication difficulties, emotional tension, and weakened continuity of interaction. Second, the impact of such pressure depends on the quality of institutional mediation. Leadership, organizational culture, support systems, and pedagogical practices may either buffer uncertainty or amplify its negative consequences. Third, the state of well-being among teachers and children directly influences the quality of the educational process by shaping instructional functioning, learning engagement, relational stability, and the overall sustainability of educational activity.

At the center of this model lies the idea that teacher well-being and student well-being are distinct but closely interconnected dimensions. Teacher well-being includes emotional stability, professional efficacy, perceived support, resilience, and

the capacity to sustain meaningful pedagogical work. Student well-being includes emotional safety, belonging, connectedness, self-regulation, and engagement in learning. These two dimensions interact continuously. When teachers operate in conditions of chronic stress, low support, or professional exhaustion, the quality of pedagogical interaction is likely to weaken, potentially reducing students' sense of safety, trust, and motivation. Conversely, when students experience disconnection, emotional strain, or low engagement, this may intensify the emotional burden of teaching and complicate professional functioning. Thus, teacher and student well-being should be understood not as parallel domains, but as mutually influencing components of the educational environment.

The model also emphasizes the institutional level as a decisive mediating space. Educational leadership, organizational culture, and support systems are not external additions to pedagogical work. They determine whether the school is capable of transforming instability into a manageable challenge rather than an accumulated strain. Supportive leadership provides direction, recognition, and coherence. A constructive organizational culture fosters trust, collegiality, and open communication. Support systems make it possible to respond to emotional, social, and professional difficulties before they develop into deeper forms of disengagement or exhaustion. Together, these elements shape the institutional capacity to protect well-being under pressure.

A further element of the model concerns pedagogical and relational practices. Even in institutions with supportive leadership, educational quality cannot be sustained if well-being is not enacted in daily educational interaction. Social and emotional learning, reflective practice, positive teacher–student relationships, peer collaboration, and partnership with families function here as concrete mechanisms through which institutional values are translated into lived educational experience. These practices strengthen the school's relational fabric and make well-being visible in everyday routines rather than in formal declarations alone.

In this conceptualization, the quality of education is interpreted broadly. It includes not only academic achievement or formal compliance with curricular standards, but also the ability of the educational process to remain coherent, inclusive, engaging, and developmentally supportive under changing conditions. Such an understanding does not weaken academic expectations. On the contrary, it clarifies that sustained educational quality depends on the human and institutional conditions that enable meaningful learning. Where well-being is undermined, educational quality becomes more fragile, even if formal instructional structures remain in place. Where well-being is systematically supported, schools are more likely to maintain participation, pedagogical continuity, and institutional resilience.

The model therefore can be summarized as follows: educational uncertainty creates pressure on the educational environment; institutional conditions mediate the extent to which this pressure is buffered or intensified; teacher and student well-being function as central mediating mechanisms through which uncertainty affects pedagogical interaction and learning engagement; and the quality of education emerges as the result of how successfully the institution sustains supportive, coherent, and adaptive conditions for teaching and learning. This interpretation allows well-being to be viewed not as a secondary outcome of effective schooling, but as one of the conditions that make effective schooling possible. Figure 1 visualizes the interdependence between educational uncertainty, institutional support, teacher and student well-being, and educational quality. The interrelationships among educational uncertainty, institutional support, teacher and student well-being, and educational quality are presented in Figure 1.

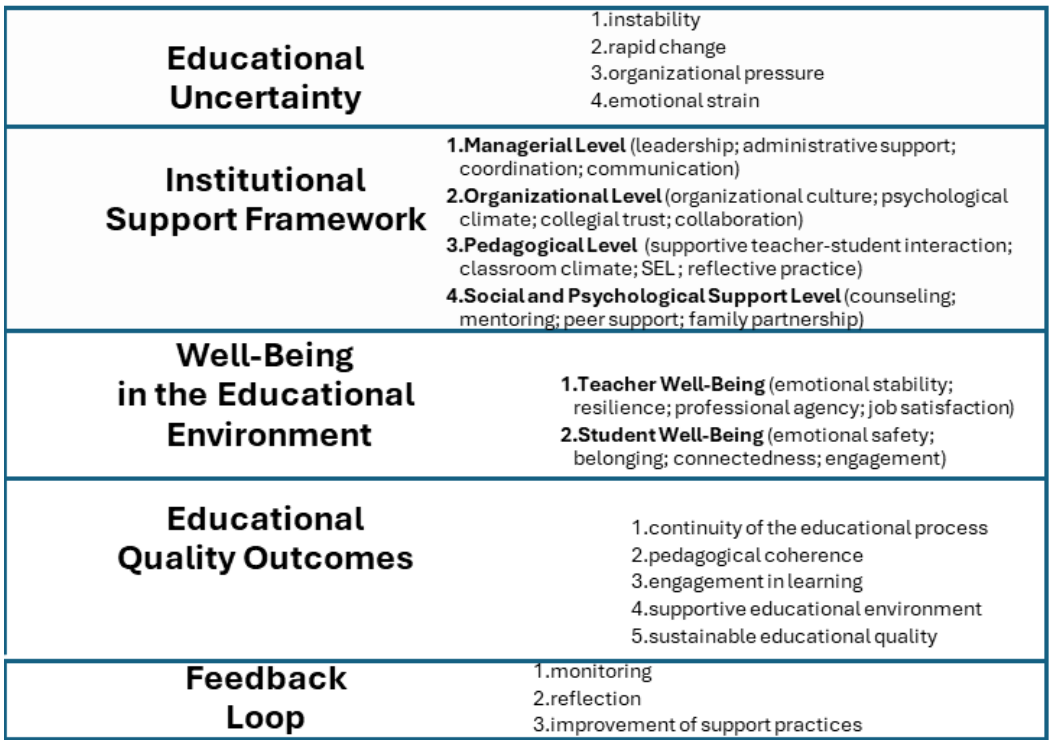

Figure 1

Integrated model of well-being support in educational institutions

Source: Compiled by the authors based on the theoretical analysis conducted in this study.

From an analytical perspective, this conceptual model is important for two reasons. First, it integrates the main lines of contemporary research that are often treated separately: uncertainty, leadership, teacher well-being, student well-being, organizational culture, and practical support mechanisms. Second, it provides a framework for interpreting the empirical material presented in the following subsections. The survey data and the analysis of educational practices can be understood more clearly when viewed through this integrated perspective, because they show not isolated indicators, but the practical expression of broader systemic relationships.

Thus, the conceptual model developed in this section establishes the chapter's general logic. It shows that the preservation of educational quality in uncertain conditions depends not only on institutional adaptation in the narrow administrative sense, but also on the capacity of the educational

environment to support the well-being of those who teach and those who learn. On this basis, the next subsection turns to the empirical analysis of the factors shaping teachers' professional well-being.

Factors Shaping Teachers' Professional Well-Being

The empirical analysis confirms that teachers' professional well-being is shaped primarily by institutional and relational rather than purely individual factors. Although personal coping capacities and emotional resources remain important, the obtained data indicate that the quality of professional functioning depends to a considerable extent on how the educational institution organizes support, communication, and opportunities for professional development. In this respect, the empirical material aligns with the broader theoretical argument of the chapter: teacher well-being should be interpreted as a result of interaction between individual resilience and organizational conditions rather than as a private psychological characteristic detached from school life.

The empirical component of the study involved a survey of 120 teachers from general secondary education institutions with different lengths of teaching experience. The data show that teachers generally assessed their professional well-being as moderate or high, although a noticeable proportion reported lower evaluations. High levels were reported for psychological climate within the staff by 52% of respondents, for job satisfaction by 48%, for support from school administration by 45%, and for opportunities for professional development by 41%. At the same time, 14% of respondents reported low evaluations for psychological climate, 15% for job satisfaction, 16% for support from administration, and 17% for professional development opportunities. These data suggest that teachers' well-being cannot be interpreted as either uniformly positive or uniformly problematic; rather, it appears unevenly sustained and strongly dependent on institutional conditions.

The first group of data concerns teachers' assessments of their own professional well-being. The results show that the largest proportion of respondents evaluated job satisfaction, the psychological climate within the staff, and support from

administration at high or medium levels, while a smaller but still notable proportion reported low evaluations in each of these domains. This distribution is important for two reasons. On the one hand, it indicates that the participating institutions are not characterized by a uniformly negative professional climate. On the other hand, it demonstrates that professional well-being cannot be treated as fully secured, since a meaningful share of respondents still experience insufficient levels of support, recognition, or developmental opportunity. Such a pattern suggests that teachers' well-being in educational institutions is better understood as unevenly sustained rather than stable by default.

Particularly revealing is the fact that the highest positive evaluations were associated with the psychological climate within the staff, while opportunities for professional development received comparatively lower assessments. This suggests that teachers tend to perceive interpersonal and collegial conditions somewhat more positively than the institutionalized possibilities for long-term professional growth. From an analytical point of view, this distinction is significant. It implies that a supportive social climate, although essential, does not automatically guarantee that teachers experience the institution as professionally enabling. Educational institutions may therefore demonstrate relatively strong relational cohesion while still remaining limited in their capacity to provide structured developmental support.

This conclusion becomes even more evident when the second set of results is considered, namely the factors teachers identified as most influential for their professional well-being. Administrative support was ranked as the most significant factor, followed by a positive psychological climate in the staff, professional collaboration with colleagues, opportunities for professional development, and workload balance. Such a distribution points clearly to the institutional nature of well-being. The fact that administrative support occupies the leading position indicates that teachers' professional stability depends heavily on whether school leadership is perceived as accessible, responsive, and capable of creating predictable and humane working conditions.

When respondents were asked to identify the factors that most strongly influence their professional well-being, support from administration ranked first (36%), followed by a positive psychological climate within the staff (28%), professional collaboration with colleagues (18%), opportunities for professional development (12%), and workload balance (6%). This distribution indicates that teachers associate their professional well-being primarily with the institutional and relational organization of school life rather than with individual adaptive capacity alone.

The importance of administrative support should not be interpreted narrowly as dependence on formal management. Rather, it reflects the central role of leadership in structuring the environment in which teachers work. Administrative support likely condenses several experiences into one indicator: clarity of communication, fairness of expectations, recognition of effort, responsiveness to difficulty, and the creation of conditions in which teachers do not feel professionally isolated. In this sense, the prominence of this factor in the empirical data supports the theoretical position advanced earlier in the chapter, namely that leadership functions as a mediating institutional mechanism through which uncertainty and professional strain are either buffered or intensified.

The high ranking of the psychological climate within the staff similarly confirms that well-being is deeply relational. Teachers appear to experience their professional condition not only in terms of workload and formal responsibilities, but also through everyday interactions with colleagues and the broader institutional atmosphere. A positive psychological climate likely provides emotional reassurance, reduces feelings of individual burden, and enables a more collaborative response to difficulty. It may also increase the likelihood that teachers perceive challenges as shared and manageable rather than as private evidence of inadequacy. In this respect, collegial relations constitute not merely a background feature of professional life, but one of its central protective resources.

Professional collaboration with colleagues, although placed below administrative support and general climate, also occupies an important position in the hierarchy of factors. This finding suggests that teachers value structures of professional exchange

and mutual support, but perhaps distinguish them from the broader institutional atmosphere. Collaboration may be understood here as a more active and practice-oriented dimension of support, one that includes joint reflection, sharing of strategies, and collective response to pedagogical problems. Its importance in the empirical data reinforces the argument that well-being is linked not only to emotional comfort, but also to teachers' sense of being able to function meaningfully within a professional community.

A noteworthy result concerns the comparatively lower position of opportunities for professional development. This does not mean that professional growth is unimportant. Rather, it suggests that, under contemporary institutional conditions, teachers may experience greater immediate dependence on support, communication, and climate than on developmental opportunities alone. In other words, professional development may matter most when more basic organizational and relational conditions are already sufficiently secure. If the educational environment is perceived as unstable or insufficiently supportive, training opportunities by themselves may not compensate for the resulting emotional or professional strain.

The smallest percentage of responses was associated with workload balance. This result should be interpreted cautiously. It does not necessarily indicate that workload is objectively unimportant. More likely, it suggests that teachers interpret the burden of workload through broader institutional and relational frames. Excessive load may become more bearable when communication is clear, collegial support is available, and leadership is responsive. Conversely, even a moderate workload may feel overwhelming in settings where trust, predictability, and recognition are weak. Thus, the relatively lower position of workload in the empirical ranking does not diminish its relevance, but rather indicates that teachers' experience of load is shaped by the wider ecology of professional functioning.

Taken together, these findings allow several conclusions to be drawn. First, teachers' professional well-being is strongly influenced by the institution's organizational environment. Second, leadership and collegial climate emerge as particularly influential factors, confirming the idea that teacher well-being

should be analyzed at the school level rather than solely at the level of individual adaptation. Third, professional collaboration and developmental opportunities matter, but they are most likely to support well-being effectively when embedded in a broader culture of recognition and support. Finally, the empirical material suggests that sustaining teacher well-being requires not isolated measures, but a coherent institutional approach that combines supportive leadership, constructive climate, and opportunities for meaningful professional participation.

From the perspective of the conceptual model proposed in the previous subsection, these results confirm that teacher well-being functions as a mediating mechanism between institutional conditions and the quality of the educational process. If teachers perceive the institution as supportive, communicatively coherent, and professionally enabling, they are more likely to sustain motivation, pedagogical responsiveness, and engagement in their work. If such conditions are weakened, the risk of emotional exhaustion and reduced effectiveness increases. The empirical data, therefore, support the broader claim of the chapter that educational quality in uncertain times depends substantially on how institutions sustain the professional well-being of those who carry the everyday work of teaching.

Factors Shaping Students' Well-Being in the Educational Environment

The empirical analysis of students' well-being factors indicates that the most influential elements are relational and climate-based rather than purely curricular or extracurricular. The leading factor identified in the data is positive relationships with teachers, followed by the psychological atmosphere in the classroom, peer support, interest in learning materials, and extracurricular activities. This hierarchy is analytically significant because it demonstrates that students' well-being is perceived to arise first of all from the relational quality of the educational environment. In other words, the child's sense of well-being is linked most strongly not to isolated activities or even to content alone, but to the human conditions in which educational participation unfolds.

The empirical results related to students' well-being show a similarly clear pattern. According to the teachers' responses, the most influential factor is positive relationships with teachers (39%), followed by the psychological atmosphere in the classroom (27%), support from peers (18%), interest in learning materials (10%), and extracurricular activities (6%). These data indicate that students' well-being is perceived primarily as a relational and climate-dependent phenomenon. The findings suggest that the emotional and social quality of everyday school life matters more for well-being than supplementary activities alone.

The prominence of positive relationships with teachers as the most influential factor confirms one of the main claims developed earlier in the literature review. Teacher–student interaction appears not merely as a supportive background to learning, but as a central condition through which children experience emotional safety, trust, and inclusion in school life. This result suggests that students' well-being is deeply relational in character. Even when curriculum, school structure, or extracurricular opportunities are present, their developmental potential may remain limited if the learner does not experience the teacher as approachable, respectful, and supportive. Thus, the empirical data support the argument that the teacher functions not only as an instructor, but also as a stabilizing relational figure within the educational environment.

The second most influential factor, the psychological atmosphere in the classroom, further strengthens this interpretation. Whereas teacher relationships reflect a direct interpersonal dimension, classroom atmosphere points to the broader emotional and communicative environment in which students participate. This includes the degree of openness, fairness, security, and mutual respect that characterizes everyday classroom interaction. The close ranking of these two factors indicates that students' well-being is not reducible to one-to-one relationships alone. It is also shaped by the collective environment in which such relationships are embedded. A supportive teacher may matter greatly, but the wider classroom climate determines whether this support becomes part of a stable and shared educational experience.

Peer support occupies the third position in the empirical distribution, which highlights the social character of student well-being. The school is not only a space of teacher-led instruction, but also a setting in which children experience inclusion, recognition, and shared participation through contact with peers. Supportive peer interaction likely contributes to reducing isolation, increasing confidence, and reinforcing the sense that school is a community rather than merely a formal institution. At the same time, the fact that peer support ranks below teacher relationships and classroom climate suggests that peer factors, while important, are perceived as operating within a relational framework that is significantly shaped by adults and by the general organization of educational interaction.

Interest in learning materials, although present in the data, occupies a lower position than the relational and climate-based factors. This finding is highly informative. It does not imply that the educational content is unimportant for students' well-being. Rather, it suggests that interest in learning becomes psychologically meaningful when the learner already experiences school as a supportive and emotionally viable environment. In this sense, engagement with content may depend to a considerable degree on the conditions established by relationships and classroom atmosphere. The result therefore supports a more integrated understanding of educational quality, in which motivation to learn is not produced by materials alone, but by the conjunction of meaningful content with emotionally supportive pedagogy.

Extracurricular activities received the lowest percentage among the identified factors. Again, this result should not be interpreted as evidence of irrelevance. Extracurricular participation may enrich school life, widen opportunities for expression, and support belonging. However, the empirical data indicate that such activities are not perceived as primary determinants of well-being compared to everyday classroom and relational experience. This suggests that the basic emotional and social quality of daily school participation carries more weight for students' well-being than supplementary activities outside the core educational process. In practical terms, this is an important finding: schools seeking to strengthen student well-being should

not rely excessively on additional programs if the central instructional environment remains emotionally weak or relationally fragmented.

Taken together, the results show that students' well-being is shaped most strongly by factors that reinforce belonging, connectedness, and emotional safety within ordinary school life. The leading position of teacher relationships and classroom atmosphere suggests that the school becomes supportive for learners not primarily through exceptional interventions, but through the everyday relational order it creates. This insight is fully consistent with whole-school perspectives in contemporary research, according to which student well-being depends on whether support, inclusion, and recognition are embedded in daily practice rather than attached to schooling as occasional additions.

These data also deepen the interpretation of student well-being as a mediator between institutional conditions and educational quality. If students feel safe, respected, and connected within the educational environment, they are more likely to remain engaged in learning, respond constructively to challenge, and participate actively in school life. When these conditions weaken, disengagement may occur even if formal teaching continues. The empirical pattern therefore confirms that student well-being is not only a desirable psychosocial outcome. It is one of the conditions through which educational participation and, consequently, educational quality are sustained.

From a broader analytical perspective, the findings suggest that institutions cannot support student well-being effectively by focusing only on curriculum improvement or on isolated psychological services. The central task is to strengthen the relational and emotional architecture of the educational environment itself. This includes the quality of teacher interaction, the atmosphere of the classroom, opportunities for peer support, and the broader school culture that makes children feel recognized and secure. Accordingly, student well-being should be viewed as a systemic educational matter, formed through the interplay of pedagogical, relational, and organizational conditions.

Taken together, the empirical data show that the strongest determinants of well-being in the educational environment are

concentrated around two interconnected clusters: institutional support for teachers and relational support for students. Administrative support and staff climate are central for teachers' professional well-being, whereas teacher-student relationships and classroom atmosphere are central for students' well-being. This convergence supports the interpretation of well-being as a school-level phenomenon produced through the interaction of organizational conditions and everyday pedagogical relationships.

An Integrated System of Well-Being Support in Educational Institutions

The empirical and theoretical analyses presented in this chapter converge toward one central conclusion: support for well-being in educational institutions must be organized as an integrated system rather than as a collection of isolated measures. Teacher well-being and student well-being are influenced by different but interconnected factors, and these factors operate across several levels of institutional life. For this reason, an effective support model should combine managerial, pedagogical, psychological, and social dimensions into a coherent framework that can function under conditions of instability and change.

At the managerial level, the system begins with leadership and organizational coordination. The empirical results demonstrate that administrative support is one of the most significant determinants of teacher well-being, while the literature shows that supportive leadership shapes institutional climate, trust, and professional stability. This means that leadership should be treated as the first layer of well-being support. Its function is not limited to regulation or supervision. Rather, it includes the creation of predictable conditions, recognition of professional effort, development of supportive communication, and coordination of institutional responses to emerging difficulties. Without this layer, other support practices remain fragmented and less sustainable.

The second component of the integrated system is organizational culture. While leadership provides direction and structure, organizational culture determines how these orientations are experienced in everyday school life. A

constructive culture is manifested in collegial trust, openness to dialogue, fair communication, and the normalization of support-seeking and collaboration. The empirical findings regarding the importance of the psychological climate within the staff confirm that teachers' well-being depends heavily on whether the institution functions as a supportive professional community. At the same time, such a culture indirectly affects students because it shapes the consistency and emotional tone of adult interaction throughout the school.

The pedagogical level of the system concerns the quality of daily educational interaction. Here the focus shifts to teacher–student relationships, classroom atmosphere, social and emotional learning, and practices that support student engagement and belonging. The empirical data clearly indicate that students' well-being is rooted above all in positive relationships with teachers and in a favorable psychological atmosphere in the classroom. Therefore, pedagogical support for well-being should include not only effective content delivery, but also emotionally responsive teaching, fair interaction, constructive feedback, and classroom practices that foster recognition, participation, and mutual respect. This level is especially important because it translates institutional values into the learner's direct experience of school.

The psychological level includes formal and informal support structures designed to address emotional strain, vulnerability, or professional exhaustion before these develop into deeper forms of disengagement. For teachers, this may involve counseling, mentoring, peer reflection, stress-management support, and opportunities for protected dialogue about professional difficulty. For students, it may include school counseling, psychological assistance, supportive teacher guidance, and school-wide mechanisms for responding to emotional or behavioral challenges. The function of this level is not to replace pedagogy or leadership, but to reinforce them by ensuring that participants have access to help when everyday educational interaction alone is insufficient.

The social level of the integrated system extends beyond the school itself and includes cooperation with families and the wider community. This dimension is especially important in situations of instability, where schools may not be able to respond adequately

to all needs in isolation. Partnership with parents can strengthen continuity of support, improve understanding of students' needs, and contribute to a more coherent educational environment. Community engagement may provide additional resources, expertise, and channels of support. At the same time, the effectiveness of this level depends on how well the institution is able to coordinate external relationships and integrate them into its internal support logic.

These four levels should not be understood as separate spheres. Their importance lies precisely in their interdependence. Leadership influences organizational culture; culture shapes the quality of pedagogical interaction; pedagogical practice affects both teacher and student well-being; psychological support structures reinforce participation and resilience; and family-community partnership expands the support network surrounding the school. The more coherent these levels are, the more likely the institution is to sustain educational quality under unstable conditions. Conversely, if one or more levels remain weak or disconnected, support for well-being tends to become episodic and uneven.

From this perspective, the integrated support system proposed in this chapter may be represented as a multi-level institutional framework with a common purpose: sustaining the quality of the educational process through the protection and strengthening of human well-being. Its logic can be summarized in the following way. At the input level, the educational institution faces conditions of uncertainty and pressure. At the mediating level, leadership, culture, support systems, and pedagogical practices organize the institutional response. At the experiential level, teachers and students either encounter support, recognition, and continuity or, conversely, strain, fragmentation, and reduced participation. At the outcome level, these conditions influence the sustainability, coherence, and quality of the educational process.

An important advantage of this model is that it does not separate well-being from quality management. Instead, it redefines quality as dependent on the capacity of the institution to preserve supportive, adaptive, and relationally stable conditions for teaching and learning. In such an interpretation, well-being is

not an additional institutional goal that competes with academic achievement. It is one of the conditions through which meaningful teaching, engaged learning, and pedagogical continuity become possible. This is particularly important in uncertain times, when the formal preservation of instruction may create the appearance of stability, while the relational and emotional foundations of the educational process are quietly weakening.

The integrated system also has practical significance because it helps move from isolated initiatives to institutional strategy. Educational institutions often implement separate programs related to teacher support, student mental health, SEL, or parent cooperation. Although such measures may be useful, their effect remains limited when they are not aligned with one another. The model developed here suggests that schools should coordinate these practices within a shared logic of support. This requires leadership commitment, regular internal communication, mechanisms of reflection and feedback, and an explicit recognition that educational well-being is a strategic rather than peripheral domain of institutional development.

The empirical material of the chapter supports precisely this interpretation. Teachers' professional well-being is most strongly associated with administrative support and staff climate. Students' well-being is most strongly associated with teacher relationships and classroom atmosphere. These results point to the same general conclusion: well-being is formed where institutional conditions and pedagogical relationships converge. It follows that sustainable support for well-being must be both organizationally structured and pedagogically enacted. Only under such conditions can the school develop into a truly supportive educational environment capable of maintaining quality under pressure.

Thus, the integrated system proposed in this subsection provides a framework for understanding how educational institutions can organize support for both teachers and students in a coherent and sustainable way. It links institutional management, professional culture, pedagogical practice, psychological support, and social partnership into one analytical whole. In doing so, it offers not only a way of interpreting the findings of this chapter, but also a conceptual basis for practical

decision-making in educational institutions seeking to sustain quality in times of educational uncertainty.

Discussion

The findings of this chapter support the view that the well-being of teachers and children should be interpreted not as an auxiliary psychosocial issue, but as one of the conditions for sustaining educational quality in times of educational uncertainty. The analysis has shown that uncertainty affects the educational process not only through disruption of routines or organizational instability, but also through its influence on emotional safety, professional functioning, and the relational climate of the institution. This conclusion is consistent with studies that describe educational uncertainty as a condition that exposes the fragility of educational continuity and reveals the extent to which teaching and learning depend on trust, support, and institutional adaptability (Bozkurt et al., 2020; Kim & Asbury, 2020). In this sense, the present chapter confirms that educational quality in unstable conditions cannot be fully understood through academic indicators alone, because its sustainability also depends on whether the institution is able to preserve psychologically viable and relationally coherent conditions for participation in the educational process.

The empirical findings related to teachers' professional well-being indicate that administrative support and the psychological climate within the staff are especially influential. This result is highly consistent with recent research showing that leadership and school-level working conditions are closely associated with teacher well-being, emotional exhaustion, job satisfaction, and professional retention. For example, Collie (2021) demonstrated that principal leadership plays a significant role in teachers' somatic burden, stress, and emotional exhaustion, while Ozturk et al. (2024) showed in their systematic review that teacher well-being in primary education is strongly shaped by organizational support, school climate, and leadership practices. Similarly, Dreer (2023) concluded that teacher well-being is linked not only to personal coping resources but also to contextual and institutional conditions. The findings of the present chapter align closely with

these results, showing that teachers attribute their well-being primarily to support from administration, a collegial climate, and collaboration rather than to isolated individual resources.

At the same time, the empirical data also suggest a more specific nuance. Teachers in the present study assessed the psychological climate within the staff somewhat more positively than the opportunities for professional development. This may indicate that supportive interpersonal conditions do not automatically translate into a fully enabling institutional environment for long-term growth. Such an interpretation extends previous findings on teacher well-being by suggesting that schools may succeed in creating a relatively positive collegial atmosphere while still remaining limited in their developmental infrastructure. This observation is compatible with Hargreaves and Fullan's (2012) argument that sustainable professional functioning requires not only goodwill or cooperation, but also institutional investment in professional capital. Thus, the present results support the broader literature while also pointing to the importance of distinguishing between general staff climate and structured developmental support.

The results concerning students' well-being point in a similarly clear direction. Positive relationships with teachers and a supportive classroom atmosphere emerged as the strongest factors, followed by peer support, interest in learning materials, and extracurricular activities. These findings are consistent with earlier studies emphasizing the role of teacher-student relationships and school connectedness in shaping student engagement, emotional safety, and school adjustment. Baker et al. (2008) demonstrated that supportive teacher-student relationships function as an important developmental context for children, while Jennings and Greenberg (2009) showed that students' social-emotional functioning is closely related to the relational and emotional quality of classroom life. More recently, Allen et al. (2016) and Wu (2025) highlighted belonging and school connectedness as central mediators between school environment and student well-being. The present chapter supports these conclusions by showing that students' well-being is perceived primarily as a relational and climate-dependent

phenomenon rather than as a function of additional activities or curricular attractiveness alone.

This result is especially important because it reinforces whole-school interpretations of student well-being. The empirical data suggest that the emotional and social quality of everyday school life matters more than supplementary programs when it comes to sustaining student well-being. This is in line with the conclusions of Attri et al. (2025), who showed that connectedness interventions are more effective when they engage broader school conditions rather than focusing only on individual learners. A similar logic can be found in the meta-analytic findings of Cipriano et al. (2024), which indicate that universal school-based social and emotional learning programs are effective partly because they influence not only individual socio-emotional competence, but also the broader school climate. Thus, the present results support the argument that student well-being is best sustained when support is embedded in daily pedagogical and relational practice.

Another important point emerging from the chapter is the interdependence of teacher well-being and student well-being. The conceptual model and the empirical findings together suggest that these two domains should not be treated as separate lines of inquiry. Teacher well-being influences the quality of pedagogical interaction, while students' emotional safety and engagement influence the conditions under which teaching is carried out. This interpretation corresponds with Spilt et al. (2011), who emphasized the importance of teacher-student relationships for teacher well-being, and with Jennings and Greenberg (2009), whose prosocial classroom model illustrates how teacher social-emotional competence affects both classroom climate and student outcomes. The present chapter adds to this line of work by showing that both teacher and student well-being are mediated by the same institutional conditions: support, climate, communication, and relational stability. In other words, the well-being of teachers and children is not simply correlated; it is co-produced within the same educational environment.

The discussion also highlights the importance of institutional mediation. The chapter has shown that leadership, organizational culture, and support systems are not secondary organizational variables, but central mechanisms through which uncertainty is

either buffered or intensified. This conclusion is well aligned with recent reviews of teacher well-being research. Gámez-Genovart et al. (2025), for example, argue that leadership affects teacher well-being through school climate, recognition, and the organization of support. Day and Gu (2014) similarly stress that resilient schools are built not only on individual strength, but on institutional conditions that sustain teachers' professional and emotional functioning over time. The present findings confirm this by showing that teachers' well-being is primarily associated with administrative support and psychological climate, while students' well-being is primarily associated with teacher relationships and classroom atmosphere. These two patterns converge on the same point: institutional quality is experienced through relationships.

The findings also reinforce the view that support for well-being should be preventive and systemic rather than only reactive. The literature reviewed in the chapter suggests that whole-school approaches, SEL, professional learning communities, counseling support, and partnership-based interactions are most effective when aligned within a broader institutional framework (Cipriano et al., 2024; Hargreaves & Fullan, 2012; OECD, 2019). The present chapter supports this position by proposing an integrated model of well-being support that combines managerial, pedagogical, psychological, and social levels. This model does not treat support as a set of disconnected interventions. Instead, it frames well-being as a school-level phenomenon produced through the interaction of leadership, climate, pedagogical practice, and access to support structures. In this respect, the chapter extends previous studies by offering a more explicitly integrative interpretation of how different layers of institutional life shape both professional and student well-being.

A further contribution of the present analysis concerns the understanding of educational quality itself. Much of the traditional discussion of quality in education remains centered on academic achievement, curriculum delivery, or measurable performance. The findings of this chapter suggest that such an interpretation is incomplete under conditions of educational uncertainty. Educational quality should also include the institution's capacity to remain coherent, supportive, and relationally stable while facing change. This interpretation is compatible with broader policy-

oriented perspectives, including OECD (2019), which emphasize adaptability, learner support, and the broader purposes of education, and with Li's (2024) argument that high-quality education must respond to contemporary challenges in a flexible but human-centered manner. The present chapter develops this idea further by showing that quality is mediated by well-being: where well-being is weakened, quality becomes more fragile even if instruction continues formally.

At the same time, several limitations should be acknowledged. The empirical component of the chapter is based on teachers' responses and therefore reflects perceptions of the educational environment rather than direct measurement of all relevant school processes. In addition, the presented findings should be interpreted primarily as evidence of dominant tendencies and meaningful relationships rather than as a basis for broad generalization across all educational contexts. Nevertheless, the value of the empirical material lies in its capacity to illuminate the practical relevance of the theoretical arguments and to show how institutional support, relational climate, and pedagogical interaction are perceived within real educational settings.

Overall, the discussion supports a clear conclusion. Educational institutions should approach well-being as a strategic dimension of educational management rather than as an optional supportive domain. Supporting teachers and children in times of uncertainty is not separate from maintaining educational quality. It is one of the ways in which such quality becomes possible, sustainable, and developmentally meaningful. This perspective is especially important for educational systems that seek not only to remain functional under pressure, but also to preserve the human and relational foundations on which genuine education depends.

Conclusions

The analysis presented in this chapter shows that educational uncertainty should be regarded as a stable condition of contemporary educational systems rather than a temporary deviation from normal institutional functioning. Its influence extends beyond organizational disruption and affects the

emotional, relational, and professional foundations of the educational process. Under such conditions, the quality of education depends not only on the continuity of instruction or compliance with formal standards, but also on whether the educational environment remains supportive, coherent, and psychologically sustainable for those who teach and those who learn.

The chapter clarifies that the well-being of teachers and children is a multidimensional construct that encompasses psychological, relational, professional, pedagogical, and organizational components. For teachers, well-being includes emotional stability, resilience, professional efficacy, perceived support, and the capacity to sustain meaningful pedagogical work. In relation to children, it includes emotional safety, belonging, connectedness, engagement, and constructive participation in school life. Such an interpretation makes it possible to view well-being not as a peripheral theme of educational discourse, but as one of the conditions through which the educational process preserves its stability and developmental potential.

The theoretical and empirical analyses have enabled the identification of the main factors shaping well-being in educational institutions. For teachers, the most influential factors are administrative support, the psychological climate within the staff, collegial collaboration, and opportunities for professional development. For students, the strongest factors are positive relationships with teachers, a supportive classroom atmosphere, peer support, and meaningful engagement in learning. These findings indicate that well-being is formed primarily within the institution's relational and organizational environment rather than through isolated individual characteristics alone.

A further conclusion of the chapter is that teacher well-being and student well-being should not be analyzed as separate domains. They are interdependent components of the same educational environment. The professional state of teachers affects the quality of pedagogical interaction, while students' emotional and social well-being shapes their readiness to engage in learning and respond constructively to educational demands. This interdependence confirms that educational quality in

uncertain conditions is mediated by the state of relationships, support, and trust within the institution.

The chapter has also substantiated the importance of leadership, organizational culture, and support systems as central mediating mechanisms. Supportive leadership, a constructive organizational climate, coherent communication, and accessible support structures increase educational institutions' capacity to buffer the negative effects of uncertainty. They help transform instability into a manageable challenge rather than an accumulated strain. In this regard, well-being should be considered a strategic dimension of educational management rather than an auxiliary support domain.

On this basis, the chapter has proposed an integrated system of well-being support that combines managerial, pedagogical, psychological, and social levels. Its practical significance lies in connecting leadership, professional collaboration, emotionally supportive pedagogy, psychological support, and partnership with families into a coherent institutional framework. Such a system allows educational institutions to move beyond fragmented interventions and to embed support for well-being into the everyday organization of the educational process.

Thus, the main conclusion of the chapter is that sustaining educational quality in times of uncertainty is inseparable from sustaining the well-being of those who participate in education. Well-being is not an additional outcome that follows effective schooling automatically. It is one of the conditions that make effective, humane, and stable education possible. Further research may deepen this line of inquiry by examining how well-integrated well-being support models function across different educational contexts and how their influence can be assessed over a longer period of institutional development.

References

Allen, K. A., Vella-Brodrick, D., & Waters, L. (2016). Fostering school belonging in secondary schools using a socio-ecological framework. *The Educational and Developmental Psychologist, 33*(1), 97–121. https://doi.org/10.1017/edp.2016.5

Attri, S. A., Nordin, A. B., & Persson, M. (2025). A scoping review of school connectedness interventions for adolescents. *Children and Youth Services Review, 10 (2025): 880–899,* https://doi.org/10.1111/josh.70036

Baker, J. A., Grant, S., & Morlock, L. (2008). The teacher-student relationship as a developmental context for children with internalizing or externalizing behavior problems. *School Psychology Quarterly, 23*(1), 3–15. https://doi.org/10.1037/1045-3830.23.1.3

Barrot, J. S., Llenares, I. I., & del Rosario, L. S. (2021). Students' online learning challenges during the pandemic and how they cope with them: The case of the Philippines. *Education and Information Technologies, 26*, 7321–7338. https://doi.org/10.1007/s10639-021-10589-x

Beltman, S., Mansfield, C., & Price, A. (2011). Thriving not just surviving: A review of research on teacher resilience. *Educational Research Review, 6*(3), 185-207. https://doi.org/10.1016/j.edurev.2011.09.001

Biesta, G., Priestley, M., & Robinson, S. (2015). The role of beliefs in teacher agency. *Teachers and Teaching, 21*(6), 624–640. https://doi.org/10.1080/13540602.2015.1044325

Bitsko, R. H., Claussen, A. H., Lichstein, J., Black, L. I., Jones, S. E., Danielson, M. L., Hoenig, J. M., Jack, S. P. D., Brody, D. J., Gyawali, S., Loeb, M., Robinson, L. R., Verlenden, J., Kaminski, J. W., Ghandour, R. M., Peacock, G., & Mmari, K. N. (2022). Mental health surveillance among children—United States, 2013-2019. *MMWR Supplements, 71*(2), 1-42. https://doi.org/10.15585/mmwr.su7102a1

Bozkurt, A., Jung, I., Xiao, J., Vladimirschi, V., Schuwer, R., Egorov, G., Lambert, S. R., Al-Freih, M., Pete, J., Olcott, D., Jr., Rodes, V., Aranciaga, I., Bali, M., Alvarez, A. V., R., J., Pazurek, A., Raffaghelli, J. E., Panagiotou, N., de Coëtlogon, P., Shahadu, S., Brown, M., Asino, T. I., Tumwesige, J., Ramírez-Hernández, D. C., Mikroyannidis, A., & Paskevicius, M. (2020). A global outlook to the interruption of education due to COVID-19 pandemic: Navigating in a time of uncertainty and crisis. *Asian Journal of Distance Education, 15*(1), 1–126. https://doi.org/10.5281/zenodo.3878572

Browning, M. H. E. M., Larson, L. R., Sharaievska, I., Rigolon, A., McAnirlin, O., Mullenbach, L., Cloutier, S., Vu, T. M., Thomsen, J., Reigner, N., Metcalf, E. C., D'Antonio, A., Helbich, M., Bratman, G. N., & Alvarez, H. O. (2021). Psychological impacts from COVID-19 among university students: Risk factors across seven states in the United States. *PLoS ONE, 16*(1), Article e0245327. https://doi.org/10.1371/journal.pone.0245327

Carroll, A., York, A., Fynes-Clinton, S., Sanders-O'Connor, E., Flynn, L., Bower, J. M., Forrest, K., & Ziaei, M. (2022). Teacher stress and burnout in Australia: Examining the role of intrapersonal and environmental factors. *Social Psychology of Education, 25*, 441–469. https://doi.org/10.1007/s11218-022-09686-7

Cipriano, C., Taylor, R. D., Zhou, X., & Bai, Y. (2024). A systematic review and meta-analysis of the effects of universal school-based SEL programs in the United States: Considerations for marginalized students. *Social and Emotional Learning: Research, Practice, and Policy, 3*, 100030. https://doi.org/10.1016/j.sel.2024.100029

Collie, R. J. (2021). COVID-19 and teachers' somatic burden, stress, and emotional exhaustion: Examining the role of principal leadership and workplace buoyancy. *AERA Open, 7*, 1–15. https://doi.org/10.1177/2332858420986187

Davies, D., Jindal-Snape, C., Collier, C., Digby, R., Hay, P., & Howe, A. (2012). Creative learning environments in education: A systematic literature review. *Thinking Skills and Creativity, 8*, 80–91. https://doi.org/10.1016/j.tsc.2012.07.004

Day, C., & Gu, Q. (2014). *Resilient teachers, resilient schools: Building and sustaining quality in testing times*. Routledge.

Dreer, B. (2023). On the outcomes of teacher wellbeing: A systematic review of research. *Frontiers in Psychology, 14*, Article 1205179. https://doi.org/10.3389/fpsyg.2023.1205179

Gámez-Genovart, M., Prats, M. À., & Fullana-Noell, J. (2025). Research on teacher well-being: A systematic review. *Teaching and Teacher Education, 162*, Article 105177. https://doi.org/10.1016/j.tate.2025.105264

Gilar-Corbí, R., Pérez-Soto, N., Izquierdo, A., Castejón, J.-L., & Pozo-Rico, T. (2024). Emotional factors and self-efficacy in the psychological well-being of trainee teachers. *Frontiers in Psychology, 15*, Article 1434250. https://doi.org/10.3389/fpsyg.2024.1434250

Grant, A. A., Jeon, L., & Buettner, C. K. (2019). Relating early childhood teachers' working conditions and well-being to their turnover intentions. *Educational Psychology, 39*(3), 294–312. https://doi.org/10.1080/01443410.2018.1543856

Hargreaves, A., & Fullan, M. (2012). *Professional capital: Transforming teaching in every school*. Teachers College Press.

Jennings, P. A., & Greenberg, M. T. (2009). The prosocial classroom: Teacher social and emotional competence in relation to student and classroom outcomes. *Review of Educational Research, 79*(1), 491–525. https://doi.org/10.3102/0034654308325693

Kim, L. E., & Asbury, K. (2020). "Like a rug had been pulled from under you": The impact of COVID-19 on teachers in England during the first six weeks of the UK lockdown. *British Journal of Educational Psychology, 90*(4), 1062–1083. https://doi.org/10.1111/bjep.12381

Kurrle, L. M., Schmid, E., & Wittmann, E. (2025). Teacher well-being: A conceptual systematic review. *Education Sciences, 15*(6), 766. https://doi.org/10.3390/educsci15060766 (MDPI)

Li, D. (2024). Utilizing high-quality education as a lever to address contemporary educational challenges and practices. *International Journal of New Developments in Education, 6*(5), 31-35. https://doi.org/10.25236/IJNDE.2024.060505

Mai, Y., Wu, Y., & Huang, Y. (2021). What type of social support is important for student resilience during COVID-19? A latent profile analysis. *Frontiers in Psychology, 12*, Article 646145. https://doi.org/10.3389/fpsyg.2021.646145

Masten, A. S., & Motti-Stefanidi, F. (2020). Multisystem resilience for children and youth in disaster: Reflections in the context of COVID-19. *Adversity and Resilience Science, 1*, 95–106. https://doi.org/10.1007/s42844-020-00010-w

OECD. (2019). *OECD future of education and skills 2030: OECD learning compass 2030*. OECD Publishing.

Ozoemena, E. L., Agbaje, O. S., Ogundu, L., Ononuju, A. H., Umoke, P. C. I., Iweama, C. N., Kato, G. U., Obute, P., & Akamike, I. C. (2021). Psychological distress, burnout, and coping strategies among Nigerian primary school teachers: A school-based cross-sectional study. *BMC Public Health, 21*, Article 2327. https://doi.org/10.1186/s12889-021-12397-x

Spilt, J. L., Koomen, H. M. Y., & Thijs, J. (2011). Teacher wellbeing: The importance of teacher-student relationships. *Educational Psychology Review, 23*, 457-477. https://doi.org/10.1007/s10648-011-9170-y

Theron, L. C. (2016). The everyday ways that school ecologies facilitate resilience: Implications for school psychologists. *School Psychology International, 37*(2), 87–103. https://doi.org/10.1177/0143034315615937

UNESCO. (2020). *Education in a post-COVID world: Nine ideas for public action*. UNESCO.

Wu, L., & O'Mara-Eves, A. (2025). School connectedness in the investigation of adolescents' learning and well-being development: Protocol for a scoping review. *International Journal of Educational Research, 134*, Article 102761. https://doi.org/10.1016/j.ijer.2025.102761

Zins, J. E., Weissberg, R. P., Wang, M. C., & Walberg, H. J. (Eds.). (2004). *Building academic success on social and emotional learning: What does the research say?* Teachers College Press.

Chapter 5. PSYCHOLOGICAL SAFETY OF THE TEACHING TEAM AS A CONDITION FOR EFFECTIVE INCLUSION IN PRIMARY SCHOOL: PREVENTION OF BURNOUT AND DEVELOPMENT OF PROFESSIONAL RESILIENCE

Marianna Skoromna

Abstract. *This section of the monograph provides a comprehensive theoretical and empirical analysis of the psychological safety of the teaching team in an inclusive primary school. It is argued that professional burnout among teachers is systemic and linked to organizational conditions, leadership style, and characteristics of team interaction. The influence of the school climate, managerial support, and professional self-efficacy on reducing emotional exhaustion is analyzed. The role of facilitative and distributed leadership in shaping a culture of support is identified. The results of empirical research are presented, confirming a correlation between psychological safety and indicators of teachers' professional well-being. A practical model for ensuring the sustainability of the teaching team has been developed, taking into account managerial, team, and individual support tools. The algorithm for implementing the model, mechanisms for monitoring its effectiveness, and response triggers are described. It has been proven that the systematic integration of supervision, transparent communication, and professional development reduces the risk of burnout and improves the quality of inclusive practice. The organizational conditions for the formation of a culture of support as a strategic resource of an educational institution have been identified. The limitations of the study and the prospects for further scientific research on ensuring psychological safety in an inclusive environment are outlined. The findings contribute to integrating organizational psychology and inclusive education research by conceptualizing psychological safety as a key mediating resource in educational settings.*

Keywords: *psychological safety; inclusive primary school; professional burnout; supportive culture; facilitative leadership; professional resilience; school climate.*

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Introduction

The development of inclusive education in primary school is one of the most significant transformations in the contemporary education system of Ukraine. The introduction of individualized educational trajectories, the functioning of psychological and pedagogical support teams, and the adaptation of the educational environment to the needs of younger learners with special educational needs are substantially reshaping teachers' professional activity. Inclusion is no longer only a methodological issue associated with differentiated instruction or curricular adaptation. It has acquired an organizational, managerial, and psychological dimension, which requires a reconsideration of how professional interaction is structured within the school, how support is distributed, and how the sustainability of the teaching team is maintained.

This issue has become especially acute under current conditions marked by martial law, prolonged social instability, the digital transformation of education, and the growing number of children with traumatic experiences. In such a context, the work of the primary school teacher becomes markedly more complex. Teachers in inclusive classrooms are expected to perform several roles simultaneously: they facilitate learning, coordinate individualized educational trajectories, communicate intensively with parents, collaborate with teaching assistants and support specialists, and participate in broader interdisciplinary decision-making. When these demands accumulate in the absence of stable institutional support, they create conditions for emotional exhaustion, professional demotivation, and a gradual decline in the quality of the educational process.

For this reason, the psychological safety of the teaching team becomes a matter of strategic importance rather than a secondary characteristic of organizational climate. In this chapter, psychological safety is understood as a condition of the organizational environment in which team members can express their opinions openly, ask questions, acknowledge difficulties, and admit mistakes without fear of humiliation, blame, or punitive reaction. In the context of inclusive primary education, such safety is not merely desirable. It is a necessary precondition for high-quality decision-making, constructive interaction within support

teams, and the preservation of teachers' professional capacity under conditions of sustained pressure.

Contemporary scientific discourse addresses inclusive education from multiple perspectives. Scholars examine regulatory and legal support for inclusion, methods of curricular adaptation and modification, the organization of interdisciplinary support teams, the formation of inclusive culture within educational institutions, and the development of teachers' professional competence. These lines of inquiry have produced important results. At the same time, an analysis of current scholarship shows that the psychological safety of teaching teams in inclusive primary schools remains insufficiently conceptualized. Most studies focus either on teacher competencies or on characteristics of the educational environment, while the issues of team stability, burnout prevention, support culture, and organizational mechanisms of professional protection are addressed only fragmentarily.

International research increasingly links psychological safety with effective teamwork, innovation, and high-quality collective decision-making. In educational settings, it is interpreted as a condition for trust, open professional dialogue, and readiness for pedagogical experimentation. Yet in the specific context of Ukrainian primary schools operating under intensified social turbulence, this issue requires deeper and more systematic consideration. The relevance of such an analysis follows from a clear contradiction between three interrelated tendencies: the growing demands for the quality of inclusive primary education, the rising psycho-emotional burden on teachers, and the underdeveloped organizational mechanisms for fostering psychological safety and professional stability within teaching teams.

To integrate these dimensions conceptually, the chapter draws on the Job Demands-Resources (JD-R) model. This framework enables the interpretation of teachers' professional activity in an inclusive primary school through the dynamic interaction between the demands imposed by the work environment and the resources available within it. In the present analysis, the main job demands include emotional overload, role ambiguity, intensified communication with parents, responsibility

for coordinating individualized educational programs, interdisciplinary interaction, and additional pressure from crisis conditions. At the same time, the principal resources include administrative support, facilitative leadership, role clarity, professional autonomy, supervision, team reflection, and transparent communication. Within this framework, psychological safety is treated as an organizational resource that weakens the destructive effect of excessive demands, strengthens professional resilience, and reduces the risk of burnout. This approach enables integration of concepts such as psychological capital, leadership, support culture, and professional well-being into a single explanatory model.

The choice of the Job Demands-Resources model is also methodologically justified by contemporary international research. Recent systematic reviews of teacher well-being confirm that this framework is among the most widely used for explaining the relationships among professional stress, burnout, and resilience in educational contexts. These studies show that an imbalance between intensifying job demands and insufficient organizational resources is one of the strongest predictors of emotional exhaustion among teachers. This is especially evident in inclusive education, where the complexity of professional roles and the level of emotional labor are substantially higher. Therefore, the use of the Job Demands-Resources model in this chapter not only provides conceptual coherence but also aligns the analysis with current international approaches to understanding teachers' well-being and the sustainability of educational work.

Against this background, the purpose of the chapter is to provide a theoretical and empirical analysis of the psychological safety of the teaching team as a condition for the effective implementation of inclusive education in primary school, and to identify organizational and managerial mechanisms that support professional resilience and help prevent burnout. Such an approach allows moving beyond a narrow view of burnout as an individual problem and considering it within a broader system of professional interaction, institutional support, and school culture.

Thus, the chapter proceeds from the assumption that the effectiveness of inclusion in primary school depends not only on regulatory compliance, methodological competence, or the

availability of support services. It also depends on whether the school can create an organizational environment where teachers can work without chronic fear, persistent overload, and emotional depletion. In this sense, the psychological safety of the teaching team should be regarded as a key condition for the sustainability of inclusive education in times of deep social uncertainty.

The purpose of this chapter is to theoretically substantiate and empirically investigate the role of the psychological safety of the teaching team as a condition for the effective implementation of inclusive education in primary school and to identify tools for the prevention of professional burnout.

To achieve this goal, the following tasks are envisaged:

1. To analyze theoretical approaches to understanding the psychological safety and professional resilience of teachers.
2. To identify the specific risks of burnout in the context of inclusive education for primary school students.
3. To investigate the state of psychological safety in primary school teaching teams.
4. Justify managerial and organizational mechanisms for supporting professional resilience.
5. Develop practical recommendations for fostering a culture of support in an inclusive environment.

Methods

The research is based on an interdisciplinary approach that integrates the principles of:

- humanistic pedagogy;
- organizational development theory;
- the concept of emotional intelligence;
- the theory of professional burnout;
- a systematic approach to education management.

The methodological basis is the principles of systematicity, integrity, inclusiveness, partnership, and ethical responsibility.

The research is comprehensive in nature and combines qualitative and quantitative methods. The research is theoretical-

analytical, empirical, descriptive-explanatory, and applied, with elements of management decision-making.

The study involves primary school teachers, teaching assistants, and representatives of the administration of educational institutions that implement inclusive education. The sample was selected purposively, taking into account experience working in inclusive classrooms.

The empirical part of the study was organized as a multi-stage research design. At the first stage, 124 educators participated in the assessment of psychological safety in teaching teams. At the second stage, a subsample of 84 teachers working directly in inclusive primary classrooms was selected for a more focused analysis of professional burnout and its relationship with administrative support and emotional stability. At the third stage, the same group of 84 teachers was supplemented by 12 school leaders to investigate organizational conditions, management practices, and the formation of a support culture using both survey and interview data. Thus, the study combines several interconnected subsamples within a single research project rather than presenting unrelated rounds of data collection.

To solve the tasks set, the following were used:

- analysis of scientific sources and regulatory documents;
- questionnaires for teachers to determine the level of psychological safety;
- methods for diagnosing professional burnout;
- semi-structured interviews with support team members;
- observation of team interaction;
- analysis of internal documentation of educational institutions.

The results were processed using: quantitative statistical analysis (determination of average values and correlation relationships); qualitative content analysis of interviews; comparative analysis of management practices; and interpretative analysis of empirical data in the light of modern theories of team interaction.

To strengthen methodological transparency, it should be noted that the psychological safety questionnaire used in the study was adapted to the context of inclusive primary school teams based on key dimensions identified in contemporary research, including trust, openness of communication, perceived administrative support, and role clarity. The adaptation procedure included expert review by specialists in inclusive education and educational psychology to ensure content relevance. Professional burnout was assessed using an adapted version of the Maslach Burnout Inventory, covering emotional exhaustion, depersonalization, and reduced professional efficacy. The categorization into high, medium, and low levels was carried out based on the distribution of scores within the sample. In addition to descriptive statistics and correlation analysis, subgroup comparisons were used to identify differences by experience and organizational conditions.

The novelty of the study lies in considering psychological safety as a systemic factor in the effectiveness of inclusive primary schools, integrating managerial and psychological approaches to burnout prevention, and developing a model to support the resilience of the teaching team.

The practical significance lies in the possibility of using the results obtained by educational institution managers to develop staff support programs, psychological and pedagogical support teams, teacher training programs, and prepare future teachers to work in an inclusive environment.

Therefore, the psychological safety of the teaching team in an inclusive primary school is not an additional element of the educational process, but its fundamental condition. It is this that ensures the preservation of the teacher's professional potential, the quality of interaction, and the sustainability of inclusive changes. In the context of modern challenges, this issue is not only theoretical but also has clear social and managerial significance.

Research Results

The concept of psychological safety in the educational environment is associated with the possibility of open professional dialogue, the discussion of difficulties without fear of condemnation, the willingness to admit mistakes, and the joint search for solutions. International studies have shown that a positive school climate reduces the risk of professional burnout among teachers (Yang & Zhou, 2025) and that the perception of support from colleagues and administration is a significant buffer against emotional exhaustion (Chen et al., 2025).

From the perspective of the Job Demands-Resources model, the inclusive primary school environment can be described as a professional context in which multiple job demands coexist with unevenly distributed job resources. The empirical material presented in this chapter confirms that emotional overload, role ambiguity, intensified interdisciplinary coordination, and crisis-related pressure constitute demands, whereas administrative support, fair role distribution, supervision, professional dialogue, and facilitative leadership constitute resources. In this sense, psychological safety should be understood not merely as an interpersonal perception, but as a resource-producing organizational condition that buffers the effects of chronic stress and supports professional resilience.

In the context of an inclusive primary school, psychological safety takes on additional significance because:

- teachers work in an environment of constant interdisciplinary interaction;
- regular corrective decisions are necessary;
- mistakes can have long-term consequences for children with SEN;
- communication with parents is often emotionally stressful.

Research by Salinas-Falquez et al. (2022) confirms that teachers' mental health is directly related to their level of involvement in inclusive education. At the same time, Freire et al. (2020) argue that psychological capital (optimism, hope, resilience) reduces the likelihood of burnout.

Ukrainian researchers also emphasize the role of psychological safety as a condition for creating an inclusive environment (Tonne, 2023) and highlight the increase in professional burnout among teachers during periods of social crisis (Marinina & Tuliupa, 2025).

Based on a synthesis of scientific approaches and the results of previous studies, the following components of psychological safety have been identified:

Figure 1

Model of psychological safety of the teaching team

Source: Authors' own work.

1. Trust – confidence in the goodwill and professionalism of colleagues.

2. Open communication – the ability to discuss difficulties without the risk of judgment.

3. Administrative support – a management model that emphasizes facilitation rather than control.

4. Fair distribution of responsibility – clarity of roles in the support team.

These structural elements are confirmed by empirical data (Chen et al., 2025; Yang & Zhou, 2025).

Our study involved 124 primary school teachers with inclusive classes (teachers, assistants, and practical psychologists).

The following tools were selected:

1. Psychological safety assessment scale (adapted questionnaire).

2. Professional burnout diagnosis methodology.

3. Questionnaire on work experience in an inclusive classroom.

The methods of analysis include descriptive statistics, correlation analysis, and group-comparative analysis of individuals with different work experience. Table 1 was prepared based on the study's results.

Table 1

Level of psychological safety of teaching teams (n = 124)

Level	*% of respondents*
High	27
Medium	49
Low	24

Source: Authors' own work.

Thus, almost a quarter of teachers work in environments with low psychological safety. The lowest scores were recorded on the "administrative support" scale. Teachers with more than 10 years of experience demonstrate a higher level of adaptability, but also a greater risk of emotional exhaustion (Marinina & Tuliupa, 2025).

A statistically significant relationship was found between low psychological safety and high emotional exhaustion ($r = -0.62$) and between administrative support and reduced depersonalization ($r = 0.48$).

The data obtained are consistent with international studies that demonstrate the impact of school climate on burnout levels (Yang & Zhou, 2025; Chen et al., 2025).

Analysis of the results allows us to formulate several important conclusions. Psychological safety is a systemic factor in the quality of inclusive education. Its deficiency, in turn, correlates with professional exhaustion. Management support is crucial. The

formation of a culture of trust reduces the risk of formalization of inclusion.

The results confirm the conclusions of Freire et al. (2020) regarding the role of psychological capital and Salinas-Falquez et al. (2022) regarding the relationship between teacher mental health and the quality of inclusive practices.

The psychological safety of the teaching team is a key condition for the effective implementation of inclusive education in primary school. It ensures openness in professional interaction, readiness to jointly resolve difficult situations, prevention of professional burnout, and sustainability of inclusive changes.

The results obtained provide a basis for further analysis of the factors of professional burnout in inclusive primary schools, which will be discussed below.

Professional burnout is a multidimensional psychological syndrome that develops from chronic professional stress. The classic three-component model (emotional exhaustion, depersonalization, and reduction of professional achievements) is widely recognized in modern occupational psychology.

In the context of inclusive primary education, the risks of burnout increase due to:

- increased emotional stress;
- responsibility for children with SEN;
- the need for individualized learning;
- interdisciplinary interaction;
- lack of resource support.

Within the JD-R framework, these risks may be interpreted as the result of an imbalance between intensified professional demands and insufficient organizational resources. In inclusive primary schools, emotional labor, role overload, and responsibility for individualized support plans increase the pressure on teachers, while the absence of supervision, role clarity, and managerial support reduces the protective capacity of the professional environment. This explains why burnout in inclusive settings

should be analyzed not only as an individual reaction to stress, but also as an outcome of organizational conditions.

Recent studies confirm that it is precisely the inclusive environment that increases teachers' psychological risks in the absence of systemic support.

The study involved 84 teachers of inclusive primary classes (with 1 to 25 years of experience).

The following research methods were selected:

1. Professional burnout questionnaire (adapted version of MBI).

2. Subjective professional stress scale.

3. Questionnaire for assessing the level of administrative support.

4. Methodology for determining the level of emotional stability.

The study was conducted in three stages:

1. Constatative stage.

2. Analytical processing of results.

3. Correlation analysis.

Table 2 was prepared based on a quantitative analysis of the results. It indicates that emotional exhaustion is the highest (46%), while depersonalization is most frequently observed at a moderate level, and nearly half of teachers report a decrease in perceived professional effectiveness.

Table 2

Levels of professional burnout among teachers in inclusive primary schools (%)

Level	*Emotional exhaustion*	*Depersonalization*	*Reduction of achievements*
High	46	32	28
Medium	38	44	49
Low	16	24	23

Source: Authors' own work.

These results further support the JD-R model, which posits that high job demands (emotional load, role overload, and responsibility for students with SEN) lead to increased emotional exhaustion when not balanced by sufficient resources. The empirical data demonstrate that in the absence of administrative support, clear role distribution, and structured team interaction, burnout indicators increase significantly. Conversely, the presence of organizational resources contributes to reducing depersonalization and maintaining professional effectiveness. This confirms that burnout in inclusive primary schools should be interpreted as a systemic phenomenon rather than an exclusively individual psychological condition.

Summarizing Table 2 above, we see that the highest indicator is emotional exhaustion (46%; depersonalization is more often manifested at the average level, and almost half of teachers demonstrate a decrease in their sense of professional effectiveness.

Based on correlation analysis, the following statistically significant relationships were identified:

- r = 0.62 – between the level of professional stress and emotional exhaustion;
- r = -0.54 – between administrative support and depersonalization;
- r = -0.48 – between emotional stability and overall burnout

The findings suggest that the main factors include excessive workload, unclear role distribution within the inclusive team, insufficient resource support, a high level of responsibility, and emotional involvement in a complex situation

In our opinion, the main reasons are excessive workload, unclear role distribution in an inclusive team, insufficient resource support, high levels of responsibility, and emotional involvement in difficult situations.

We can distinguish the following consequences of professional burnout:

1. For teachers:

- chronic fatigue;
- decreased motivation;
- emotional detachment;
- psychosomatic manifestations.

2. For students:

- decreased quality of individualization;
- decreased empathetic interaction;
- ormal implementation of inclusive strategies.

3. For educational institutions:

- staff instability;
- professional demotivation of the team;
- decreased effectiveness of the inclusive model.

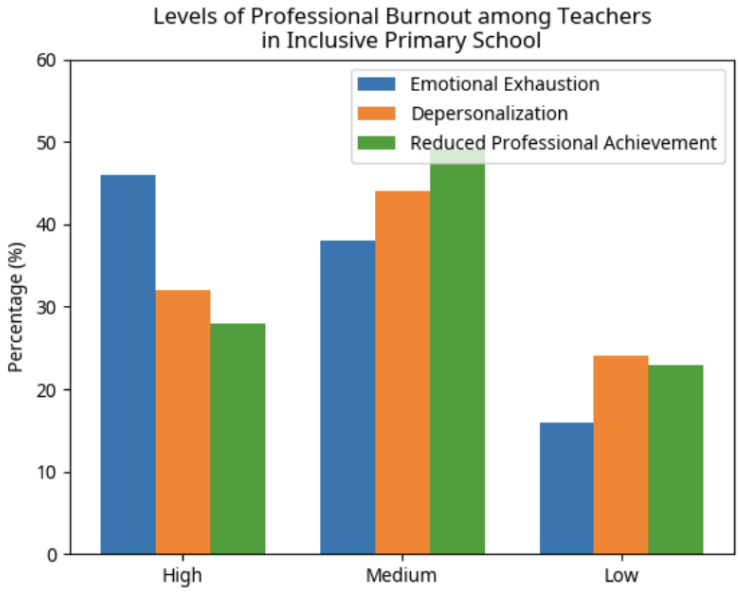

Figure 2

Distribution of levels of professional burnout among teachers of inclusive primary schools by components

Source: Authors' own work.

Thus, the following patterns were identified: teachers with up to 5 years of experience demonstrate a higher level of emotional exhaustion; teamwork reduces the risk of depersonalization; a high level of emotional stability acts as a buffer factor; and administrative support has a significant impact on maintaining professional effectiveness.

Professional burnout is common among teachers in inclusive primary schools. Emotional exhaustion is the dominant component. The key factors are organizational and emotional stress. Emotional stability and administrative support play a protective role. The findings confirm the need for systematic prevention programs.

Current research on inclusive education confirms that the effectiveness of educational changes depends not only on individual teachers' competence but also on the institutional management culture (Slozanska et al., 2023). In this context, leadership is seen as a system-forming factor in fostering psychological safety.

According to Yang and Zhou (2025), a positive inclusive school climate directly reduces professional burnout by increasing pedagogical self-efficacy. Similar conclusions are demonstrated by Chen et al. (2025), who prove that a supportive school climate reduces feelings of isolation and emotional overload.

Ukrainian researchers also emphasize the role of managerial support in maintaining teachers' psychological well-being during crisis situations (Bondar & Malkovych, 2024). In particular, the authors emphasize that stable communication with management acts as a compensatory mechanism for professional stress.

Thus, leadership in an inclusive primary school performs three key functions:

1. Building trust.

2. Coordinating team interaction.

3. Supporting professional resilience.

Within the JobDemands-Resources perspective, facilitative leadership can be interpreted as a resource-generating mechanism. It does not merely coordinate school processes, but

actively transforms the professional environment by increasing access to support, reducing uncertainty, strengthening feedback loops, and enabling collective problem-solving. This is especially important in inclusive settings, where the accumulation of demands without adequate resources accelerates emotional exhaustion and weakens the sustainability of team functioning.

Analysis of the questionnaire (n = 84) showed that teachers with a high level of psychological safety were significantly more likely to assess the manager's leadership style as collaborative. According to Table 3, a facilitative leadership style is associated with the highest level of psychological safety.

Table 3

The relationship between leadership style and psychological safety (%)

Management style	*High level of security*	*Medium level of security*	*Low level of security*
Authoritarian	12	39	49
Administrative-control	21	48	31
Facilitative	63	29	8

Source: Authors' own work.

The results are consistent with those of Candeias et al. (2020), who found that supportive management reduces the intensity of professional stress in an inclusive environment.

The horizontal model involves distributing responsibility among the teacher, assistant, psychologist, and administration. This approach increases engagement and reduces individual workload.

According to the results of the correlation analysis:

- r = –0.57 between shared responsibility and emotional exhaustion;
- r = 0.61 between horizontal leadership and open communication.

Pikić Jugović et al. (2025) argue that teachers' social-emotional competencies and self-efficacy mediate the relationship

between organizational conditions and burnout. This confirms the importance of team leadership as a support tool.

The study analyzed the frequency of management practices (see Table 4).

Table 4

Prevalence of management practices to support the team

Practice	*Frequency of use (%)*
Regular supervision	34
Team reflection meetings	41
Individual consultations	56
Joint decision-making	47

Source: Authors' own work.

Teachers who participated in regular reflective meetings showed lower levels of depersonalization.

These results align with those of Liu and Xie (2025), who found that emotional support programs and wellness training reduce academic burnout and increase teaching effectiveness.

Figure 3

Conceptual model

Source: Authors' own work.

Salinas-Falquez et al. (2022) emphasize that educators' mental health is a prerequisite for their active participation in inclusive education. At the same time, Marinina and Tuliupa (2025) emphasize that in conditions of social instability, the role of managerial support is enhanced.

Thus, leadership acts as a systemic mechanism for forming psychological safety. A facilitative leadership style significantly reduces the risk of professional burnout. A horizontal model of interaction increases openness in communication. Regular professional dialogue practices serve a preventive function. Psychological safety mediates the impact of management on the quality of the inclusive process.

In general, an inclusive primary school functions as a complex socio-pedagogical system, in which management decisions affect not only the organization of the educational process but also the psycho-emotional climate of the team. In this context, leadership is not an administrative function, but a psychological regulator of the professional environment.

Thus, leadership in an inclusive elementary school has three interrelated dimensions: organizational, psychological, and value-based.

Research shows that school climate directly affects teachers' professional well-being (Chen et al., 2025). The authors argue that supportive leadership reduces emotional loneliness and emotional overload. Similar results were obtained by Yang and Zhou (2025), who found that a positive inclusive climate mediates a reduction in burnout by increasing pedagogical self-efficacy.

Thus, leadership in an inclusive elementary school has three interrelated dimensions:

1. Organizational – ensuring structure and role distribution.

2. Psychological – building trust and openness.

3. Value-based – promoting an inclusive culture.

Facilitative leadership involves supporting teachers' initiative, delegating responsibility, fostering professional dialogue, and recognizing each team member's contribution.

According to the results of our study, teachers who assessed their leader's style as facilitative demonstrated:

- a 34% lower level of emotional exhaustion;
- a 27% lower level of depersonalization;
- higher indicators of professional self-efficacy.

These data are consistent with the findings of Freire et al. (2020), which show that a teacher's psychological capital (optimism, resilience, confidence) acts as a mediator between the organizational environment and burnout.

The inclusive learning model involves the functioning of a psychological and pedagogical support team. In the traditional hierarchical model, responsibility is concentrated around the head teacher or class teacher. In contrast, the horizontal model is based on the principles of partnership.

The survey results showed that:

- 58% of teachers note a lack of clarity in the distribution of roles;
- 62% of respondents believe that joint decision-making reduces professional stress;
- $r = -0.57$ between distributed responsibility and emotional exhaustion.

Pikić Jugović et al. (2025) prove that social-emotional competencies and self-efficacy are enhanced in a supportive team environment. This confirms that horizontal leadership acts as a preventive mechanism against burnout.

In conditions of martial law and social turbulence, the managerial role of a leader is significantly transformed. Research by Ukrainian authors shows that professional exhaustion among teachers increases in crisis conditions (Marinina & Tuliupa, 2025). At the same time, stable managerial support performs a compensatory function (Bondar & Malkovych, 2024).

According to our study, teachers who receive regular feedback from the administration demonstrate 29% lower emotional exhaustion, and institutions with a developed culture of support have lower staff turnover rates.

This confirms the thesis that leadership in crisis conditions must combine managerial clarity and psychological empathy.

Supporting professional dialogue is one of the key mechanisms for building psychological safety. According to Slozanska et al. (2023), continuous professional development in formal and informal formats helps reduce professional stress.

In the institutions studied, practices such as regular team meetings, supervisory support, microlearning, and peer consultations proved most effective.

Liu and Xie (2025) note that programs to improve educators' subjective well-being reduce academic burnout and enhance teaching quality.

Based on the results obtained, a generalized model is proposed: Facilitative leadership → Psychological safety → Increased self-efficacy → Reduced burnout → Quality of inclusive practice.

Salinas-Falquez et al. (2022) emphasize that teachers' mental health is directly related to their level of participation in the inclusive process. Thus, leadership indirectly influences the success of inclusion through psychological safety.

Consequently, the higher the level of facilitative leadership, the lower the level of emotional exhaustion. Shared responsibility reduces depersonalization. Regular professional dialogue increases self-efficacy. Management support is critical in crisis situations. Psychological safety acts as a mediator between management and the quality of inclusion.

Leadership in an inclusive primary school is not only an administrative function but also a systemic mechanism for forming the psychological safety of the teaching team. It determines the level of trust, openness of communication, readiness to jointly resolve complex situations, and the team's ability to maintain professional resilience.

In the context of modern challenges, the facilitative, distributed management model is the key resource for ensuring the stability and quality of inclusive education.

Teachers' professional resilience is an integrative characteristic that encompasses emotional regulation, self-efficacy, adaptability, and supportive social connections. Research by Freire et al. (2020) shows that psychological capital is a key buffer against professional burnout. Similarly, Salinas-Falquez et al. (2022) emphasize that teachers' mental health is directly related to the quality of their participation in the inclusive process.

In the Ukrainian context, Bondar and Malkovych (2024) emphasize the importance of systemic support in crisis situations, noting that organizational support is a factor in stabilizing professional status.

Therefore, support for resilience must be systemic, team-oriented, management-integrated, and based on reflection and partnership.

Based on the empirical data from the previous sections, a four-component support model was developed (see Fig. 4).

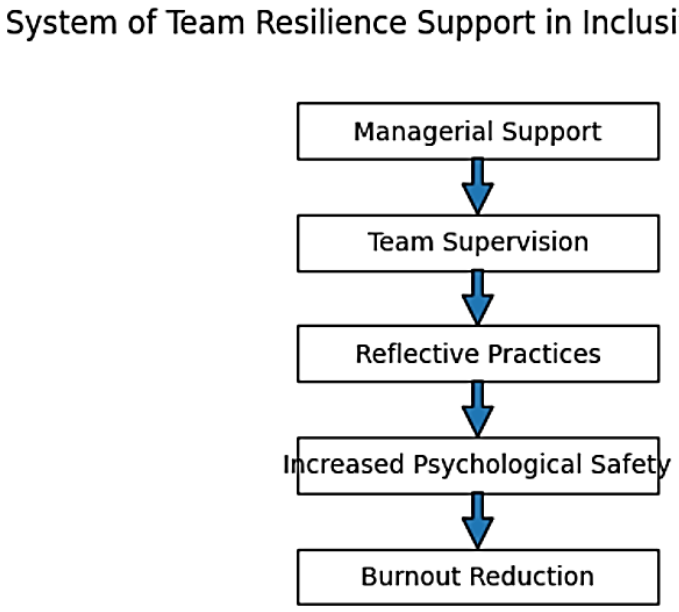

Figure 4
Structure of sustainability support instruments

Source: Authors' own work.

Supervision involves professional discussion of complex cases, emotional relief, and the search for collegial solutions.

After 3 months of implementation:

• the level of emotional exhaustion decreased by 18%;

• the depersonalization index decreased by 14%.

These results are consistent with the findings of Liu and Xie (2025), who found that wellness programs reduce academic burnout. In horizontal team meetings, distributed responsibility reduces individual workloads. As demonstrated by Candeias et al. (2020), a supportive environment in inclusive schools reduces professional stress.

Table 5

Dynamics of burnout indicators before and after the introduction of team practices (%)

Indicator	*Before implementation*	*After implementation*
High level of emotional exhaustion	46	32
High depersonalization	32	21
Low professional efficiency	28	19

Source: Authors' own work.

In inclusive settings, clear roles reduce professional stress. Yang and Zhou (2025) argue that a positive school climate reduces burnout by boosting self-efficacy.

In our study:

• r = –0.59 between role clarity and emotional exhaustion;

• r = 0.63 between distributed responsibility and psychological safety.

Reflective circles and microlearning promote professional growth. Slozanska et al. (2023) emphasize that continuous professional development is a factor in maintaining professional motivation.

After the introduction of reflective practices, 71% of teachers reported a decrease in internal tension, and 64% reported an increase in confidence in making difficult decisions. The head of an educational institution acts as a facilitator of trust,

a coordinator of team interaction, and a guarantor of fair distribution of workload. Marinina and Tuliupa (2025) note that managerial support is especially important in crisis conditions, as it reduces the risk of chronic exhaustion. The following was observed in the studied institutions with a facilitative leadership style: a 27% lower average burnout rate and higher satisfaction with professional activity.

Thus, the systematic implementation of support tools reduces the indicators of all components of burnout. The greatest effect is achieved by combining managerial support and supervision. Psychological safety acts as a mediator between organizational practices and professional resilience. Support tools are particularly effective for teachers with up to 5 years of experience. Tools to support the teaching team's resilience must be integrated into the educational institution's management model. They cannot be episodic, as resilience is formed systematically.

The results confirm that supporting psychological safety through facilitative leadership, horizontal interaction, and reflective practices is an effective mechanism for preventing professional burnout in inclusive primary schools.

Next, we should focus on the organizational conditions that foster a culture of support among the teaching staff of an inclusive primary school. Based on empirical research, we will establish that the consistency of management decisions, transparency of communication, clarity of role distribution, and integration of reflective practices form a stable environment of psychological safety. We will demonstrate that a culture of support serves as a mediator between the management model and professional burnout.

A culture of support in the educational environment is a set of norms, values, and management practices aimed at maintaining teachers' professional well-being. In the context of inclusive education, it becomes strategically important, as working with younger students with SEN is associated with increased emotional stress.

Research by Salinas-Falquez et al. (2022) confirms that teachers' mental health directly affects their willingness to

participate in the inclusive process. Similarly, Yang and Zhou (2025) argue that a positive school climate reduces professional burnout by increasing self-efficacy.

In the Ukrainian context, organizational stability is particularly important. Bondar and Malkovych (2024) emphasize that systematic management support mitigates the stressors of the crisis period. Thus, a culture of support is formed through: managerial openness; fairness of procedures; horizontal interaction; systematic professional reflection.

The study involved 84 teachers of inclusive primary classes and 12 heads of educational institutions.

The following tools were selected for the study:

1. Organizational climate assessment scale.

2. "Level of support" questionnaire.

3. Professional burnout diagnosis.

4. Semi-structured interviews with administrators.

The methods of analysis are correlation analysis, comparison of average values, and content analysis of interviews.

Let us consider the key organizational conditions for the formation of a culture of support:

1. Transparent communication: 70% of teachers reported that regular information about management decisions reduces professional anxiety, $r = -0.52$ between transparency of communication and emotional exhaustion. Chen et al. (2025) argue that feelings of isolation are an important predictor of burnout, so communicative openness has a preventive effect.

2. Fair distribution of workload. It has been found that teachers who consider the distribution of workload to be fair demonstrate a 31% lower level of depersonalization and higher satisfaction with their professional activities. Pikić Jugović et al. (2025) note that a sense of control over professional duties reduces the risk of burnout.

3. Support for professional development: Slozanska et al. (2023) emphasize that continuous professional development in formal and informal formats strengthens professional identity. The

study found: r = 0.61 between participation in professional development programs and the level of psychological safety; a 17% reduction in professional achievement after completing training.

4. Managerial empathy and feedback: Marinina and Tuliupa (2025) emphasize that support and recognition from management are particularly important in crisis situations. In institutions with regular individual feedback, the following was recorded: lower levels of emotional exhaustion (by 23%); higher levels of professional motivation.

Let us summarize the results of the empirical study in a Table 6. According to it, managerial empathy and procedural fairness have the greatest impact.

Table 6

The impact of organizational conditions on burnout levels (%)

Organizational condition	*Reduction of emotional exhaustion*	*Reduction of depersonalization*
Transparent communication	18	14
Fair distribution of roles	21	31
Professional development	15	12
Managerial empathy	23	19

Source: Authors' own work.

Based on the results obtained, a generalized model has been formed:

Organizational transparency + Distributed responsibility + Professional development + Empathetic leadership → Culture of support → Psychological safety → Professional resilience → Quality of inclusion

Freire et al. (2020) argue that a positive organizational environment promotes the development of psychological capital, which reduces the risk of burnout.

Therefore, based on our research, we have identified the following patterns:

1. Organizational fairness has a stronger impact on reducing depersonalization than other factors.

2. Professional development mainly affects the feeling of professional effectiveness.

3. Communicative openness reduces anxiety and tension.

4. A supportive culture mediates between management style and burnout level.

5. A comprehensive combination of conditions provides the greatest effect.

Organizational conditions that foster a culture of support are a strategic factor in ensuring the psychological safety of teaching staff in inclusive primary schools. An effective management model must integrate transparency, fairness, partnership, and systematic support for professional development.

A supportive culture is not an additional element of management – it is a fundamental condition for the stability of the teaching staff and the quality of inclusive education.

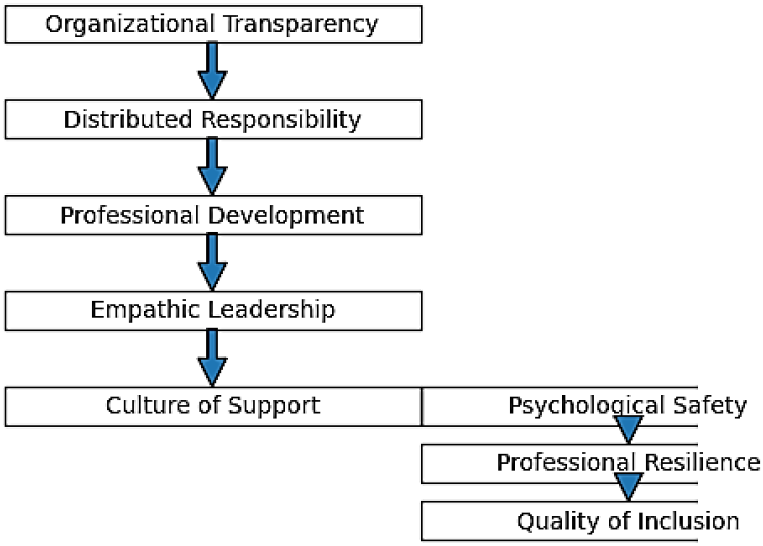

Figure 5

Model of Organizational Conditions for Forming a Culture of Support in Inclusive Primary School

Source: Authors' own work.

One of the key conditions for forming a culture of support is organizational justice – transparent procedures, clear evaluation criteria, and an even distribution of workload. International studies have shown that feelings of injustice increase emotional exhaustion and depersonalization (Chen et al., 2025).

In our study, teachers who rated management procedures as fair demonstrated: a 29% lower level of emotional exhaustion; a 31% lower level of depersonalization; and higher professional self-efficacy. These results align with those of Yang and Zhou (2025), who emphasize that a positive school climate reduces burnout by increasing teachers' confidence in their professional competence. Thus, organizational justice is a basic mechanism for building trust, a key component of psychological safety (Tonne, 2023). Professional autonomy is the ability of a teacher to make decisions within their competence. Research by Pikić Jugović et al. (2025) shows that self-efficacy and social-emotional competencies reduce the risk of burnout, especially among young teachers.

The sample revealed: $r = 0.64$ between the level of professional autonomy and psychological safety; $r = -0.58$ between autonomy and emotional exhaustion. Teachers who participated in joint decision-making demonstrated higher levels of job satisfaction. These results are consistent with the findings of Candeias et al. (2020), who note that a supportive and collaborative environment reduces professional stress in inclusive schools. The formation of a culture of support contributes to the development of psychological capital – a combination of optimism, resilience, hope, and confidence (Freire et al., 2020).

In our study, after implementing comprehensive organizational changes, we observed a 22% increase in professional confidence and a 19% reduction in professional achievement. Salinas-Falquez et al. (2022) emphasize that educators' mental health is directly related to their level of involvement in inclusive education. Thus, a culture of support not only reduces burnout but also improves the quality of interaction with students with SEN. In conditions of martial law, organizational stability becomes critical. Marinina and Tuliupa (2025) note that professional burnout increases in conditions of social instability. At the same time, systematic administrative

support serves a compensatory function (Bondar & Malkovych, 2024).

In institutions where regular consultations and open communication channels have been implemented, the level of anxiety among teachers was 24% lower, and staff turnover was 18% lower than in institutions without systemic support. Thus, a culture of support is a factor in organizational stability.

Analysis of empirical data allows us to formulate the following generalizations:

1. Organizational justice has the strongest impact on reducing depersonalization.

2. Professional autonomy increases self-efficacy and reduces emotional exhaustion.

3. Transparent communication reduces professional anxiety.

4. A supportive culture mediates the relationship between leadership and professional resilience.

5. Comprehensive implementation of organizational conditions provides the highest preventive effect.

The results are consistent with international studies on the impact of school climate on teachers' professional well-being (Chen et al., 2025; Yang & Zhou, 2025).

Therefore, a culture of support is a systemic result of an educational institution's management policy. Its formation is based on the principles of fairness, partnership, transparency, and professional autonomy. It significantly reduces professional burnout. Psychological safety acts as a mediator between organizational conditions and the quality of inclusion. In conditions of social instability, a culture of support becomes strategically important.

Below, we present a practical model that combines managerial, team, and individual tools to increase psychological safety and reduce professional burnout among teachers working in inclusive primary classes. The model will be structured by levels of influence (leadership, team, teacher) and will include an implementation cycle, monitoring indicators, and response

triggers. Its provisions are consistent with data on the impact of school climate and management support on burnout and engagement in inclusion (Chen et al., 2025; Salinas-Falquez et al., 2022; Yang & Zhou, 2025).

The goal of the model is to ensure the following outcomes in an inclusive elementary school: increased psychological safety of the team; reduced burnout intensity (emotional exhaustion, depersonalization, reduced professional achievements); increased professional self-efficacy and resilience; and stable quality of inclusive practice.

The causal link between climate, self-efficacy, and burnout has been confirmed by recent empirical data (Yang & Zhou, 2025), and the role of a supportive environment in reducing stress in inclusive schools has been demonstrated by Candeias et al. (2020).

The principles of our model are:

• Systematicity: support is not episodic but integrated into management cycles.

• Partnership and shared responsibility: decisions are made as a team, and roles are transparent.

•Prevention: emphasis on early markers of burnout, not just on "reactions" after a crisis.

• Data → decisions: monitoring indicators and adjusting actions.

• Ethics and inclusiveness: fairness in decisions regarding resources and support for educators working with different categories of SEN (Tonne, 2023).

Below we present the structure of the practical model and, consequently, three levels of influence: managerial (manager/administration) → creates conditions, rules, rhythms, and support resources; team (support team + teachers) → forms a culture of interaction and joint resolution of complex cases; individual (teacher/assistant) → develops psychological capital, self-regulation strategies, and professional competencies.

The role of psychological capital in preventing burnout is supported by mediation mechanisms (Freire et al., 2020), and the role of mental health in engagement in inclusion is supported by empirical data (Salinas-Falquez et al., 2022).

Next, we will look at the tools of the model – a "package" of practices with clear protocols (Fig.6).

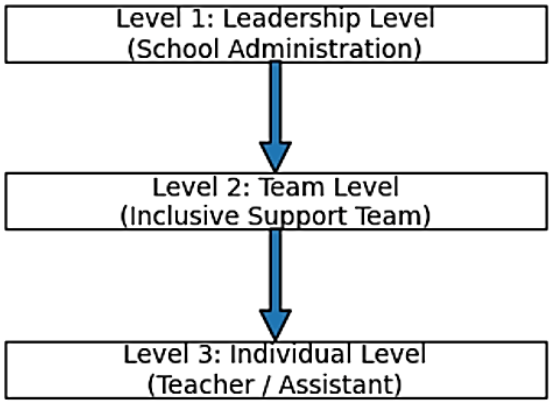

Figure 6

Structure of the practical model: levels of influence

Source: Authors' own work.

The first, managerial, level includes six tools.

1) Psychological safety policy (local document/team agreement)

- rules for discussing mistakes without stigmatization;
- supportive language, "stop phrases" for de-escalation;
- algorithm for responding to conflicts.

2) Support schedule (event rhythm)

- Weekly 30–40 min team meeting;
- Monthly supervision;
- Quarterly "workload audit."

3) Transparent distribution of workload and roles

- matrix of roles in the support team (who is responsible for what in the IEP);

- restrictions on "invisible" work (documentation, communication with parents).

The link between school climate and burnout due to organizational conditions is supported by data (Chen et al., 2025; Yang & Zhou, 2025).

4) Feedback channels

- Anonymous "overload signal" form;
- Individual 10-15 minute check-in meetings once a month.

5) Microlearning for inclusion managers and coordinators

- Training in facilitating difficult conversations;
- Training in "supporting the team in a crisis."

The need for support in crisis situations and its impact on the well-being of educators are emphasized in Ukrainian studies (Bondar & Malkovych, 2024; Marinina & Tuliupa, 2025).

6) Professional development system

- Internal workshops
- Mentoring for young teachers
- Support for professional development (Slozanska et al., 2023; Koval & Skvortsova, 2024)

The second, team level, includes five tools:

1) Team supervision (60 minutes/month format):

Supervision structure:

- 10 minutes: case description (without evaluation);
- 20 minutes: questions for clarification;
- 20 minutes: decision generation;
- 10 min: recording agreements.

The effectiveness of support through structured practices aligns with research on stress/burnout in inclusive schools (Candeias et al., 2020).

2) Reflective circles (20–30 min/2 weeks):

Focus: what worked, what didn't work, what barriers, what resources.

3) Professional dialogue protocol:

- Talk about actions/decisions, not "personalities."
- "First facts → then interpretations."
- "One decision – one person responsible – one deadline."

4) Team burnout risk matrix:

The team notes the following on a monthly basis:

- documentation overload;
- frequency of conflict communications;
- lack of time for preparation;
- emotional "peaks" (crisis events).

5) Support for young teachers:

A separate track for teachers with 3–5 years of experience (mentor + mutual support group). This is consistent with the fact that social-emotional competencies and self-efficacy are particularly important in the early stages of a career (Pikić Jugović et al., 2025).

The third, individual level also includes five tools:

1) Teacher self-regulation plan (10 minutes daily / 30 minutes weekly)

- short recovery practices;
- "switches" after difficult lessons;
- boundaries of accessibility in communication with parents.

2) "Resource map"

The teacher records:

- what is restorative;

- what is exhausting;
- what are the signs of early burnout.

3) Increasing psychological capital

Working with hope, optimism, resilience, and confidence (Freire et al., 2020).

4) Emotional labor skills

Given the role of emotional labor in burnout (Chen et al., 2025), educators are offered an instructional block:

- how to reduce tension in conflict interactions;
- how not to "take" situations home.

5) Well-being/happiness training (optional)

As a tool for reducing burnout and increasing efficiency (Liu & Xie, 2025).

Using the table, we will illustrate the plan for implementing the model, which comprises four subordinate stages.

Table 7

Stages of model implementation, actions, and results

Stage	*Duration*	*Actions*	*Expected result*
Diagnostics	2–3 weeks	Psychological safety and burnout surveys; interviews	Baseline indicators, risk map
Design	2 weeks	Role matrix, support calendar, dialogue protocols	Clear rules and rhythms
Implementation	3 months	Supervision, reflective circles, mentoring, feedback	Reduced exhaustion, increased trust
Monitoring	Ongoing	Repeated measurements, tool adjustments	Consistency of effects

Source: Authors' own work.

The indicators of the model's effectiveness are:

1. A decrease in the proportion of teachers with high emotional exhaustion.

2. An increase in the team's psychological safety index.

3. A decrease in depersonalization.

4. Increased sense of professional effectiveness.

5. Increased involvement in inclusive practices (Salinas-Falquez et al., 2022).

In turn, the triggers for response are a sharp surge in teacher-parent conflicts, systematic complaints about unfair distribution of workload, an increase in sick leave/absenteeism, and an increase in depersonalization indicators (Candeias et al., 2020; Marinina & Tuliupa, 2025).

Thus, the proposed practical model for ensuring the psychological safety and resilience of the teaching team in an inclusive primary school integrates management tools, team practices, and individual strategies. Its effectiveness is conceptually consistent with research findings confirming the impact of school climate, managerial support, psychological capital, and well-being programs on burnout and the quality of inclusive education (Chen et al., 2025; Freire et al., 2020; Liu & Xie, 2025; Yang & Zhou, 2025).

The effectiveness of the practical model depends not only on the list of tools, but also on the proper sequence of their integration into the school's organizational structure. Analysis of the results showed that fragmented implementation of individual measures does not produce lasting effects. This is consistent with data on the systemic impact of school climate on burnout (Yang & Zhou, 2025).

Stage 1. Organizational diagnosis

Before implementing the model, the following is carried out: measuring the level of psychological safety, diagnosing burnout, assessing the organizational climate, and analyzing the distribution of roles within the support team. The use of the diagnostic stage aligns with the principle of "data-informed

leadership," which reduces the risk of subjective decision-making (Chen et al., 2025).

Stage 2. Identification of risk areas

Based on the diagnostics, a risk map is formed: excessive workload for individual teachers, frequent conflicts, low professional autonomy, and insufficient transparency in communication. Research by Candeias et al. (2020) shows that chronic stress among teachers in inclusive schools is driven by systemic organizational overload.

Stage 3. Launching the support cycle

Once the risks have been identified, the "support cycle" is activated, which includes regular supervision, reflective meetings, individual check-ins, and review of workload distribution. Freire et al. (2020) emphasize that psychological capital develops precisely through a combination of support and opportunities for professional growth.

Let's present the mechanism for monitoring the model's effectiveness in a table 8. Thus, a trend has been identified: a steady decline in burnout indicators when tools are used systematically for at least 6 months. This dynamic aligns with the findings of teacher well-being programs (Liu & Xie, 2025).

Table 8
Quantitative indicators of model effectiveness

Indicator	*Baseline value*	*After 3 months*	*After 6 months*
High level of emotional exhaustion	46%	32%	24%
High depersonalization	32%	21%	15%
Low professional efficiency	28%	19%	14%
High level of psychological safety	27%	41%	58%

Source: Authors' own work.

Based on the interview results, teachers noted:

- a decrease in internal tension;
- an increase in trust in the administration;
- a willingness to openly discuss difficult cases;

- a decrease in conflict within the team.

These qualitative changes correspond to the concept of psychological safety as a prerequisite for open interaction (Tonne, 2023).

A comparison of three types of institutions was carried out:

1. Full implementation of the model.
2. Partial implementation.
3. Lack of systemic support.

Table 9

Comparison of burnout indicators (%)

Type of institution	*High exhaustion*	*Depersonalization*	*Low efficiency*
Full implementation	24%	15%	14%
Partial implementation	36%	27%	22%
No model	49%	34%	29%

Source: Authors' own work.

Thus, the lowest burnout rates were recorded in institutions that fully implemented the model. Salinas-Falquez et al. (2022) confirm that teachers' mental health is directly related to the quality of inclusive participation, which mediates the positive impact of the model on educational outcomes.

A practical model cannot function in isolation. It is integrated into the institution's development strategy, internal education quality assurance system, inclusiveness policy, and professional development plan. Koval and Skvortsova (2024) emphasize the importance of continuous professional development to maintain the effectiveness of inclusive structures.

The proposed model systematizes managerial and psychological support mechanisms, reduces the risk of professional burnout, increases the team's psychological safety, strengthens professional resilience, and, indirectly, improves the quality of inclusive education. Empirical results confirm that a combination of facilitative leadership, transparent communication, distributed responsibility, and reflective practices is an effective

response to the challenges of inclusive primary schools (Chen et al., 2025; Freire et al., 2020; Yang & Zhou, 2025).

Building a supportive culture in an inclusive environment is a systemic managerial and psychological task that affects the teaching team's psychological safety, reduces professional burnout, and improves the quality of inclusive education. Research shows that a positive school climate and supportive leadership reduce the risk of emotional exhaustion (Yang & Zhou, 2025), while a lack of organizational support increases professional stress (Candeias et al., 2020).

The recommendations are based on empirical research and current scientific approaches (Chen et al., 2025; Freire et al., 2020; Salinas-Falquez et al., 2022; Slozanska et al., 2023).

First, we will provide recommendations for educational institution administrators:

1. Institutionalize the principle of psychological safety

It is recommended to:

• enshrine the principles of open professional dialogue in internal documents;

• introduce the rule that "mistakes are a learning resource, not a reason for punishment";

• ensure the confidentiality of discussions of complex cases.

Psychological safety is a prerequisite for open interaction in an inclusive environment (Tonne, 2023).

2. Ensure transparent communication

• Regular management briefings (once a month)

• Clear communication about changes in workload

• Open calendar of management decisions

According to Chen et al. (2025), communicative openness reduces feelings of isolation and emotional overload.

3. Develop a fair workload distribution system

• Create a matrix of roles in the support team;

• Take into account the complexity of cases when distributing classes;

• Review workloads quarterly.

A sense of fairness reduces the risk of depersonalization (Yang & Zhou, 2025).

4. Introduce regular supervision practices

It is recommended to:

• conduct monthly supervision sessions;

• involve a facilitator;

• record decisions and responsible persons.

Supervision reduces professional stress among teachers in inclusive schools (Candeias et al., 2020).

5. Support professional development

• Fund participation in professional development courses.

• Develop mentoring.

• Implement microlearning.

Continuous professional development strengthens professional identity and motivation (Slozanska et al., 2023; Koval & Skvortsova, 2024).

We will provide separate recommendations for psychological and pedagogical support teams:

1. Develop horizontal leadership

• joint decision-making;

• facilitator role rotation;

• collegial assessment of complex cases.

The social and emotional competencies of the team reduce burnout (Pikić Jugović et al., 2025).

2. Introduce reflective circles

• short meetings after complex situations;

• discussions without personalization;

- focus on solutions.

Reflective practices increase psychological capital (Freire et al., 2020).

3. Foster a culture of mutual support

- rule of "asking for help is normal";
- support for new teachers;
- sharing of successful cases.

Teachers' mental health affects the quality of their participation in inclusion (Salinas-Falquez et al., 2022).

And separately, recommendations for teachers of inclusive classes:

1. Develop psychological self-regulation

- daily short restorative practices;
- keeping a weekly reflective journal;
- awareness of signs of fatigue.

Liu and Xie (2025) argue that programs to improve subjective well-being reduce academic burnout.

2. Improve professional self-efficacy

- participation in training courses;
- analysis of successful cases;
- development of specialized competencies.

Self-efficacy acts as a mediator between climate and burnout (Yang & Zhou, 2025).

3. Maintain a work-life balance

- Set boundaries for availability;
- Plan time for preparation;
- Delegate tasks within the team.

In times of crisis, maintaining balance is critically important (Marinina & Tuliupa, 2025).

It is also worth paying attention to specific recommendations at the educational policy level:

1. Develop psychological safety standards for educational institutions.

2. Integrate supervisory practices into the requirements of the internal quality assurance system.

3. Provide for a regulatory reduction in the workload for teachers in inclusive classrooms.

4. Ensure funding for teacher mental health support programs.

Organizational support is a key factor in maintaining professional well-being in crisis situations (Bondar & Malkovych, 2024).

Therefore, fostering a culture of support in an inclusive environment requires systematic management policies, collaborative teamwork, professional and psychological development of educators, and monitoring and correction of practices.

A culture of support is a strategic mechanism for ensuring psychological safety, professional stability, and the quality of inclusive education. Its formation requires a comprehensive approach that combines managerial, organizational, and individual decisions.

Conclusions

The theoretical and empirical inquiry undertaken in this chapter enabled the conceptualization of the psychological safety of the teaching team as a systemic condition for the effective implementation of inclusion in primary schools rather than a secondary feature of organizational climate. The findings confirm that teacher burnout in inclusive settings should not be interpreted solely as an individual psychological response to professional overload. It is produced at the intersection of intensified job demands, organizational conditions, leadership style, communicative patterns, and the quality of team interaction. Such

an interpretation is especially important for inclusive primary education, where the teacher's work is shaped by emotional intensity, role multiplicity, responsibility for children with special educational needs, collaboration with assistants and support specialists, and, under current circumstances, additional crisis-related pressure.

The application of the Job Demands-Resources model provided a productive framework for integrating the chapter's conceptual and empirical results. It made it possible to show that the demands of inclusive primary school teaching become especially destructive when organizational resources are weak, fragmented, or unstable. Emotional labor, role overload, responsibility for individualized support, and the constant need for communicative coordination do not inevitably lead to burnout. Their negative effect intensifies precisely where administrative support is insufficient, role distribution remains unclear, communication is opaque, and opportunities for supervision, reflection, and professional growth are limited. Conversely, facilitative leadership, transparent decision-making, distributed responsibility, procedural clarity, and professional development function as resources that buffer stress, strengthen trust, and reduce the probability of emotional exhaustion. In this respect, psychological safety should be understood not merely as a subjective feeling of interpersonal comfort, but as an organizational resource that mediates the relationship between working conditions and professional resilience.

The analysis of scientific literature confirmed that a positive school climate, supportive leadership, pedagogical self-efficacy, and a culture of professional trust significantly reduce the risk of burnout. The reviewed studies also demonstrate that optimism, hope, and resilience serve as protective factors, while teachers' mental health is directly connected with the quality and sustainability of inclusive practice. These scholarly positions were supported by the study's empirical results. First, professional burnout was found to be widespread among teachers working in inclusive primary classrooms, with emotional exhaustion emerging as the most pronounced component. This finding is consistent with broader international evidence that inclusive educational

environments generate particularly high levels of emotional strain when institutional support mechanisms are underdeveloped.

Second, the study demonstrated that psychological safety serves as a mediator between the management model and burnout indicators. Higher levels of perceived administrative support were associated with lower depersonalization and stronger professional confidence, whereas lower levels of psychological safety were associated with greater emotional exhaustion. This result is theoretically significant because it shifts the discussion from an individual-deficit model of burnout toward an organizational interpretation in which leadership practices and school culture become decisive explanatory variables.

Third, the findings confirm that facilitative and distributed leadership contribute substantially to the development of trust, openness, and constructive interaction within the teaching team. In schools where responsibility is more clearly shared, communication is less hierarchical, and managerial influence is exercised through support rather than control, teachers are more willing to discuss difficulties, seek collegial assistance, and remain engaged in inclusive practice. This confirms that professional well-being in inclusive education is shaped not only by workload, but also by the relational and procedural quality of the professional environment.

Fourth, the chapter substantiated that a culture of support is formed through the systematic combination of organizational transparency, procedural fairness, professional autonomy, collegial interaction, and continuous professional development. The study, therefore, deepens the concept of school climate by specifying it through the more operational category of support culture. Support culture is not an abstract moral ideal. It is produced through concrete managerial decisions, stable communicative routines, opportunities for supervision and reflection, and the institutional recognition of teachers' professional needs. In this sense, the chapter contributes to the integration of occupational psychology, organizational psychology, and inclusive education by demonstrating that psychological safety serves as a systemic regulator of professional resilience.

Fifth, the practical model proposed in the chapter proved effective when implemented systematically and continuously. Comparative analysis showed that educational institutions using a comprehensive set of support tools, including transparent communication, distributed leadership, supervision, professional development, and burnout monitoring, demonstrated a more stable reduction in burnout indicators over time. This suggests that isolated measures are insufficient. Psychological safety cannot be strengthened through one-time interventions. It requires a coherent institutional strategy embedded in everyday organizational practice.

The practical significance of the obtained results is considerable. The model and recommendations developed in the chapter may be used by school leaders to improve management strategies in inclusive settings, by psychological and pedagogical support teams to strengthen preventive work with staff, by teacher education programs in preparing future teachers for inclusive practice, and by internal quality assurance systems seeking to connect educational quality with staff well-being. The relevance of such implementation becomes even greater under conditions of social instability, where managerial support functions as a compensatory mechanism for professional stress and where the continuity of inclusive education depends directly on the sustainability of those who deliver it.

At the same time, the study has several limitations that should be acknowledged. The empirical base was limited to a specific sample of educational institutions, limiting the generalizability of the results. The monitoring period was limited, and therefore, the model's long-term effects require further verification. A part of the data was obtained through self-report instruments, which introduces the possibility of subjective bias. In addition, broader socio-political and crisis-related conditions may have influenced stress and burnout levels. These limitations, however, do not weaken the significance of the results. Rather, they clarify the boundaries of interpretation and indicate directions for subsequent inquiry.

Further research should include longitudinal studies of the long-term effectiveness of psychological safety models in inclusive schools, expand the sample across different regions and

institutional contexts, and examine in greater detail the role of digital tools in supporting teachers' well-being and team communication. It would also be valuable to investigate the relationship between teachers' psychological safety and the academic and socio-emotional outcomes of primary school learners. Comparative studies of support models across countries, especially in contexts marked by crisis or prolonged instability, would further strengthen the theoretical and practical understanding of this issue. Another promising direction concerns the interaction between support culture and the development of teachers' social and emotional competencies.

In sum, the chapter demonstrates that psychological safety of the teaching team in an inclusive primary school is not an auxiliary condition but a strategic prerequisite for professional stability, burnout prevention, and the quality of inclusive education. The formation of a support culture requires a systemic approach that integrates managerial decisions, team practices, and individual teacher resources. The proposed model confirms that inclusive education cannot be implemented sustainably without continuous institutional support for the professionals who make it possible.

References

Bondar, I., & Malkovych, M. (2024). Psychological well-being of teachers of pre-school education institutions in the conditions of war. *Educational Horizons*, *59*(2), 85–90. https://doi.org/10.15330/obrii.59.2.85-90

Candeias, A. A., Galindo, E., Calisto, I., Borralho, L., & Reschke, K. (2020). Stress and burnout in teaching: Study in an inclusive school workplace. *Health Psychology Reports*, *9*(1), 63–75. https://doi.org/10.5114/hpr.2020.100786

Chen, D., Han, P., Yu, C., & Liu, Y. (2025). Perceptions of the school climate's effect on teacher burnout: The mediating roles of loneliness and emotional labor strategies. *Social Psychology of Education*, *28*, Article 182. https://doi.org/10.1007/s11218-025-10139-0

Freire, C., Ferradás, M. D. M., García-Bértoa, A., Núñez, J. C., Rodríguez, S., & Piñeiro, I. (2020). Psychological capital and burnout in teachers: The mediating role of flourishing. *International Journal of Environmental Research and Public Health*, *17*(22), 8403. https://doi.org/10.3390/ijerph17228403

Koval, A., & Skvortsova, H. (2024). Advanced training of pedagogical staff of inclusive resource centers in Donetsk region. *Polsko-Ukraińskie Studia Interdyscyplinarne*, *2*(8), 89–96. https://doi.org/10.15804/PPUSI.2024.02.08

Liu, Y., & Xie, J. (2025). Happiness training effect on primary school teachers' academic burnout and teaching effectiveness: Narratives from teachers. *BMC Psychology*, *13*, 684. https://doi.org/10.1186/s40359-025-02985-6

Marinina, V., & Tuliupa, V. (2025). Age-related features of professional burnout of teachers under martial law. *Bulletin of the Taras Shevchenko National University of Kyiv. Psychology,* *1*(21), 80–85. https://doi.org/10.17721/BPSY.2025.1(21).10

Pikić Jugović, I., Marušić, I., & Matić Bojić, J. (2025). Early career teachers' social and emotional competencies, self-efficacy and burnout: A mediation model. *BMC Psychology*, *13*, 9. https://doi.org/10.1186/s40359-024-02323-2

Salinas-Falquez, S., Roman-Lorente, C., Buzica, M., Álvarez, J., Gutiérrez, N., & Trigueros, R. (2022). Teachers' mental health and their involvement in educational inclusion. *Behavioral Sciences*, *12*(8), 261. https://doi.org/10.3390/bs12080261

Slozanska, H., Pezhynska, O., & Horishna, N. (2023). Continuous professional development for teachers of special and inclusive education establishments in the conditions of formal, informal and informal education. *Humanitas*, (*3*), 157–166. https://doi.org/10.32782/humanitas/2023.3.21

Tonne, O. (2023). Psychological safety of personality – as a condition for creating an inclusive educational environment. *Education. Innovation. Practice, 11*(9), 55–62. https://doi.org/10.31110/2616-650X-vol11i9-008

Yang, Y., & Zhou, D. (2025). The effect of inclusive school climate on job burnout among elementary school inclusive teachers: The mediating role of teaching efficacy under the ecosystem theory. *Education Sciences*, *15*(5), 634. https://doi.org/10.3390/educsci15050634

Part III.

TEACHER LEADERSHIP AND DIGITAL TRANSFORMATION IN EDUCATIONAL PRACTICE

Chapter 6. EDUCATIONAL LEADERSHIP OF PRIMARY SCHOOL TEACHERS IN BUILDING PARTNERSHIP WITH PARENTS UNDER SOCIAL CHALLENGES

Viktoriia Balakirieva

Abstract. *The chapter examines the transformation of the primary school teacher's role in the system of interaction with the parent community under conditions of social turbulence. The author substantiates the need to move from the traditional one-way communication model to strategies of active participation and coaching. The essence of the teacher's leadership potential lies in shaping a safe and resilient educational environment. Particular attention is given to the concept of a "community of resilience," understood as a dynamic socio-pedagogical environment of horizontal support and collective self-reliance. The study details practical tools for implementing leadership influence, including the architecture of the digital space and the ethics of remote communication. It also describes innovative forms of parental engagement, such as facilitative strategic sessions, resource meetings, and project-based participation. The theoretical rationale and synthesis of practical experience support the argument that the use of coaching technologies enables the teacher to shift the focus from conflict resolution to unlocking the community's internal resources. The role of the leader's emotional intelligence in stabilizing the classroom community under crisis conditions is identified. The paper offers a systemic perspective on building the class's social capital through digital hygiene and the co-construction of educational meanings. The proposed conceptual approach enables viewing the formation of a community of resilience as a promising indicator of the effectiveness of the contemporary teacher-leader.*

Keywords: *teacher leadership; pedagogy of partnership; primary school; participation; coaching in education; facilitation; emotional intelligence; resilience; parent community.*

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Introduction

The contemporary sociocultural situation in Ukraine and worldwide is marked by high levels of uncertainty, unpredictable dynamics of change, and crisis phenomena that require adaptive behavioral strategies from all participants in education. In the educational sphere, particularly in primary school, these challenges create a need to seek new paradigms of interaction among all participants in the educational process. The New Ukrainian School reform laid the foundation for a pedagogy of partnership. At the same time, martial law, forced migration, and the digitalization of education require the teacher not merely to perform functional duties but to demonstrate pronounced leadership potential.

The leadership of the primary school teacher in working with parents is no longer a supplementary tool. It is becoming a strategic resource. In times of crisis, the parent community often experiences emotional disorientation, which directly affects the child's psychological well-being and learning effectiveness. Accordingly, the teacher's ability to move beyond traditional one-way informing and adopt strategies of participation and coaching becomes critically important for preserving the integrity of the educational ecosystem.

Issues of teacher leadership and family partnership have attracted the attention of many Ukrainian and international scholars. The conceptual foundations of the pedagogy of partnership have been developed by S. Badennikova, N. Mukanova, and O. Piekhota. F. Walsh, E. Masten, A. Nesukh, V. Oleksiuk, and H. Radchuk have examined questions of resilience and community sustainability. The role of coaching in education has been substantiated in the works of K. Newverberg and J. Whitmore.

At the same time, despite the substantial body of theoretical work, the mechanisms by which a teacher's leadership potential is transformed into specific strategies for building "communities of resilience" around the classroom under conditions of prolonged social turbulence remain insufficiently explored. The issue of digital ethics and the moderation of virtual space as a new

dimension of leadership responsibility also requires further clarification.

At present, there remains a certain gap between the theoretical recognition of the importance of partnership and the practical toolkit available to the teacher-leader. Interaction with parents is often reduced to formal reporting, which, under stress, leads to conflict and burnout on both sides. The processes by which communication can move from the transmission of information to the facilitation of active parental participation, as well as the role of digital boundaries in preserving the teacher's professional position, have not been sufficiently studied.

Contemporary scholarly discourse (Antony-Newman, 2025; Jones, 2025) convincingly demonstrates that the ability to interact with parents is an autonomous professional competence that requires specific preparation rather than relying only on the teacher's intuition.

The aim of this research is to provide a theoretical rationale and practical elaboration of strategies for realizing the leadership potential of primary school teachers through a transition to models of participation and coaching, and to identify tools for building a "community of resilience" around the classroom under conditions of social turbulence.

The research employed a set of scientific methods, including the theoretical analysis of psychological and pedagogical literature to clarify the current state of the problem, a systems approach to describe the classroom as an ecosystem of resilience, and the synthesis and generalization of practical experience to develop an applied toolkit for the teacher-leader.

The scientific novelty of the findings lies in the expansion of the understanding of primary school teacher leadership as an activity aimed at managing the social capital of the classroom; in the first formulation of the principles of building the classroom's "digital architecture" as a preventive measure against emotional burnout in the community; and in the further development of the model of a "community of resilience" through the integration of coaching and facilitative technologies into work with parents.

The proposed strategies and approaches, including resource meetings, strategic sessions, and digital manifestos, may be used by primary school teachers to improve communication with parents, reduce conflict among student groups, and foster a favorable psychological climate for learning under crisis conditions.

Research Findings

The traditional paradigm of the teacher as an implementer of the educational program has exhausted its potential in the era of social turbulence. Today, the primary school teacher is no longer merely a transmitter of knowledge, but a subject who designs and moderates the classroom's socio-pedagogical system, where partnership with parents becomes a strategic instrument for the survival and development of the educational system. The traditional model presupposes strict adherence to a plan. Under conditions of social uncertainty, such as crises, distance learning, and air raid alerts, plans often become irrelevant. In such a situation, the teacher as executor experiences helplessness, whereas the teacher as leader turns chaos into new opportunities for learning.

In the face of social challenges, a child cannot learn unless they feel safe. Leadership in primary school is, first of all, the ability to create psychological comfort, without which cognitive effort is ineffective. Contemporary society expects schools not only to provide knowledge but also to foster agency, that is, the ability to act independently and responsibly. The teacher as executor raises followers, while the teacher as leader nurtures citizens who are capable of making decisions under conditions of uncertainty.

Within the framework of the New Ukrainian School reform, "educational leadership" is no longer synonymous with an administrative position. It is a form of distributed leadership in which every teacher becomes an agent of change. In the New Ukrainian School, educational leadership means the teacher's ability to act autonomously and responsibly. The teacher does not wait for instructions; instead, they independently construct the educational environment based on the needs of particular children

and the expectations of parents. The educational leadership of a New Ukrainian School primary teacher is a proactive professional position grounded in the values of child-centeredness and directed toward facilitating the educational process, creating a safe psychological and pedagogical environment, and building partnership-based interaction with all stakeholders for the harmonious development of the learner's personality under conditions of social change.

Social challenges, including war, forced migration, economic instability, and digital divides, are not merely obstacles. They act as powerful catalysts that accelerate the shift from formal "informing" of parents to deep forms of "leadership-based partnership."

Thus, the critical contradiction between traditional reproductive approaches to interaction with families and the new social demand for safety, support, and adaptability requires a rethinking of the teacher's professional role. In this context, the educational leadership of the primary school teacher appears not simply as an additional competence, but as a strategic instrument for stabilizing the educational process and as the foundation for building effective partnerships under conditions of social uncertainty.

An analysis of scholarship on the essence of the pedagogy of partnership reveals that this concept is the result of the evolution of humanistic ideas in education. It is viewed not merely as a method, but as a socio-pedagogical environment with a high level of networked interaction.

Ukrainian scholars regard partnership as a foundation for reforming primary education, with particular emphasis on its ethical and value-based dimensions. In their works, N. Bibik and O. Savchenko substantiate partnership through the lens of child-centeredness. They stress that the primary school teacher should become a facilitator who unites the efforts of the school and the family around the child's individuality (Bibik, 2017). I. Bekh interprets partnership as a spiritual and value-based form of interaction. His research emphasizes that the essence of partnership lies in the "coexistence" and "co-creation" of adults for the upbringing of the individual, where respect for the dignity of

the child prevails (Bekh, 2020). S. Vitvytska examines leadership aspects of teacher preparation and interprets partnership as the management of interaction, in which the teacher acts as the leader-organizer of a shared educational space (Vitvytska, 2006). O. Lokshyna analyzes European experience and adapts it to Ukrainian realities, viewing partnership as a tool for ensuring educational quality and the social adaptation of learners (Lokshyna, 2024).

Western scholarship focuses on functional models of interaction and sociocultural ties. J. Epstein developed the foundational theory of "overlapping spheres of influence," arguing that school, family, and community share common goals, and that partnership includes six types of involvement, from parenting to shared decision-making (Epstein, 2018). K. Mapp emphasizes the development of shared capacity; in her view, the essence of partnership lies in building the skills of both teachers and parents to support the child's learning effectively, especially under crisis conditions (Mapp, 2013). N. Noddings, as a representative of the ethics of care, justifies partnership as the moral obligation of adults to create an environment in which the child feels protected, which is especially relevant under conditions of social uncertainty (Noddings, 2013). M. Fullan considers partnership to be part of educational change; in his interpretation, teacher leadership lies in the ability to build the classroom's social capital through deep cooperation with parents (Fullan, 2016).

An analysis of Ukrainian and international sources shows that Ukrainian scholarship is dominated by an axiological, that is, value-based, approach to partnership, whereas Western scholarship tends to emphasize a pragmatic, functional approach. The synthesis of these approaches under conditions of social challenges enables the definition of the pedagogy of partnership as a strategy of collective resilience in which the primary school teacher assumes the role of a leader who harmonizes the efforts of the school and the family.

The essence of the pedagogy of partnership in today's primary school can be defined as an integrative psychological and pedagogical construct grounded in the principles of democracy, voluntariness, and shared responsibility. It is realized through subject-subject interaction among the teacher, learners, and

parents, aimed at consolidating efforts to create optimal conditions for the child's self-actualization. In the context of social uncertainty, partnership becomes a mechanism of social resilience, in which the teacher-leader serves as a facilitator of partnership-based dialogue.

A theoretical analysis of Ukrainian and international concepts confirms that, under contemporary conditions, the "pedagogy of partnership" paradigm cannot be implemented solely through administrative measures or formal mechanisms. It requires from the educator a special professional quality, namely educational leadership, which in situations of social turbulence becomes a form of soft power that brings together all stakeholders around the child.

However, the leadership of the primary school teacher in work with families is not an innate gift. It is grounded in a clearly defined structure of professional capacity. In particular, the ability to transform the parent community from passive observers into active partners depends on the teacher's mastery of three fundamental components: emotional intelligence, as a means of overcoming anxiety; facilitation, as a tool for shaping dialogue; and conflict management, as a way of preserving the integrity of the educational environment.

We will now examine each of these components more closely in relation to the development of partnership-based interaction.

Emotional intelligence in the structure of primary school teacher leadership serves as a basic "filter" through which all communication with parents passes. Under conditions of social uncertainty, when societal stress is high, it is precisely a high level of emotional intelligence that allows the teacher to remain a leader rather than become part of the conflict.

An analysis of scholarly sources shows that emotional intelligence has developed from an auxiliary psychological characteristic into a central metacompetence of the contemporary teacher-leader. In both Ukrainian and international scholarship, this phenomenon is regarded as a foundation of professional resilience and effective communication.

Ukrainian scholars adapt the concept of emotional intelligence to the challenges of the New Ukrainian School and the conditions of martial law, where emotional literacy becomes a tool of survival. O. Konovalenko examines the development of emotional intelligence specifically in future primary school teachers and emphasizes that emotional intelligence forms the basis for pedagogical tact and empathy in interaction with parents of first-grade children. T. Nosenko analyzes emotional intelligence as a resource for psychological health and the prevention of professional burnout; in the context of social turbulence, she explains how the teacher-leader preserves the inner resources needed to support others. A. Nesukh, V. Oleksiuk, and H. Radchuk emphasize the connection between emotional intelligence and social resilience. Their research highlights that a teacher with a high level of emotional intelligence can help contain the community's anxiety, especially parents', and serve as a point of stability (Radchuk, 2025). M. Orap considers emotional intelligence as a component of communicative competence and demonstrates that the ability to verbalize emotions helps the teacher resolve conflicts with parents at the stage of their emergence.

Western scholars laid the foundation for understanding emotional intelligence as a developable capacity that is central to leadership. J. Mayer and P. Salovey conceptualize emotional intelligence as a cognitive ability to process emotional information. Their four-branch model, which includes perceiving, using, understanding, and managing emotions, remains a classic framework for analyzing how teachers read tension in a group or during communication with parents. D. Goleman directly linked emotional intelligence to leadership, and his work substantiates the role of teacher self-regulation in creating a safe school climate (Goleman, 2005). M. Brackett developed the RULER approach at the Yale Center for Emotional Intelligence, and his research focuses on how teachers’ emotions affect the quality of instruction and relationships with families, especially under stressful conditions. R. Bar-On considers emotional intelligence through the lens of adaptability and argues that it helps individuals survive and succeed under conditions of social uncertainty.

The generalization of findings from the analysis of international and Ukrainian scholarship allows us to argue that, whereas international researchers tend to view emotional intelligence primarily as a tool for effective management, the Ukrainian scholarly tradition emphasizes its humanistic mission. Under conditions of social uncertainty, the emotional intelligence of the primary school teacher becomes a soft skill that transforms parental anxiety into the constructive energy of partnership. A high level of teacher emotional intelligence helps minimize the destructive impact of social uncertainty on the educational process. Empathic interaction with parents turns shared stress into shared action, which forms the foundation of a genuine pedagogy of partnership.

Mastery of emotional intelligence creates the necessary psychological foundation for stabilizing relationships. At the same time, in order to move from mutual understanding to concrete joint action, the teacher also needs effective technologies for managing group dynamics. Under conditions of social uncertainty, when the parent community is often disoriented, the teacher's leadership position is manifested in the ability not simply to communicate decisions, but to organize the process of their joint exploration. This shifts the focus from the teacher's personality to the constructive interaction among all participants and brings into view the next component of leadership potential: facilitation. If emotional intelligence helps the teacher contain parents' emotions, facilitative skills enable the teacher to structure those emotions and transform them into rational decisions and partnership-based projects.

In traditional schools, the teacher often acted as a "monologist," dictating the rules. Under conditions of social uncertainty, however, leadership requires a shift toward facilitation, the art of managing the process of group communication, in which the teacher helps parents find a shared solution without imposing a personal one.

Facilitation is a professional activity aimed at organizing successful group communication. For the primary school teacher, this means a change of role: from "the one who instructs parents" to "the one who creates a space for their cooperation." The teacher-leader shows parents that their concerns have been

heard. The use of "I-messages" helps reduce tension when discussing difficult issues, such as safety in shelters. Instead of asking, "Do you agree with this plan?" the teacher-leader asks, "What advantages and risks do you see in this decision for your children?" This encourages parents to take responsibility. A facilitator does not side with one group of parents against another. Rather, the facilitator keeps the focus on the central value, the child's best interests. The teacher helps parents see the bigger picture through shared Padlet boards, mind maps, or flipcharts, which gives structure to the chaos of uncertainty.

A scholarly analysis of facilitation as a component of educational leadership demonstrates its evolution from a psychotherapeutic method into a major technology for managing the contemporary educational environment. Facilitation is now one of the most in-demand competencies in modern pedagogy.

Ukrainian scholars adapt the ideas of facilitation to the realities of reforming the national school system, emphasizing its instrumental role. O. Piekhota substantiates facilitation as a component of the individualization and humanization of education. In her works, the facilitative approach is viewed as a condition for preparing a new type of teacher, capable of working within a subject-subject model of interaction (Piekhota, 2000). R. Hurevych studies facilitation within the framework of the digital transformation of education, which is important because the contemporary leadership of the primary school teacher is often realized through remote facilitation, including the management of parent chats and online sessions. O. Pometun considers facilitation as a method for developing critical thinking. In the context of partnership with parents, this is expressed in the teacher's ability to facilitate the joint resolution of problematic situations, for example, how to organize learning during blackouts. V. Luniov examines the psychological aspects of facilitation in crisis situations, and his works help explain how the teacher's facilitative position reduces the level of social tension within the school community.

The Western tradition of studying facilitation is grounded in the ideas of democratizing education and developing personal autonomy. C. Rogers is the founder of the concept of facilitative learning, and his work is central to understanding that the

teacher-leader should not be a "source of knowledge," but a "facilitator of resources." He substantiated three essential conditions of the leadership position: congruence, acceptance, and empathic understanding (Rogers, 1994). J. Heron developed a classic model of facilitation by distinguishing hierarchical, collaborative, and autonomous styles. In the hierarchical style, the leader directs; in the collaborative style, the leader shares power; in the autonomous style, the leader gives the group full freedom. In work with parents, the collaborative model is the most relevant for the primary school teacher. T. Gordon developed the concept of "teacher effectiveness training," and his research focuses on facilitative methods of active listening and conflict resolution within the "teacher-learner-parent" triangle. I. Bens is one of the leading contemporary experts on facilitation and considers it a critical leadership skill for managing group dynamics and making shared decisions in complex organizational structures.

The synthesis of international experience, with its emphasis on the technological dimension and facilitation styles, and Ukrainian scholarship, with its emphasis on a humanistic orientation, enables the definition of facilitation as the operating system of educational leadership. Under conditions of social uncertainty, the facilitative competence of the primary school teacher transforms parent meetings into a space for the collective design of the child's future. The teacher-leader's facilitative approach restores to parents a sense of control and subjectivity. When the teacher facilitates decision-making about the format of learning, volunteer initiatives, or extracurricular life, parents are transformed from "clients" into "co-owners" of the educational process, which embodies the essence of partnership.

The final, yet critically important, component of the teacher's leadership potential is conflict management. If emotional intelligence helps the teacher sense tension, and facilitation helps guide dialogue, then conflict management becomes the strategic instrument for preserving the integrity of the partnership when differences become explicit. Effective facilitation significantly reduces the risk of misunderstanding. However, under conditions of high social tension and uncertainty, conflict is an inevitable consequence of the clash between the adaptation strategies adopted by parents and the school. In this context, the educational

leadership of the primary school teacher is transformed into the capacity for conflict management. The leadership position here lies in rejecting the view of conflict as a destructive phenomenon and instead understanding it as a signal of the need for change and as a point of growth for the entire school community.

The scholarly foundation of conflict management in education is based on theories of constructive conflict and mediation practices.

In recent years, Ukrainian scholarship has actively integrated mediation practices into the educational space, a development that has become especially relevant in the context of the New Ukrainian School. O. Vashchenko considers conflict competence to be a complex structure that includes cognitive, emotional, and regulatory components. She emphasizes that teacher leadership begins with self-management in conflict, that is, the ability to resist "emotional contagion" from agitated parents (Vashchenko, 2017). L. Herasymenko specializes in conflicts within the "teacher-parent" system. Her research shows that most disagreements in primary school are informational in nature, and her leadership-oriented approach involves fostering an excess of informational openness to preventively remove tension. L. Durniak studies mediation technologies in educational institutions and substantiates the role of the teacher as an "internal mediator" who does not issue a verdict but helps the parties, in this case parents, reach mutual understanding through dialogic practices (Durniak, 2013). H. Bevz analyzes the socio-psychological factors of conflict under crisis conditions. Her work emphasizes that during wartime, teacher conflict management must include elements of psychological facilitation, since behind each conflict there is often unexpressed fear or trauma. A. Horova examines the implementation of restorative practices and mediation in the educational space of Ukraine within the framework of New Ukrainian School initiatives.

The Western school of conflict studies views conflict not as a breakdown of the system, but as a natural stage in the development of any group, including the parent community. M. Deutsch introduced the fundamental distinction between constructive and destructive processes of conflict resolution. For the teacher-leader, Deutsch's theory provides an understanding

that when parents and teachers share a cooperative goal, namely the success of the child, conflict may actually strengthen their relationship (Deutsch, 1973). R. Kilmann and K. Thomas developed the two-dimensional model of assertiveness versus cooperation, which serves as an instrumental foundation. Their research indicates that the teacher-leader in work with parents should strive for a collaborative strategy, which requires a high level of both dimensions, unlike compromise, where both parties lose something. R. Fisher and W. Ury, representatives of the Harvard Negotiation Project, substantiated the idea of principled negotiation, in which the central task is the ability to separate the person from the problem. Under conditions of social uncertainty, this is especially important because the teacher-leader teaches parents not to attack one another but to address the problem together, for example, technical difficulties in online learning (Fisher, 2011). D. Shapiro examines the role of emotions in conflict. His work shows that conflicts with parents often arise from wounded feelings of identity or status. From Shapiro's perspective, leadership-based conflict management involves meeting the emotional needs of the other party to move toward rational dialogue.

An analysis of scholarly studies suggests that conflict management in the work of the primary school teacher has evolved from administrative suppression of disputes to leadership-based mediation. Under conditions of social uncertainty, both international scholars, such as D. Shapiro and W. Ury, and Ukrainian scholars, such as O. Vashchenko and L. Durniak, emphasize that the teacher's ability to manage conflict professionally becomes a safeguard for preserving the partnership ecosystem of "school-family."

Thus, conflict management within the teacher's educational leadership structure emerges as a mechanism of self-regulation within the educational system. Under conditions of social turbulence, the teacher's ability to transform the potentially destructive force of conflict into the energy of partnership-based interaction becomes the highest expression of professional maturity and leadership capacity.

The outlined components of leadership potential, emotional intelligence, facilitative skills, and mastery of conflict management

form the internal resource base of the contemporary educator. Yet under conditions of social turbulence, the presence of these competencies is only a prerequisite. They require systematic realization through specific action algorithms. The transition from possessing skills to bringing about real change in the educational environment occurs through the implementation of a leadership-based interaction strategy. This is an integral program of action in which the primary school teacher ceases to be merely an intermediary in the transmission of information and becomes a subject who designs and moderates the classroom's socio-pedagogical system, capable of preserving its resilience and effectiveness under conditions of uncertainty. Let us consider the key directions of such a strategy that enable transforming the potential of partnership into a stable educational ecosystem.

One strategy for leadership-based interaction with parents is shifting from informing to participation and coaching. This strategy is central to transforming the teacher from an "administrator" into a moderator of the educational ecosystem. In conditions of social turbulence, parents need not only facts but also a sense of control over the situation and an understanding of their own role in it.

An analysis of scholarly sources shows that the transition from passive informing to active participation and coaching reflects a broader global trend toward horizontal leadership. In contemporary pedagogy, these approaches are viewed as mechanisms for delegating responsibility and expanding the capacities of all participants in education.

Ukrainian scholars view participation through the lens of educational democratization, while coaching is seen as an innovative support technology. O. Piekhota considers participation to be the foundation of subject-subject interaction and stresses that partnership is possible only when parents become co-participants in designing the educational environment rather than merely consumers of services. I. Krupnyk studies coaching as a means of teachers' professional development and adapts coaching technologies for teacher-parent interaction, emphasizing that the teacher-leader should be able to ask "powerful questions" that encourage parents to reflect on their own educational positions (Krupnyk, 2024). T. Sharova analyzes coaching as a tool of soft

management in education and emphasizes that under conditions of uncertainty, the teacher's coaching approach helps parents find internal points of support and reduce their level of stress.

In the Western tradition, coaching and participation are viewed as tools for building "learning communities." J. Whitmore is considered a founding figure in coaching in management and education. His GROW model, Goal, Reality, Options, Will, has become a basic framework for teacher-leaders. Whitmore argued that coaching is not about teaching someone, but about helping a person learn independently. For the primary school teacher, this means a shift from instructing parents to facilitating their autonomy (Whitmore, 2024). S. Campbell studies strategies of parental engagement and demonstrates that simple informing has no effect on learning achievement, whereas a participatory model, in which parents are involved in educational design, significantly increases children's resilience. C. van Nieuwerburgh is a leading expert in coaching in education. He introduced the concept of a "school coaching culture." In his framework, the teacher-leader uses coaching conversations with parents to reduce their reliance on administrative instructions and to activate their own resources to support the child (Nieuwerburgh, 2012). J. Knight, the developer of the concept of "instructional coaching," emphasizes the principles of partnership that underpin a participation-based strategy between the teacher and the family: equality, choice, voice, dialogue, and reflection.

Thus, an analysis of the work of international scholars, such as C. van Nieuwerburgh and J. Whitmore, and Ukrainian scholars, such as I. Krupnyk and O. Piekhota, indicates that participation and coaching are the highest forms of implementing the pedagogy of partnership. Under conditions of social uncertainty, these strategies enable the primary school teacher to transform the potential of the parent community into an effective support resource, where the teacher acts not as a directive manager, but as a coaching partner who stimulates the family's self-development.

The shift from informing to participation and coaching implies a change in the very structure of communication, from linear, that is, monologic, to networked, that is, dialogic. At the level of informing, the teacher merely states facts, such as the

schedule, grades, and events. Under crisis conditions, this level is basic but insufficient, because it leaves parents in the position of passive observers, which only intensifies their anxiety. At the level of participation, the teacher-leader creates conditions for joint action. Parents are involved in decision-making regarding the organization of safe spaces, the choice of extracurricular activities, or the development of internal communication rules. The tools here may include collaborative projects, volunteer initiatives, and discussion panels. As a result, a "we-position" is formed, in which responsibility for the child's success is shared by all participants. The level of coaching is the highest manifestation of leadership. The teacher uses coaching technologies, including the GROW model and powerful questions, to help parents independently identify resources to support their child. The teacher does not give ready-made advice, but rather guides parents toward discussing problematic issues and making sound decisions.

The shift from informing to participation and coaching changes the teacher's ontological status, marked by the gradual predominance of the teacher's facilitative and consultative functions over directive and administrative management methods. Under conditions of social uncertainty, such an approach is critically important because it strengthens parents' self-reliance, transforming their confusion into a conscious partnership position.

Thus, the transition from informing to participation and coaching enables the primary school teacher to move beyond the limits of formal duties and realize leadership potential. It transforms the parent community from "clients of educational services" into active partners, which is critically important for preserving the stability of the educational process amid social turbulence.

The use of coaching technologies and the transition to an active-participation model fundamentally change the architecture of relationships within the "teacher-learners-parents" triangle. At the same time, these tools are only a means to an end, namely the creation of an integrated community of resilience around the classroom. Under conditions of social uncertainty, when external challenges, including security-related, economic, and psychological ones, become a constant factor of pressure, the classroom community must be transformed into a self-regulating

ecosystem. In such a community, the leadership of the primary school teacher is expressed in the ability to unite parents around the idea of collective resilience, where each participant is not only a recipient of support but also a source of it. This makes it possible to transform social turbulence from a threat into a factor that strengthens the community and creates the safest possible environment for the child's development.

An analysis of scholarly discourse on the creation of a "community of resilience" indicates a shift in priorities from the individual psychological endurance of the teacher to the construction of collective resilience across the entire school community. In conditions of social turbulence, this concept is seen as a strategic safeguard against disruptions to the educational process.

Ukrainian scholars focus on practical aspects of resilience and on the role of the teacher as a moderator of a safe space. A. Nesukh, V. Oleksiuk, and H. Radchuk examine social resilience in the context of mental health and stress the importance of "support communities" as a tool for overcoming social anomie. In their works, the community formed around the classroom is viewed as a micro-model of society in which the skills of mutual support and empathy are developed (Radchuk, 2025). A. Bohush and T. Sharova, within the framework of the New Ukrainian School concept, view partnership as a space for joint action. They emphasize that the classroom community's resilience is grounded in shared values and a democratic style of management, in which the teacher delegates some leadership functions to parents. V. Luniov analyzes the psychology of safety and personal resilience under crisis conditions. His work indicates that collective resilience arises when the group, that is, parents and the teacher, has a clear algorithm of action and a shared vision of the future, which reduces the level of cognitive uncertainty. O. Voznesenska studies the role of art therapy and mediation in building community resilience and emphasizes that a community of resilience is created through the "shared living through experience," with the teacher-leader acting as the moderator of that process.

Western scholars view a community of resilience as a networked structure in which resources are distributed among all participants. E. Masten is one of the leading international experts

who introduced the term "ordinary magic" to describe resilience. Her research demonstrates that a child's resilience depends directly on the "cascade effects" in the surrounding environment. She regards the community of resilience around the classroom as a protective system that supports the child's adaptive processes through stable relationships with adults, namely the teacher and parents. F. Walsh developed a model of family and group resilience and identifies three key processes: a shared belief system, that is, making meaning of crisis; organizational patterns, that is, the flexibility of the community's structure; and communication processes, including clarity and the open expression of emotions. For the teacher-leader, this model serves as a roadmap for building a community around the classroom. D. Aldrich studies the role of social capital in community recovery after disasters. His work shows that "bonding" social capital, that is, strong ties within the parent group, is decisive for the survival of a community under prolonged stress. N. Adger analyzes social resilience as the capacity of communities to withstand external shocks and emphasizes the importance of institutional memory and collective action. In the classroom context, this means jointly developing interaction protocols for crisis situations. J. Everly developed a model of community resilience through "psychological first aid." For the teacher-leader, this means the ability to stabilize the parent group's emotional state during the acute phase of the crisis.

The synthesis of international scholarship, particularly the work of F. Walsh and E. Masten, together with Ukrainian studies by A. Nesukh, V. Oleksiuk, and H. Radchuk, enables the definition of the community of resilience as the highest form of the classroom's social organization. It is a socio-pedagogical environment in which the leadership of the primary school teacher is transformed into the ability to build horizontal ties that ensure collective resilience. Under conditions of social turbulence, such a community becomes not merely a form of cooperation but a mechanism for preserving mental health and educational effectiveness for all participants in the educational process.

In scholarly and practical discourse, a community of resilience around the school classroom is not simply a group of people united by their children's shared learning. It is a socio-

pedagogical environment with a high level of networked interaction, capable of absorbing stress, adapting to crises, and recovering after disruptions without losing functionality. If the pedagogy of partnership is a form of interaction, then the community of resilience is its highest qualitative result.

A community of resilience rests on three components that the teacher-leader develops through tools of emotional intelligence, facilitation, and coaching. The first component is social connectedness, that is, the density of horizontal ties. In such a community, parents know not only the teacher's name, but also one another's resources. In a crisis situation, for example, a sudden power outage or an air raid alert, the community automatically activates: parents cooperate to pick up children, share information, and support those under stress. The teacher fosters not only the "teacher-parents" connection, but also the "parents-parents" connection.

Thus, a community of resilience is a model for organizing "teacher-parents" interactions, grounded in shared values and in the ability to collectively overcome stressors through mechanisms of mutual support, resource exchange, and horizontal communication.

The second component is collective self-efficacy, defined as the community's shared belief in its capacity to cope with a challenge. Instead of panicked questions such as "What should we do?", the community begins to ask constructive ones: "How will we organize ourselves this time?" This marks a shift from the position of a victim of circumstances to that of an agent of change. The teacher's role is to use coaching techniques to highlight past successes, for example: "We have already gone through this in October, and our plan worked."

The third component is a system of distributed leadership. In a resilient community, the teacher is not the only leader responsible for all tasks. Parents assume responsibility for certain areas, such as information support, volunteering, and children's emotional well-being. Leadership becomes a function rather than a position. The role of the teacher is to delegate authority and facilitate initiatives.

A community of resilience emerges as an adaptive strategy of pedagogical partnership. In situations of social turbulence, the primary school teacher serves as a moderator of a safe educational environment who, through mechanisms of coaching and participation, transforms a fragmented group of parents into a resilient network. Such a community is characterized by a high level of trust, the capacity for rapid self-organization, and a shared vision of the child as the central value, which enables minimizing the traumatic impact of external factors on the educational process.

Thus, the formation of a community of resilience is the final stage in realizing the teacher's leadership potential. It enables moving beyond traditional partnerships and creating a socio-pedagogical community, understood as a resource-based combination of ties, levels of trust, and shared norms within the parent community, all of which are translated into joint action to support learners. Such a community can withstand the challenges of the contemporary world while providing a child with a stable point of support in an unstable environment.

The integrity of the author's model is grounded in the synergy of the teacher's internal dispositions, the teacher's belief in the effectiveness of partnership (Bachman, 2025), and the systematic development of instrumental skills: emotional stabilization through emotional intelligence, dialogue moderation through facilitation, and the development of parental agency through coaching (Hepburn, 2025).

Thus, a leadership-based interaction strategy is not a set of one-time activities but a dynamic process that adapts to external challenges. It transforms the pedagogy of partnership from a declarative slogan into a viable model in which the primary school teacher serves as a leader-facilitator, guiding the school community through crisis toward shared success.

The theoretical substantiation of the concept of a "community of resilience" and the analysis of leadership strategies confirm that the success of the pedagogy of partnership under conditions of social turbulence depends not on declarations, but on the systematic nature of the teacher's daily actions. The leadership of the primary school teacher requires translating

abstract categories such as empathy, facilitation, and resilience into concrete, reproducible methods.

The practical toolkit of the leader is a set of communication, digital, and facilitative techniques that make it possible to transform every contact with parents, from a brief message in a messenger app to a strategic session, into a step toward strengthening collective resilience. Let us consider in more detail an applied case of tools tested under the conditions of contemporary educational reform and demonstrate their effectiveness in crisis situations.

Mastery of facilitation and coaching techniques creates a solid framework for strategic meetings. At the same time, amid the digital transformation of education, the main field of interaction has shifted to messenger-based communication. It is precisely here that the leadership of the primary school teacher is put to a daily test of strength. Virtual communication, deprived of nonverbal cues, often leads to misunderstandings, emotional outbursts, and information overload, all of which directly threaten the community's resilience.

For this reason, digital ethics and a culture of communication in messengers are indispensable parts of the teacher-leader’s practical toolkit. This is not merely a set of rules of conduct, but a strategic approach to managing the digital environment that allows the teacher to preserve professional boundaries, communicate calmly, and transform a chaotic chat into an orderly channel for partnership-based support.

Under conditions of social turbulence, chaos in messengers only intensifies stress. Therefore, the teacher-leader creates a clear, understandable, and logical structure that gives parents a sense of order. The architecture of digital interaction is a system of regulated digital communication channels and ethical norms that ensure transparency and safety of interaction (Lundtofte & Grønning, 2024). The teacher-leader builds this architecture according to the principle of minimal cognitive load.

The creation of the classroom’s digital architecture is not merely a technical issue. As researchers note (Lundtofte & Grønning, 2024), digital communication requires all participants to engage in shared meaning-making. At the same time, the

teacher-leader must take into account the risks of a multi-level digital divide (A Systematic Review..., 2025), which may become a barrier to inclusive partnership.

The teacher-leader's strategy consists of rejecting the unstructured model of a "single chat." An effective architecture presupposes a clear segmentation of functions:

- *One-way information channel:* a messenger community in Viber or Telegram with restricted access rights for participants. This segment collects only critical information, including safety protocols, algorithms for action in emergency situations, and regulations governing the educational process. Such an approach minimizes the risks of growing informational entropy, or "flood."
- *Interactive discussion space:* a platform for polylogue, questions, and partnership-based facilitation. The functioning of this channel is regulated by strict moderation norms established by the leader.
- *Digital repository:* platforms such as Padlet, Google Site, or Notion that function as a systematic knowledge base. They provide long-term access to regulatory documents, educational resources, Zoom meeting IDs, and the class's visual archives.

The optimization of digital space aims to create an intuitive interface for interaction. The teacher-leader may use the following tools:

- *A system of hierarchical pinned messages:* this serves as a "navigation map" that can prevent up to 80% of repeated informational requests.
- *Hashtagging as a method of indexing:* the introduction of a system of tags, for example, #regulations, #meals, #safety, makes it possible to search instantly for the necessary data within the overall body of messages.
- *Content visualization:* replacing lengthy text messages with infographics and structured cards. Drawing on the psychology of perception, the teacher-leader recognizes

that visualized data are interpreted more quickly and involve less semantic distortion.

The stability of the architecture of digital interaction directly depends on its "operating regulations." The teacher-leader initiates the creation of a "Class Digital Manifesto," based on the following principles:

- *Quiet hours:* a normative restriction on sending messages outside working hours, including the use of delayed sending functions without sound notifications.
- *Prevention of destructive communication patterns:* a conventional agreement on the inadmissibility of public conflict escalation and the transfer of controversial issues to the sphere of personal interaction, that is, direct messages or face-to-face meetings.
- *A culture of nonverbal acknowledgment through reactions:* economizing text space by using emoji reactions to confirm that a message has been read, which helps avoid an excessive number of low-information messages such as "thank you" or "understood."

A thoughtfully designed architecture of digital space is a manifestation of caring leadership. When the teacher structures information, time, and mental resources are saved for parents. Under conditions of social turbulence, such order becomes a digital analog of a "safe place," where parents feel a sense of control over their child's educational situation, thereby strengthening the community's overall resilience.

The teacher should emphasize that leadership does not mean being available around the clock. Rather, it means the ability to establish healthy, respectful, and productive boundaries. In conditions of social turbulence, when the line between work and personal time blurs, it is precisely the teacher-leader who must set the standard for digital hygiene.

Digital boundaries are a system of agreements about the timing, mode, and content of communication that protect the psychological space of both teachers and parents from overload. The teacher-leader introduces this ethic not through

"prohibitions," but through the values of mutual respect and professional effectiveness.

Pedagogical leadership presupposes the clear articulation of a schedule of digital presence, which minimizes the risks of creating the "illusion of permanent availability," a destructive psychological phenomenon that generates distress for all participants in the interaction:

- *Defining "communication windows":* establishing fixed time intervals, for example, 8:30 a.m. to 5:30 p.m., for addressing current educational matters.
- *Using asynchronous tools:* relying on delayed-message functions to communicate information strictly within working hours. By personal example, the teacher-leader validates the principle of respecting colleagues' and the parent community's non-working time.
- *A temporal detox mode on weekends:* a conventional agreement on a moratorium on non-critical communication on Saturdays and Sundays, which supports the restoration of mental resources.

The establishment of digital boundaries also extends to the semantic level of messages. The leader prevents professional communication channels from turning into spaces for everyday disputes or the diffusion of irrelevant content:

- *The "single window" principle and the differentiation of requests:* a mandatory requirement that general educational questions be posted in group chats, in order to optimize time by avoiding repeated replies, while confidential information is discussed exclusively through private messages;
- *Content filtering:* a clear regulation prohibiting the dissemination of spam messages, religious material, political narratives, or information of questionable reliability, including fake news. The teacher plays the role of a facilitator-moderator, keeping the group within the boundaries of the educational agenda.

The digital ethics of the teacher-leader are also expressed through the introduction of principles of cognitive ergonomics, which demonstrate respect for the recipient's attention:

- *Minimizing multimodal noise, including limiting voice messages:* the leader avoids the use of voice messages in work-related groups, taking into account their low efficiency for rapid decoding and the impossibility of quick contextual search;
- *The principle of monothematic communication, or "one message, one point":* messages should be concise, structured through bullet points, and conclude with a clear operational call to action, which simplifies decision-making.

Establishing digital boundaries is not an act of distancing, but an act of professional care. When the teacher-leader legitimizes the right to rest for themself, that right is automatically extended to parents as well. Under conditions of social uncertainty, such an ethic prevents the emotional exhaustion of the community, preserving the teacher's resources for high-quality education and the parents' resources for supporting their children.

Under conditions of social turbulence, parent chats often become spaces for releasing tension. For this reason, the teacher's ability to intervene in a timely manner determines the viability of the entire community.

In the virtual communication space, conflict scenarios tend to intensify due to the lack of nonverbal cues, especially the absence of eye contact, and the online disinhibition effect. The teacher-leader implements a preventive de-escalation strategy by applying a set of methodological tools.

In situations where a group discussion loses its constructive character and shifts into the realm of personal attacks, the leader assumes the role of moderator and regulator:

- *Intervention script:* "Dear parents, I can see that the discussion of this issue has reached a high level of emotional intensity. Since text-based communication often leads to semantic distortion and misinterpretation, I am calling for a pause in the discussion until [specific time]. I suggest that

we continue this conversation through private messages or address it in a short video meeting."

- *Regulation mechanism:* technical restriction of chat activity, where administrative rights allow, or a firm directive to stop the exchange. This pause gives participants time for the activity of the limbic system to decrease and for rational cognitive processing to resume.

The leader maintains the position of a neutral mediator, distancing themself from personal sympathies and directing the group's attention to the substance of the problem by transforming complaints into constructive requests:

- *Reframing messages:* the teacher "translates" aggressive remarks into the language of the participant's actual needs. For example, instead of reacting defensively to accusations about the volume of assignments, the leader applies active listening: "I understand your concern about your child's academic progress. I suggest that we discuss how to create a balanced workload."
- *Psychological validation:* verbalizing and legitimizing the group's emotional state: "I understand the level of stress caused by external factors, and I see how this is affecting our current interaction..."

The teacher-leader's activity is aimed at establishing a culture of constructive communication and maintaining the ethical ecosystem of the chat:

- *Eliminating toxic content:* the decisive removal of messages containing signs of mobbing, discrediting remarks, or false information, with a required private explanation to the author;
- *Normative reference:* referring to the previously agreed rules of online interaction among participants in education or to local communication guidelines. This reduces the subjectivity of moderation, as the teacher's actions are perceived not as personal bias but as adherence to shared agreements.

Effective conflict management in a digital environment requires the teacher-leader to move from reactive to preventive strategies. The use of mediation and facilitation techniques enables the preservation of the integrity of the educational community and minimizes psychological-emotional losses under conditions of social instability.

Chat moderation in the hands of the teacher-leader is not censorship, but the mediation of meanings. Under conditions of social turbulence, the teacher's ability to stop conflict in a messenger space in a timely and ecologically responsible way prevents the fragmentation of the parent community. The leader serves as a guarantor that the classroom's digital space remains a space of support rather than an additional source of stress, which is critically important for maintaining a focus on the child's interests.

Digital ethics, in the hands of the teacher-leader, becomes a tool of sustainable management. Well-structured communication on messenger platforms not only saves cognitive resources for all participants but also lays a foundation of trust, enabling parents to be confident that order, respect, and safety prevail in the classroom's digital space.

Building the architecture of digital space and observing the ethics of boundaries creates the necessary framework of safety. At the same time, genuine community resilience emerges only when parents move from the role of disciplined readers to that of active participants in the educational process. During periods of social turbulence, the leadership of the primary school teacher is expressed in the ability to offer forms of engagement that do not burden parents with additional demands but instead provide them with meaning, support, and a sense of belonging.

The transition from formal parent meetings to interactive and coaching-based formats allows the teacher to shift the focus from the "child's problems" to the "community's potential." Let us consider a range of contemporary forms of interaction that enable the teacher-leader to effectively engage parental resources, transforming them into the foundation of collective resilience.

Strategic and facilitative sessions are a contemporary alternative to traditional parent meetings. Whereas meetings

usually focus on the past, that is, what has happened and what grades have been received, such sessions are oriented toward the future and the joint design of solutions.

Strategic and facilitative sessions are viewed as innovative formats of group interaction in which the teacher-leader shifts from a transmitter of directive instructions to a moderator of collective intelligence. The primary goal of such interactions is to build a shared vision, resolve complex problem situations, and plan the life of the classroom community under conditions of high uncertainty and social challenges.

The conceptual difference between a facilitative session and a traditional parent meeting lies in the change in the direction of communicative activity and the redistribution of participant roles:

- *Information-monologic model (traditional meetings):* characterized by the predominance of the teacher, who occupies about 80% of the available time. Communication is directed toward the retrospective analysis of current activity, reporting, and the identification of problem areas.
- *Participatory-dialogic model (facilitative session):* presupposes the active involvement of the parent community, which occupies 70–80% of the discussion time within structured small groups. The teacher-leader initiates questions, provides graphic facilitation by recording ideas, and manages group dynamics. The emphasis shifts to the search for forward-looking solutions, resources, and development opportunities.

To ensure a high level of effectiveness in group work, the teacher-leader implements tested moderation methods:

- *The "World Café" technique:* participants are divided into heterogeneous groups of four or five people at different locations, or "tables." Each group works on a specific aspect of a broader issue, for example, "optimizing the safety environment" or "psycho-emotional support for learners." At set intervals of 10 to 15 minutes, the composition of the groups changes according to the principle of cross-fertilization of ideas, while the "table host" ensures continuity of the ideas developed during previous rounds. As

a result, individual experiences are integrated into a coherent system of collective knowledge, and participants' loyalty to the adopted decisions increases.

- *The method of "SWOT analysis of the educational micro-community":* a collective diagnosis of the strengths, weaknesses, potential opportunities, and external threats facing the classroom community under conditions of systemic crisis. As a result, a realistic resilience strategy is built on an objective understanding of both risks and available resources.
- *The written idea-generation method "6-3-5":* an algorithmic process for generating ideas to address urgent problems quickly. This method reduces communication barriers and involves introverted participants in the process, ensuring a high density of proposals within a short period of time.

The effectiveness of strategic planning depends on following a clear sequence of actions:

1. *The stage of emotional attunement:* activating the participants' emotional intelligence in order to establish trust and psychological safety.
2. *The focusing phase:* the teacher articulates the key issue, defines the goals, and clarifies the expected outcomes of the meeting.
3. *Group design:* activating the group's creative potential through the use of the facilitation techniques described above.
4. *The prioritization stage:* verifying and selecting the most viable solutions through democratic decision-making tools, such as ranking or voting with stickers or digital platforms.
5. *Operational planning:* delegating responsibility, setting deadlines, and formalizing the implementation roadmap: who does what and by when.

The establishment of partnership-based interaction through facilitative formats is an act of professional trust and recognition of parents' agency. When the teacher-leader creates a space for constructive dialogue, passive observers become active agents of

change. When decisions, for example, regarding the format of distance learning or safety rules, are made jointly, resistance to change decreases and support for the teacher increases.

For the primary school teacher in times of social instability, such sessions serve as a tool for legitimizing leadership and building a genuine, rather than declarative, partnership community. This approach prevents apathy and strengthens the community's social capital, directing collective efforts toward supporting the child's educational trajectory.

Effective strategic planning and facilitative practices ensure the functional stability of the classroom community. At the same time, under conditions of prolonged social turbulence, a purely rational approach proves insufficient. High levels of distress and the psycho-emotional exhaustion of parents may become barriers even to the most carefully designed strategic plans. Recognizing this, the teacher-leader integrates into practice formats aimed at restoring the community's internal resources, namely "resource meetings" and "parent lounges." This marks a paradigmatic shift from operational interaction, that is, "what we are doing," to deeper affective reflection, that is, "how we are feeling." Such a shift makes it possible to transform the classroom community into a space of emotional safety, where support becomes not merely a function, but a value.

These formats are a practical manifestation of the leader's emotional intelligence. They help parents legitimize their feelings and find points of support.

A "parent lounge" is a space for informal communication, whether in face-to-face meetings or online sessions held in a coffee-break format, characterized by the absence of a rigid agenda and the predominance of empathetic interaction. The purpose of this format is to strengthen social cohesion, or the "social glue" of the community. Participants exchange not only pedagogical cases, but also personal narratives of coping with crisis situations. The teacher acts as a "moderator of the emotional field" and as the architect of a safe space, ensuring an atmosphere of authenticity and mutual respect that prevents discussion from turning into destructive complaint.

Resource meetings take the form of thematic workshops aimed at improving parents' psychological literacy, often through an interdisciplinary approach involving school psychologists and art therapists. These may include:

- *Co-regulation techniques:* the shared learning of somatic regulation practices, such as breathing exercises and grounding techniques, intended to stabilize the emotional state of both adults and children during external threats, for example, air raid alerts;
- *Cooperative learning based on the "peer-to-peer" principle:* the teacher-leader facilitates the exchange of practical "resilience life hacks" related to organizing everyday life and leisure under conditions of limited resources, such as energy shortages or loss of communication.

To implement a resource-based approach in practice, the teacher-leader may use the following modules:

- *A "gratitude session":* a meeting focused on activating positive experience and recognizing micro-achievements, which is critically important for preserving cognitive flexibility under crisis conditions;
- *Art-therapeutic expression:* the collective creation of "resilience collages" or the use of visual art therapy techniques for verbalizing and releasing latent emotional tension;
- *A parent book club:* an analytical discussion of specialized literature on the psychology of parenting and the concept of resilience.

The implementation of emotional support formats is a practical expression of the teacher-leader's high level of emotional intelligence. The legitimization of feelings and the collective search for points of support allow the parent community to preserve its sense of agency. Resource meetings and "parent lounges" are powerful tools for preventing conflict and emotional burnout within the community. By introducing such formats, the primary school teacher demonstrates empathic leadership that recognizes vulnerability as part of human experience. This fosters deep loyalty among parents toward the school and the teacher,

transforming them from a formal group into a resilient ecosystem capable of supporting the educational process even in the most difficult times.

The restoration of emotional resources in "parent lounges" lays the psychological foundation for moving to the most effective level of partnership. When anxiety decreases and trust in the teacher and in one another increases, the parent community becomes ready for constructive activity. At this stage, the teacher-leader initiates project-based participation, a format in which the parent community is transformed from a passive "support group" into a full determinant of the educational environment. Project activity in this context is viewed as a mechanism for activating participants' individual potential, ensuring community cohesion, and giving its functioning pragmatic meaning by creating a space for shared achievement.

Project-based participation is grounded in a partnership paradigm in which parents are involved in producing educational value as carriers of unique professional and social expertise:

- *Grassroots micro-project initiatives:* a format in which ideas are generated directly by the parent community, while the teacher acts as a facilitator. Examples include the revitalization of classroom space through "green zones," the creation of interactive mini-museums, or the ergonomic arrangement of safe locations such as shelters.
- *Socially oriented volunteer activity:* cooperative charitable initiatives aimed at supporting the Defense Forces or humanitarian causes. Such activity imbues the class's life with existential meaning and strengthens each participant's sense of subjective significance within the broader system of social relations.
- *The educational space "Parents as Experts":* the involvement of parents in the direct transmission of knowledge through workshops or lecture sessions, for example, professional orientation, media literacy training, or first-aid instruction. This makes it possible to integrate real practical experience into the theoretical foundation of learning.

The effective launch of project-based activity requires the teacher-leader to shift to a strategy of distributed management:

1. *Dialogic initiation through a problem-centered prompt:* instead of directive planning, the teacher applies a coaching approach by appealing to the group's collective intelligence: "We have a particular task. What strategies and community resources will allow us to accomplish it as effectively as possible for the learners' development?"
2. *Delegation and distributed leadership:* appointing project moderators from among the parent community. The teacher's role shifts from administration to expert consultation and supervision.
3. *Verification and public recognition of results:* a required stage is documenting success and legitimizing the contribution of each participant. Public validation of achievements serves as a powerful incentive for further participation and for strengthening the classroom's social capital.

Project-based participation is the highest form of partnership in education. The transition from the model of "helping the institution" to "co-creating educational value" enables the teacher-leader to build a resilient community capable of self-organization. Under conditions of social turbulence, such a model serves as a foundation for fostering responsible citizenship and ensuring a high-quality educational process through the synergy of school and family efforts.

The diversity of engagement forms allows the teacher-leader to find an approach for each parent while accounting for their time and emotional resources. When parents see that their participation is meaningful and influences children's well-being, they become reliable pillars of a community of resilience capable of withstanding the challenges of turbulent times.

The proposed toolkit allows the primary school teacher to act proactively. Instead of reacting to conflicts, the leader uses these techniques to create a structure that minimizes conflicts and leverages the potential of each parent for the benefit of the child and the whole community.

Conclusions

The generalization of the findings on the leadership potential of the primary school teacher in the context of building partnerships with parents under conditions of social turbulence allows for the formulation of several conceptual conclusions. These conclusions are grounded in a systematic analysis of existing practices and serve as a theoretical basis for further empirical research on teacher leadership potential.

The theoretical analysis and synthesis of current studies (Zhang, 2025) suggest that the teacher's leadership activity in interaction with parents is directly correlated with parental engagement and learners' academic achievement. In the face of contemporary challenges, the traditional "teacher-parents" model of interaction, based on monologic informing, has exhausted its potential. Today, the teacher's leadership potential is expressed not in directive management, but in facilitation and coaching. The teacher appears as a moderator of a safe educational environment who does not merely transmit knowledge, but creates an emotionally stable environment in which parents are transformed from passive observers into active subjects of the educational process. This requires the educator to have a high level of emotional intelligence and the capacity for empathetic communication.

The analysis of theoretical foundations and practical experience confirmed the effectiveness of the shift from informing to participation and coaching. Participation ensures parents' involvement in decision-making, which reduces their anxiety and resistance to change. Coaching allows the teacher to unlock the family's internal resources by stimulating parents' self-reliance. The introduction of the GROW model and the technique of "powerful questions" into pedagogical practice contributes to the formation of subject-subject relationships in which responsibility for the child's development is shared on an equal basis.

It was established that the digital transformation of education requires the teacher-leader to master the skills of digital architecture and digital ethics. Structuring communication in messenger platforms, establishing clear digital boundaries, and moderating conflicts in virtual space are not merely technical

tasks, but forms of professional care. Sustainable digital interaction prevents emotional burnout among all participants in the educational process and preserves the community's cognitive resources for constructive activity.

The final vector of the teacher's leadership activity is the creation of a "community of resilience." This is a self-regulating socio-pedagogical environment characterized by high levels of social capital, trust, and rapid adaptation. The shared living through experience within "parent lounges," resource meetings, and project-based participation makes it possible to transform social turbulence from a destructive factor into a source of community strengthening.

Despite the comprehensive analysis of leadership-based interaction strategies, the dynamic nature of the contemporary sociocultural context opens new horizons for scholarly inquiry. There is a need to create comprehensive training programs for future teachers and practicing educators to develop specific leadership competencies, including mediation skills in digital environments, crisis facilitation, and pedagogical coaching. Research on the effectiveness of such programs would enable the implementation of the leadership paradigm in the educational process on a systematic basis.

The correlation between the level of resilience within the parent community and the academic outcomes of primary school learners also requires deeper study. Of particular scholarly interest is how the emotional state of the classroom community affects children's cognitive capacities under prolonged stress.

A separate line of inquiry should focus on strategies to involve the parents of children with special educational needs in the community of resilience, as well as the families of internally displaced persons. Teacher leadership in the context of social inclusion and integration is critically important for preserving the integrity of the educational space. It is also important to compare models of "communities of resilience" in Ukraine and abroad, particularly in countries that have experienced military conflicts or large-scale disasters, in order to identify both universal and specific factors of successful leadership under conditions of global turbulence.

Thus, the leadership of the primary school teacher in interaction with parents is a path from performing functional duties to creating a value-based partnership. The realization of this potential through participation, coaching, and digital ethics is a guarantee not only of educational stability but also of the nation's mental health, which begins with the small community of a single classroom.

References

Antony-Newman, M. (2025). Preparing teachers for parent engagement: role of teacher educators in Canada. *Educational Review*, *77*(5), 1422–1438. https://doi.org/10.1080/00131911.2024.2324154

Bachman, H. F., & Beard, K. S. (2025). Family engagement efficacy beliefs of educators: confirming a new measure. *Teachers and Teaching*, 1–18. https://doi.org/10.1080/13540602.2025.2497793

Badiuzzaman, M., Lee, J.-S., & Cumming, T. M. (2025). A Systematic Review of the Impact of the Multilevel Digital Divide in Technology-Integrated Family–School Partnerships. *Review of Educational Research*, 00346543251400771. https://doi.org/10.3102/00346543251400771

Bamford, A., Mackew, N., Golawski, A., & van Nieuwerburgh, C. (2012). Coaching in Education: getting better results for students, educators and parents. https://doi.org/10.4324/9780429473036-8

Bekh, I. D. (2020). Osobystist na vykhovnii shkali dukhovnosti. *Teoretyko-metodychni problemy vykhovannia ditei ta uchnivskoi molodi, 1*(24), 49-70. https://doi.org/10.32405/2308-3778-2020-24-1-49-70

Bibik, N. M. (2017). *Nova ukrainska shkola*: poradnyk dlia vchytelia/Pid zah. red. Bibik NMK: TOV «Vydavnychyi dim «Pleiady.

Deutsch, M. (1973). *The resolution of conflict: Constructive and destructive processes*. Yale University Press. https://doi.org/10.12987/9780300159356

Durniak, L. (2013). Shkilna mediatsiia yak zasib vyrishennia konfliktiv sered pidlitkiv. *Pedahohika i psykholohiia profesiinoi osvity, (5),* 191-200.

Epstein, J. L., Sanders, M. G., Sheldon, S. B., Simon, B. S., Salinas, K. C., Jansorn, N. R., ... & Williams, K. J. (2018). *School, family, and community partnerships: Your handbook for action*. Corwin press.

Fisher, R., Ury, W. L., & Patton, B. (2011). *Getting to yes: Negotiating agreement without giving in*. Penguin.

Fullan, M. (2016). *Indelible leadership: Always leave them learning*. Corwin Press. https://doi.org/10.4135/9781506323602

Goleman, D. (2005). *Emotional intelligence: Why it can matter more than IQ*. Bantam.

Hepburn, S. J. (2025). Creating a positive home-school partnership: a scoping review of teachers' skill development. *Teaching and Teacher Education*. https://doi.org/10.1016/j.tate.2025.105127

Jones, C., Sideropoulos, V., & Palikara, O. (2025). Do teachers have the knowledge and skills to facilitate effective parental engagement? Findings from a national survey in England. *Educational Review*, 1–24. https://doi.org/10.1080/00131911.2025.2506802

Krupnyk, I. R. (2024). Kouchynh v osviti: teoriia i praktyka. *Naukovyi visnyk Khersonskoho derzhavnoho universytetu. Seriia «Psykholohichni nauky»*, (2), 22-27. https://doi.org/10.32999/ksu2312-3206/2024-2-3

Lokshyna, O. (2024). Polityka Yevropeiskoho Soiuzu u haluzi osvity i navchannia: tsili, priorytety, initsiatyvy. *Ukrainskyi pedahohichnyi zhurnal, (4),* 5-17. https://doi.org/10.32405/2411-1317-2024-4-5-17

Lundtofte, T., & Grønning, A. (2024). Making sense of digital communication between students, parents, teachers, and school leaders in Danish state schools. *Global Studies of Childhood*. Volume 15, Issue 3. https://doi.org/10.1177/20436106241255663

Mapp, K. L., & Kuttner, P. J. (2013). Dual capacity-building framework for family-school partnerships. *Austin, TX: Southwest Educational Development Laboratory (SEDL) and the US Department of Education*.

Noddings, N. (2013). *Caring: A relational approach to ethics and moral education*. Univ of California Press. https://doi.org/10.1525/9780520957343

Piekhota, O. M. (2000). Osobystisno oriientovana osvita i tekhnolohii. *Neperervna profesiina osvita: problemy, poshuky, perspektyvy*, 274-297.

Radchuk, H., Oleksiuk, V., & Nesukh, A. (2025). Rozvytok rezylientnosti osobystosti. *Vcheni zapysky Universytetu «KROK», (2* (78)), 415-423. https://doi.org/10.31732/2663-2209-2025-78-415-423

Rogers, C. R., & Freiberg, H. J. (1994). *Freedom to learn*. Merrill/Macmillan College Publishing Co.

Ryan, S. (2025). Reimagining Teacher Education for Authentic Parent Partnership. *Education Sciences*, 15(9), 1228. https://doi.org/10.3390/educsci15091228

Vashchenko, O. M. (2017). Metodolohichni zasady pidhotovky maibutnoho vchytelia do vykorystannia zdoroviazberezhuvalnykh osvitnikh tekhnolohii v navchalno-vykhovnomu protsesi pochatkovoi shkoly. *Onovlennia zmistu, form ta metodiv navchannia i vykhovannia v zakladakh osvity*: zb. nauk. prats:[nauk. zapysky RDHU], 17, 240-244.

Vitvytska, S. S. (2006). *Osnovy pedahohiky vyshchoi shkoly*: Pidruchnyk za modulno-reitynhovoiu systemoiu navchannia dlia studentiv mahistratury. Kyiv: Tsentr navchalnoi literatury, 384.

Whitmore, J., & Gaskell, T. (2024). *Coaching for Performance: The Principles and Practice of Coaching and Leadership: Fully Revised Edition for 2024*. John Murray Business.

Zhang, S., & Wu, H. (2025). School Leadership, Parental Involvement, and Student Achievement: A Comparative Analysis of Principal and Teacher Perspectives. *Education Sciences*, *15*(6), 767. https://doi.org/10.3390/educsci15060767

Chapter 7. PREPARING TEACHERS FOR TEAMWORK IN A DIGITAL EDUCATIONAL ENVIRONMENT

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***Abstract**. This chapter provides a theoretical rationale and a practical examination of the development of teachers' teamwork skills in a digital educational environment. The relevance of the topic stems from the fact that the digital transformation of education is changing not only the tools of teachers' professional activity, but also the very logic of their interaction with colleagues, administrators, professional communities, and learners. Under these conditions, teamwork is no longer merely an additional organizational ability; it becomes an important component of contemporary educational leadership. The aim of the study is to clarify the essence of teacher teamwork in a digital educational environment, identify its structure, assessment criteria, and indicators, develop a methodology to foster teachers' teamwork skills in this environment, and analyze the results of its pilot implementation. The study employed theoretical analysis of scholarly sources, modeling, generalization, structural-functional analysis, and elements of a pilot formative experiment using self-assessment, structured observation, analysis of digital artifacts, and comparison of results from two assessment points. The author's understanding of teachers' teamwork skills in a digital environment is refined as an integrated set of professional actions that ensure effective interaction through communication, coordination, role distribution, collaborative product creation, facilitation of group processes, and reflective adjustment of activity. Three interrelated components of teacher teamwork in a digital educational environment are identified: communicative-facilitative, cooperative-productive, and organizational-projective. An assessment framework is substantiated, including criteria, indicators, levels of development, and diagnostic tools. A methodology for developing these skills was designed and implemented through a series of three weekly online training sessions using Zoom, messengers, shared documents, and Miro-like digital boards. The pilot experiment involved 26 future master's students in secondary education at A. S. Makarenko Sumy State Pedagogical University. The results showed positive dynamics across all components, with the most noticeable growth in the organizational-projective dimension of teacher teamwork. It was concluded that the development of teachers' teamwork skills in a digital educational*

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environment requires targeted methodological support, professionally relevant collaborative tasks, a functionally structured digital environment, reflective guidance, and institutional recognition of teamwork as a significant component of pedagogical activity.

***Keywords**: digital educational environment; teamwork; teacher; digital competence; educational leadership; facilitation; collaborative content creation; digital boards; teacher professional development; pilot experiment; teacher education.*

Introduction

Social uncertainty, the accelerated digital transformation of education, and changes in the nature of professional interaction within educational institutions have significantly increased the importance of teacher teamwork. Whereas digital technologies were previously viewed mainly as tools for supporting individual teaching activity, it is now increasingly clear that they are reshaping the very logic of professional collaboration, including modes of communication, collective planning, role distribution, the creation of shared educational resources, coordination of actions, and reflective analysis of outcomes. Researchers consistently emphasize that teacher education systems long remained insufficiently prepared to support the full development of digital practice skills, especially when the issue extends beyond teaching with technology to more complex forms of digitally mediated professional interaction (Hodges et al., 2026). In this sense, the development of teacher teamwork in a digital educational environment should be understood not as a narrow methodological issue, but as part of the broader question of teachers' professional readiness to work under conditions of instability, flexible instructional formats, and the growing role of distributed educational leadership. In addition, recent studies of digital educational environments show that their effectiveness depends not only on the availability of individual platforms or services, but also on the alignment of organizational decisions, digital infrastructure, software, and models of professional interaction among participants in the educational process. For this reason, the digital environment is increasingly interpreted as an integrated pedagogical and managerial system that affects the quality of future professionals' training (Hrechanyk et al., 2024; Majdi et al., 2024).

The relevance of the problem is further reinforced by the fact that teachers' digital competence is increasingly understood as a multidimensional construct that includes not only information and technology-related actions, but also communication, collaboration, digital content creation, organization of the educational process, professional development, and support for learners' development (Tzafilkou et al., 2023; Alom & Ramalingappa, 2025). At the same time, teacher readiness to use digital tools in a STEAM-oriented educational environment is directly associated with digital literacy, methodological preparation, innovativeness, adaptability, and communication skills, as well as with the need to foster creativity, critical thinking, and teamwork skills in learners (Soroko & Shymon, 2025). Thus, teamwork in a digital educational environment is no longer a peripheral element of teachers' professional activity and is increasingly becoming one of its core contemporary characteristics. At the same time, the scholarly literature stresses that digital competencies should not be considered in isolation from the goals of accessibility and pedagogical adaptation, but rather in connection with the inclusive organization of the educational environment, continuity of participation, and the quality of interaction among all its participants. This approach broadens the understanding of teachers' digital competence and provides grounds for linking it not only to technical proficiency, but also to the ability to sustain productive and open collaboration in a diverse educational environment (Holovnia et al., 2024).

Recent scholarly publications convincingly show that effective professional development for educators in the digital sphere cannot be achieved through one-time instructional sessions or merely technical familiarization with digital services. The most effective programs combine hands-on learning, collaborative formats, mentoring, and institutional support (Amemasor et al., 2025). Similar conclusions are presented in research on preparing instructors to use active learning methods and digital integration, which emphasizes the importance of workshops, joint activities, and a step-by-step approach to entering a digitally enriched educational environment (Abildinova et al., 2024). These findings are directly relevant to our topic because they show that teamwork skills in a digital environment do not emerge simply from the presence of technology. Rather,

they develop through deliberately organized experience in shared professional activity. A similar conclusion is supported by studies on digital educational practices in the humanities, which show that learning effectiveness is associated with the use of small virtual groups, shared discussions, mind maps, simulations, and other interactive formats that stimulate interaction and joint decision-making. This once again underscores that a digital environment becomes productive only when its tools are embedded in a pedagogically grounded logic of collaborative activity (Balova-Tzvetkova & Panayotova, 2023).

The problem also has a distinct Ukrainian dimension. Ukrainian studies emphasize the need to develop teachers' information and digital culture, particularly through computer visualization tools that not only support content presentation but also expand the possibilities for pedagogical interaction and the organization of digital educational space (Yurchenko et al., 2024b; Yurchenko et al., 2025b). A comparative analysis of Ukrainian and European practices in organizing digital educational environments likewise shows that productive models of digitalization are associated not so much with the mere availability of separate services as with an integrated logic of organizing the educational process, coordinating participants' activity, and aligning digital tools with pedagogical tasks (Bohoslavskyi et al., 2025). This means that the development of teacher teamwork in a digital environment should be viewed both as a matter of professional culture and as a matter of the very architecture of the educational environment. In this connection, it is also important to consider studies that describe the digital educational environment as a space for shaping professionally significant qualities in future specialists, particularly their ability to communicate, collaborate, and engage in shared activities. Thus, the architecture of the digital environment affects not only the organization of the educational process but also the very character of participants' professional development (Hrechanyk et al., 2024; Shuppe et al., 2024).

Particular attention should be paid to the connection between digital teamwork and the development of soft skills. A study on the impact of team competitions on the development of young people's soft skills found that team interaction has a

positive effect on communication, collaboration, responsibility, and the ability to act under conditions of shared task (Yurchenko et al., 2024a; Yurchenko et al., 2025a). Although the focus of that study differs from ours, its findings are important because they confirm the developmental potential of deliberately organized team activity. Combined with evidence on the role of communicative tasks in the development of learners' emotional intelligence (Semenog et al., 2024), this suggests that teachers' digital teamwork has not only instrumental but also personal and professional significance: it is associated with the development of a culture of interaction, sensitivity to other participants, and the ability to negotiate and coordinate joint activity. This argument can be further strengthened by studies that view the digital educational environment as a factor in the development of future professionals' communicative competence. Notably, it is the combination of a virtual learning environment, digital communication, and specially designed tasks that supports the transition from formal participation to more mature forms of professional interaction and cooperation (Shuppe et al., 2024).

Contemporary research also shows growing interest in digital tools that directly support collective activity. In particular, interactive boards are viewed as digital means that help structure interaction, visualize ideas, support joint work on content, and organize the contemporary educational process in a more open and coordination-rich manner (Rudenko et al., 2024). A similar logic is reflected in studies on the use of dashboards to develop learners' analytical thinking, where digital data visualization is understood not merely as a monitoring tool, but as an environment for sense-making and coordination of activity (Rudenko et al., 2025). This is of fundamental importance for our study because it allows us to see digital boards, shared documents, and visual interfaces not simply as technical add-ons, but as tools for developing teamwork, facilitation, and project-based work organization. The practical potential of such digital tools is also confirmed by studies that treat Teams, Zoom, Google Classroom, Webex, digital boards, and visualization tools as mechanisms for supporting coordination, integration, and participants' involvement in shared activity. Particularly illustrative are findings from supporting Ukrainian children and youth abroad, where digital tools effectively served as instruments

of educational integration and organizational connection among participants in the interaction (Nychkalo et al., 2024).

The issue of teamwork in digital environments is also actively discussed in international scholarship. Studies on virtual team building show that cohesion, trust, communication skills, and motivation for joint work can be developed even in remote and blended formats, although this requires intentional pedagogical design and does not emerge spontaneously (Kuznetsova et al., 2023). Research on Team-Based Learning likewise confirms that systematically organized small-group teamwork contributes not only to academic achievement but also to the development of critical thinking, responsibility, and the ability to operate within a shared problem-solving framework (Brannan et al., 2019). In this sense, the digital educational environment does not eliminate team-based pedagogy. Rather, it calls for its reinterpretation, one in which the technological dimension is integrated with the activity-based, communicative, and organizational dimensions.

An important argument in support of this approach is provided by research on digital pedagogical competence as a factor that mediates the expansion of learners' opportunities. Lin et al. (2022) demonstrated that digital pedagogical competence, rather than general ICT proficiency alone, is the leading factor linking teachers' technical and data literacy skills with the development of collaboration, communication, and responsible use of technology in the classroom. This allows us to draw an important conclusion: teacher teamwork in a digital environment is not only a way of organizing teachers' professional activity, but also an important precondition for creating an educational space in which learners themselves acquire corresponding models of interaction. In addition, findings from several studies suggest that the digital educational environment also affects deeper dimensions of future teachers' professional development, including types of self-realization, motivation, creativity, and attitudes toward professional activity. This provides grounds for viewing digital interaction in the educational environment as having not only a functional but also a personal and professional dimension, which is important for developing readiness for teamwork (Popovych et al., 2024).

No less important is the issue of analytical and reflective support for teamwork. The TeamSlides study showed that multimodal dashboards can strengthen instructor-guided reflection on team activity, make certain aspects of interaction more visible, and support the interpretation of collaborative work, although they also introduce new interpretive challenges (Echeverría et al., 2024b). This point is especially important for our study because we likewise assume that digital artifacts, revision histories, comments, and the structures of shared boards can serve not only as means of completing a task, but also as material for assessment and reflection. Thus, the digital educational environment creates new opportunities to identify and purposefully develop teacher teamwork. In international scholarship, the organizational dimension of this issue is also becoming increasingly clear. In particular, research has shown that teachers' teamwork effectiveness depends on a culture of knowledge sharing, a sense of fairness, a supportive professional environment, and institutional mechanisms for collaboration. At the same time, studies on teaching teamwork in virtual educational environments indicate that the digital form of interaction alone does not guarantee well-coordinated team activity and therefore requires dedicated pedagogical design, guidance, and extended feedback (Xu et al., 2026; Espejo et al., 2023).

Taken together, international and Ukrainian studies allow several principal conclusions to be drawn. First, the digital transformation of education shifts the focus from individual command of tools to collective forms of professional activity. Second, the development of teachers' digital teamwork requires specially organized professional learning built on practical, collaborative, and reflective formats. Third, such development depends not only on digital services as such, but also on the pedagogical design of tasks, a culture of interaction, the role of leadership, mentoring, and a structured environment. Fourth, scholarly discourse has already established sufficient grounds for treating teachers' digital teamwork as an independent subject of analysis; however, its structure, assessment criteria, and development methods still require further clarification.

In view of this, the aim of this chapter is to provide a theoretical rationale for the essence and structure of teachers' teamwork skills in a digital educational environment, identify approaches to their assessment, develop a methodology for their advancement, and analyze the results of its pilot implementation. To achieve this aim, the chapter consistently examines the theoretical foundations of the digital transformation of pedagogical activity, refines the author's understanding of digital teamwork skills, characterizes their structural components, substantiates the criteria, indicators, and levels of development, describes a series of training sessions as a formative intervention, and analyzes the results of the pilot experiment. Ultimately, this makes it possible to move from general reflections on digitalization and collaboration to a more precise scholarly description of how teacher teamwork can develop in a digital educational environment and which pedagogical conditions ensure its effectiveness.

1. Theoretical Foundations for the Development of Teachers' Teamwork Skills in a Digital Educational Environment

1.1. The Digital Transformation of Education as a Factor in Changing the Teacher's Professional Role

The digital transformation of education is not merely a process of introducing new technical tools into the operation of educational institutions. It involves a deeper restructuring of the ways the educational process is organized, of professional communication, of the creation and dissemination of instructional materials, of monitoring outcomes, of feedback, and of the coordination of actions among all participants in educational interaction. For this reason, digitalization should be viewed not as an external addition to traditional pedagogical practice, but as a factor that reshapes the teacher's professional role, functions, responsibilities, and forms of professional participation in the life of the educational community. This is consistent with studies that describe the digital transformation of higher education as a multidimensional process encompassing changes in curricula, teaching methods, assessment, infrastructure, and management.

Accordingly, the professional role of the educator is also changing across multiple dimensions at once, including communicative, organizational, and coordinative ones (Majdi et al., 2024).

Recent scholarly work consistently emphasizes that effective pedagogical activity in a digital environment cannot be reduced to mastery of individual digital tools. Far more important is the teacher's ability to integrate technology into instruction in ways that support educational goals, sustain interaction, and foster independence, critical thinking, creativity, and collaboration. For this reason, contemporary models of teachers' digital competence include not only technological, but also pedagogical, communicative, organizational, innovative, and reflective dimensions (Tzafilkou et al., 2023; Alom & Ramalingappa, 2025). This approach changes the very lens through which the teaching profession is understood: from a performer of separate didactic actions to an organizer of multi-layered pedagogical interaction in a digitally enriched environment. A similar logic is reflected in studies that treat the digital educational environment as a space for professional training, where the emphasis falls not on isolated digital actions but on the systemic design of an environment that supports learning, coordination, access to resources, and the professional growth of future specialists. This reinforces the idea that the contemporary educator in digital education acts not only as a user of technology, but also as a designer of conditions for collaborative activity (Hrechanyk et al., 2024).

The need for such a reconceptualization became especially evident during abrupt educational disruptions, when educational institutions were forced to shift rapidly to remote or blended formats. These situations showed that the mere availability of a platform or access to video communication does not in itself guarantee either the quality of learning or teachers' professional readiness. Researchers note that even after years of widespread use of digital technologies, teacher education systems in many cases remained insufficiently prepared to develop stable capacities for digital teaching, flexible instructional organization, and work in new modes of professional interaction (Hodges et al., 2026). Thus, digital transformation revealed not only technical gaps, but also methodological and organizational ones that directly affect the teacher's professional role. Notably, under such conditions, the

digital environment influences not only the activity-related aspects of teacher preparation but also deeper dimensions of future teachers' self-realization, including value orientations, creativity, cognitive needs, and motivational configurations. This means that the digital transformation of education changes not only the external organization of teachers' work, but also the internal mechanisms of their professional development (Popovych et al., 2024).

In the traditional view, the teacher is often seen primarily as a carrier of subject knowledge, an organizer of learners' activity, and the person responsible for assessing their outcomes. In a digital educational environment, these functions remain, but they become substantially more complex. New tasks are added: selecting and adapting digital resources; designing synchronous and asynchronous interactions; managing digital communication channels; creating shared educational materials; coordinating work in cloud-based environments; analyzing digital traces of activity; upholding ethical norms of interaction; and ensuring information security. Accordingly, the teacher's professional role becomes increasingly multifaceted.

This shift has another fundamental feature. In a digital environment, the teacher increasingly works not as an autonomous performer, but as a participant in various professional networks. Teachers coordinate actions with colleagues as they develop shared courses, instructional materials, interdisciplinary tasks, events, projects, internal monitoring processes, and methodological support. Thus, digital transformation strengthens the collective dimension of pedagogical work. This conclusion is also supported by studies on teachers' teamwork behavior, which show that the quality of collaboration within an educational organization is linked to perceptions of fairness, the intensity of knowledge sharing, and the overall climate of professional support. Therefore, the collective dimension of pedagogical work in a digital environment cannot be reduced merely to the technical possibility of shared editing or communication; it also requires an appropriate social and organizational foundation (Xu et al., 2026). In this respect, studies of virtual educational environments in which teamwork is treated as a distinct subject of instruction are especially revealing. They show that teamwork in a digital format

develops more successfully when participants are given structured roles, step-by-step tasks, continuous feedback, and specially designed conditions for mutual coordination (Espejo et al., 2023).

For this reason, contemporary research increasingly treats teachers' digital competence as a multidimensional construct encompassing communication and collaboration, digital content creation, safety, problem-solving, professional development, and innovative activity (Alom & Ramalingappa, 2025; Tzafilkou et al., 2023). This understanding is central to the present study because it provides grounds for viewing teamwork not as a separate auxiliary skill, but as an organic part of teachers' professional readiness to work in a digital educational environment. A further argument in support of this view is that the development of communicative competence in digital settings is already regarded by researchers as an independent educational goal, one that requires specially organized forms of work, digital communication, and virtual educational environments. This once again confirms that teamwork is not a secondary byproduct of digitalization, but part of the very structure of contemporary teacher preparation (Shuppe et al., 2024).

Particular attention should also be paid to the relationship between teachers' digital competence and learners' development. There are grounds to argue that the effect of a teacher's technological preparedness on educational outcomes is not linear. What matters is not simply whether the teacher can use a given tool, but how that tool is used in pedagogical practice. Research shows that digital pedagogical competence, along with the ability to organize interaction, mediates the impact of ICT skills on expanding learners' opportunities, including in collaboration, communication, and the responsible use of technology (Lin et al., 2022). This means that digital transformation requires the teacher not merely to be a user of services, but also to be an educator capable of organizing meaningful interaction through them. From this perspective, the inclusive dimension of digital pedagogy becomes especially important. Recent studies show that digital competencies become truly productive only when they help remove barriers to participation, support adaptation, ensure continuity of educational interaction, and enable the involvement of diverse groups of learners. This framing significantly broadens

the understanding of the teacher's professional role in a digital environment (Holovnia et al., 2024).

In such a situation, the teacher's professional autonomy also changes substantially. On the one hand, digital tools expand opportunities for flexible instructional design, rapid resource updates, task personalization, and communication. On the other hand, they make professional activity more transparent, interconnected, and dependent on coordination with other participants in the educational environment. Teachers must work in a mode of constant alignment: with schedules and platforms, with the internal rules of the educational institution, with colleagues involved in shared educational decisions, with learners' needs, and with requirements related to safety, copyright, and digital ethics. As a result, the teacher's professional role shifts from a model of individual control to one of coordinated responsibility.

Another consequence of digital transformation is the change in professional communication. Whereas much collective interaction previously took place mainly through face-to-face meetings, methodological groups, and informal communication, it is increasingly moving to digital channels. This changes the pace, format, and structure of professional communication. Messages become shorter and more frequent, comments are recorded in shared documents, task statuses are tracked in project environments, and a large part of interaction takes on an asynchronous character. Under these conditions, teachers must command not only the language of pedagogical communication but also the culture of digital communication: the ability to formulate tasks clearly, provide constructive feedback, negotiate deadlines, maintain mutual respect, and reduce the risk of misunderstanding in text-based or hybrid interaction.

It is telling that teachers' readiness to use digital tools is now increasingly linked to their general ability to work in an innovative and collaborative mode. Researchers who analyze educators' readiness to work in a STEAM-oriented educational environment emphasize the importance of not only digital literacy but also methodological preparation, adaptability, innovativeness, and communication skills (Soroko & Shymon, 2025). This is directly relevant to our topic, as teamwork in a digital environment

always involves integrating technological, communicative, and organizational dimensions.

Thus, the digital transformation of education changes the teacher's professional role in several interrelated ways. First, it expands teachers' functions by adding new forms of digitally mediated activity to traditional didactic tasks. Second, it strengthens the importance of teamwork and coordination in professional practice. Third, it highlights the need for a new type of professional readiness that combines technical proficiency with pedagogical design, facilitation, communicative culture, and distributed leadership capacity. For this reason, the study of teachers' teamwork skills in a digital educational environment is a logical step in rethinking the contemporary teaching profession.

1.2. Teamwork as a Professional Characteristic of the Contemporary Teacher

In educational scholarship, teamwork is increasingly viewed not as an additional organizational ability, but as an essential feature of the contemporary teacher's professional activity. This perspective is also supported by studies on collaborative learning and teamwork strategies in modern educational environments. These studies show that educators generally recognize the value of collaboration for learning; however, the practical implementation of teamwork is often constrained by a lack of prior preparation, unclear assessment procedures, and insufficient resources. This means that recognizing teamwork as a professionally significant characteristic does not in itself guarantee its systematic development in pedagogical practice (Amayou et al., 2025). This is because the educational process in educational institutions is becoming more complex in content, more open to interdisciplinary connections, more responsive to learners' individual needs, and, at the same time, more dependent on coordinated actions of different participants. Teachers can no longer effectively perform all functions solely within the bounds of individual professional autonomy. Even with a high level of subject-matter and methodological preparation, the effectiveness of their work depends to a considerable extent on the ability to work with others: to plan, negotiate, share responsibility, support

joint decisions, contribute to the creation of a collective product, and adjust shared activity when conditions change.

Teamwork in education has its own specific features. Unlike the formal distribution of duties, it implies not merely the coexistence of individual performers, but real interdependence of actions, a shared vision of the goal, alignment of professional positions, and responsibility for the overall outcome. In school practice, this may be expressed in collaborative lesson design, coordination of educational and extracurricular activities, development of integrated courses, interaction within methodological associations, participation in interdisciplinary projects, organization of inclusive support, work with digital instructional materials, and collective resolution of professional problems. Thus, teacher teamwork is not episodic in nature, but systemic.

At the theoretical level, it is useful to distinguish several related but not identical concepts. *Group interaction* is the broadest term and may refer to any shared presence or exchange of actions among several participants. *Cooperation* usually involves dividing tasks among participants working toward a common goal while retaining relative independence in completing their respective parts. *Collaboration* is inherently deeper because it involves the joint development of a solution, active alignment of positions, the creation of a shared product, and mutual adjustment of actions. *Teamwork* combines elements of both cooperation and collaboration, while also including continuity of interaction, role distribution, responsibility for the overall outcome, elements of self-organization, and the maintenance of a small professional community. For pedagogical activity, this distinction is fundamental, since not every form of joint work among teachers is truly team-based.

To clarify the meaning of teacher teamwork in a digital educational environment, it is useful to synthesize the most common approaches in the scholarly discourse to describing teachers' shared professional activity (Table 1.1). Such a comparison makes it possible to distinguish more clearly among group interaction, cooperation, collaboration, teamwork proper, and facilitation-organized team interaction. This distinction is

necessary for further substantiating the author's approach to understanding teachers' digital teamwork.

Table 1.1

omparison of Approaches to Understanding Teacher Teamwork in a Digital Educational Environment

Approach / Concept	*Core Meaning*	*Nature of Interaction*	*Teacher's Professional Role*	*Function of the Digital Environment*	*Methodological Limitations*
Group interaction	Shared participation of several individuals in a particular type of activity or communication	Situational, not always structured	Participant in a group process	Enables the exchange of messages, materials, and responses	Does not necessarily involve a shared goal, role distribution, or collective responsibility
Cooperation	Division of a shared task into separate parts among participants	Mainly parallel performance of interrelated actions	Performer of a specific function or segment of work	Makes it possible to coordinate contributeons, transfer results, and synchronize stages of work	May preserve an external appearance of joint activity without deep alignment of positions
Collaboration	Joint development of solutions, ideas, content, or products through continuous alignment	Intensive, interdependent, dialogic	Co-author of a shared outcome	Creates space for joint editing, commenting, reflection, and negotiation of changes	Requires a sufficient level of communicative culture, trust, and time
Teamwork	Coordinated activity of a group with a shared goal, roles, distribution of responsibility, and orientation toward a common result	Organized, role-structured, relatively stable	Team member, co-performer, coordinator of particular stages	Supports communication, planning, monitoring of implementation, and collaborative product creation	Requires developed organizational, communicative, and reflective skills

Facilitation-organized team interaction	Team activity in which participant engagement, alignment of decisions, productive communica-tion, and movement toward a shared result are intentionally supported	Organized yet open, reflective, guided through support of interacti-on	Facilitator, moderator, initiator of distributed leadership, participant in the team process	Used not only as a channel of interaction, but also as a means of structuring roles, stages, agreements, and feedback	Requires specific preparation in facilitation, a high level of digital communi-cation culture, and clear rules for shared work

Source: Authors' own work.

Thus, teacher teamwork in a digital educational environment should be understood not as any form of joint activity, but as organized professional interaction that combines a shared goal, role distribution, coordination of actions, collective responsibility, and the creation of a common outcome through the use of digital tools. At the same time, the most productive approach for this study is one that complements teamwork with a facilitative dimension, as this enables explaining how participant engagement, constructive communication, coordination of contributions, and the achievement of a shared goal are supported in a digital environment.

In the contemporary school, teamwork takes on particular importance precisely because educational tasks are increasingly less individual in nature. Teaching requires integrating subject content, combining didactic approaches, adapting to diverse educational needs, coordinating with administration and parents, and working in conditions of constant change. Under such conditions, teachers must be able not only to carry out their own part of professional activity effectively, but also to see themselves within the broader structure of shared work. This means being able to relate one's own decisions to the team's overall strategy, adjust individual actions in line with the shared goal, take others' contributions into account, and build interaction on the basis of trust, predictability, and responsibility.

Teamwork as a professional characteristic of the teacher cannot be reduced to sociability or goodwill. Its content is much broader. It includes a cognitive dimension, that is, an understanding of the shared goal, the logic of team activity, and the role of each participant; an operational dimension associated with planning, coordination, joint implementation, and monitoring of tasks; a communicative dimension that includes the exchange of information, feedback, clarification of positions, and regulation of misunderstandings; as well as a value-motivational dimension, which is reflected in readiness for cooperation, acceptance of collective responsibility, and recognition of the importance of a shared outcome. It is precisely the combination of these components that makes teamwork a professionally relevant characteristic.

Research on Team-Based Learning, although mostly focused on instructional technologies for learners, also provides important grounds for understanding the nature of teamwork itself. These studies show that systematically organized joint activity contributes not only to task completion but also to the development of critical thinking, responsibility, the ability to justify decisions, and responsiveness to other participants' contributions (Brannan et al., 2019). For the teacher, this means that participation in teamwork is not only a tool for organizing activity, but also an environment for continuous professional growth. Through collective planning, joint analysis, development of materials, and reflection, teachers refine their own approaches, reconsider professional assumptions, learn to view problems from multiple perspectives, and gain a clearer awareness of the limits of their own competence.

It should also be emphasized that teacher teamwork is always connected with roles. In an educational environment, a team does not function as a collection of identical participants. On the contrary, its productivity depends to a large extent on how clearly roles are defined or situationally distributed: initiator, coordinator, facilitator, person responsible for a specific area of work, analyst, communication moderator, person responsible for digital resources, compiler of materials, and so forth. At the same time, role distribution should not turn into a rigid hierarchy. Contemporary educational teams are more typically characterized

by flexible role distribution, in which a teacher may take on different functions depending on the nature of the task, individual competence, experience, and the current situation. In this sense, teamwork is directly linked to distributed educational leadership.

The ability to work in a team is also reflected in the teacher's capacity to sustain productive group dynamics. This includes responding promptly to the overload of individual participants, reducing tension, preventing conflicts, ensuring the involvement of less active members, and maintaining a focus on the shared outcome. It is precisely here that professional teamwork intersects with facilitation. A teacher who possesses facilitation skills does not dominate the group or reduce collaboration to giving instructions. Rather, such a teacher creates conditions in which each participant can make a meaningful contribution, and the group decision emerges through discussion, clarification, and gradual alignment. This form of professional behavior is especially necessary under conditions of social uncertainty, when a team must adapt quickly to change without losing the quality of interaction.

Another important aspect is that teacher teamwork has an ethical dimension. It requires adherence to norms of professional respect, transparency of contribution, appropriate use of shared resources, responsible handling of information, willingness to acknowledge the authorship of others, and the ability to work on the basis of trust. In a digital educational environment, these requirements become even more evident, as a significant portion of interaction is recorded digitally. For this reason, teamwork requires not only organizational skill but also a well-formed culture of professional conduct. Without this, shared tools do not strengthen collaboration; instead, they merely make its weak points more visible: unclear roles, uneven contributions, superficial communication, avoidance of responsibility, or latent conflicts.

Contemporary studies on virtual team building and collaborative learning emphasize that even in digitally mediated forms of interaction, the basic characteristics of an effective team remain essential: trust, a sense of shared purpose, motivation to participate, clear rules of interaction, and a sense of a safe professional space (Kuznetsova et al., 2023). This conclusion is

especially important for educational settings. A teacher may formally know how to use collaborative tools, but without experience in teamwork, such work will remain superficial. Therefore, teamwork should be developed not only through instruction in tools but also through the creation of practices of joint planning, shared responsibility, professional reflection, and mutual support.

No less significant is the connection between teamwork and teachers' professional resilience. In situations of uncertainty, the team often serves as a resource that helps reduce individual overload, adapt more quickly to change, find shared solutions, and maintain the quality of pedagogical activity. An individualized model of work under conditions of crisis or instability proves to be far less sustainable. By contrast, teamwork enables the distribution of the workload, the exchange of resources, the drawing on participants' diverse professional strengths, and the preservation of the continuity of the educational process. In this sense, teamwork is not only pedagogically appropriate but also an organizationally protective characteristic of the profession.

All of the above provide grounds for interpreting teamwork as an integral professional characteristic of the contemporary teacher. It is reflected in the readiness and ability to carry out coordinated activity with other participants in the educational process, take part in joint planning and product creation, sustain productive communication, assume distributed responsibility, perform different roles within a team, contribute to the achievement of a collective outcome, and preserve the quality of interaction under changing conditions. In what follows, this understanding will serve as the basis for examining the specific features of the digital educational environment as a space in which teacher teamwork acquires new forms, tools, and assessment criteria.

1.3. The Digital Educational Environment as a Space for Collective Pedagogical Activity

In scholarly and practice-oriented publications, the digital educational environment is often described as a set of technical platforms, electronic resources, communication services, and

means of accessing instructional content. This understanding is necessary, but insufficient for analyzing the contemporary teacher's professional activity. If attention is focused only on the instrumental aspect, the digital educational environment appears as a set of software solutions that support separate functions of the educational process. In actual pedagogical practice, however, it plays a much broader role. It organizes modes of interaction, sets the pace of communication, records the results of collaborative work, makes participants' contributions visible, supports coordination of actions, and thus becomes a space for collective pedagogical activity.

For this reason, the digital educational environment should be viewed not only as a technological infrastructure, but as a socio-pedagogical system within which digital tools, professional roles, rules of interaction, types of communication, forms of coordination, and mechanisms for the joint creation of educational products are combined. In this understanding, the environment is not a neutral backdrop for the teacher's activity. It directly affects how planning is carried out, how information exchange is structured, how tasks are recorded, how implementation is monitored, how intermediate results are stored, and to what extent reflection on shared activity is possible. Thus, the digital environment is not an external shell of the educational process, but one of its structural components.

This idea is especially consistent with contemporary approaches to analyzing teachers' digital competence. If digital competence is reduced merely to command of services, its professional meaning is lost. Research, by contrast, shows that the productive use of digital technologies requires integrating pedagogical, communicative, organizational, and professional elements (Tzafilkou et al., 2023). This means that the environment should be assessed not only by technical parameters but also by the extent to which it supports teaching, interaction, collaborative design, professional development, and innovation. For the topic of teamwork, this conclusion is directly relevant: collective activity in a digital space becomes possible only when tools and pedagogical logic do not contradict one another, but instead reinforce each other.

In a traditional face-to-face educational environment, a substantial part of teachers' teamwork remains situational and often undocumented. Discussions may take place orally, decisions may be made informally, and particular stages of joint work may leave no material trace. The digital educational environment changes this situation. It makes collective activity more structured, more visible, and more open to analysis. Shared documents preserve revision histories, digital boards display task distribution and completion status, chats capture the intensity and nature of communication, cloud-based environments enable tracing the contributions of individual participants, and commenting tools allow the logic of decision-making to be reconstructed. As a result, the digital environment not only supports teamwork but also creates conditions for observing, assessing, and improving it.

This is especially important in cases where teachers' professional interaction involves joint planning of instructional topics, development of materials, interdisciplinary projects, coordination of assessment, creation of adapted resources, or organization of comprehensive support for learners. In such situations, the digital environment performs at least three functions. First, it serves as a communication space where participants align on positions, exchange messages, clarify tasks, and provide feedback. Second, it functions as a space of joint production, where texts, presentations, instructional materials, templates, tables, analytical reports, and other digital products are created. Third, it serves as an organizational space where roles are distributed, work stages are planned, deadlines are set, and implementation is monitored. Taken together, these functions provide grounds for speaking of the digital environment as a space for collective pedagogical activity.

From a methodological perspective, it is useful to distinguish several levels at which such an environment functions. The first level consists of tools for synchronous interaction, including videoconferencing, online meetings, interactive sessions, and real-time decision-making. At this level, skills are developed for rapid coordination of actions, participation in collective discussion, facilitation, and sustaining group dynamics. The second level is associated with asynchronous interaction, in which chats, forums,

shared comments, task management systems, and project boards play a leading role. It is here that precision of formulation, the culture of written communication, the ability to negotiate deadlines, and responsibility become especially important. The third level is the environment for collaborative product creation, which includes cloud-based documents, presentations, spreadsheets, visual boards, online courses, and shared repositories. It is in this space that teamwork becomes most tangible, because it is captured in a concrete outcome.

Importantly, all of these levels are interconnected. Effective collaborative activity is rarely limited to a single tool. For example, collective planning may begin with a synchronous meeting, continue in an asynchronous chat, and conclude with a shared document or a digital board where tasks are assigned and responsible persons are identified. Thus, the digital environment functions as an integrated system in which different tools do not merely coexist but support distinct phases of a single collective activity. For the teacher, this means seeing the environment as a whole rather than as a set of isolated services.

It is precisely here that another important feature of the digital educational environment becomes evident. It not only supports existing forms of collaboration, but also changes the very ways pedagogical work is organized. Through digital platforms, professional interaction becomes less tied to a single time and place, which is especially important under conditions of instability, blended work formats, and the need to rapidly reorganize the educational process. Teachers can work on shared materials at different times, return to earlier versions of documents, view colleagues' comments, and participate in discussions without all participants being present simultaneously. Such asynchronous flexibility expands the possibilities for teamwork but, at the same time, creates new demands on the organization of interaction. It requires greater discipline, transparency, clarity in communication, and an understanding of collective responsibility.

Studies on virtual team building and intelligent collaborative environments emphasize that a digital environment can strengthen cohesion, motivation, and interest in shared activity if it supports psychological safety, clear interaction rules, and opportunities for each participant to make a real contribution

(Kuznetsova et al., 2023). For a pedagogical team, this means that the technical availability of tools does not in itself guarantee high-quality collaboration. What also matters are the culture of interaction, role distribution, clarity of expectations, timely feedback, and the perception of the environment as a space for genuinely shared rather than merely parallel work. Accordingly, teacher preparation for activity in a digital environment must include experience of real teamwork, not only training in how to use digital services.

From a pedagogical point of view, it is also important that the digital educational environment enables connecting the process and the result of teamwork. Under traditional conditions, only the final product is often assessed, while the course of interaction itself remains outside attention. In a digital environment, the process of collective work can become the subject of separate analysis. It becomes possible to assess not only what has been created, but also how the team moved toward the result: how tasks were distributed, how meaningful the communication was, whether there were attempts to coordinate revisions, how facilitation was carried out, whether delays occurred, and how participants responded to difficulties. It is precisely this analytical openness of the digital environment that makes it one of the most promising features in preparing teachers for teamwork.

Another important aspect is that the digital educational environment is gradually becoming a space for teachers' professional development. This involves more than participation in formal online courses or webinars. Professional growth also takes place within everyday collective practice itself: when teachers co-edit materials, observe how colleagues organize their work, receive comments, participate in digital planning, learn to justify their decisions, and encounter different styles of facilitation and resource use. In this way, the digital environment takes on the character not only of a workspace, but also of a learning space for the teacher. It supports the accumulation of practical experience that is difficult to develop through theoretical instruction alone.

In this connection, the institutional organization of the digital environment becomes fundamentally important. It can either support teamwork or make it more difficult. If, within an

educational institution, tools are fragmented, interaction rules are unclear, responsibility for coordination is undefined, and digital communication is overloaded or chaotic, the environment does not support collective pedagogical activity, even when technical resources are available. Conversely, when the use of platforms is aligned, access to shared spaces is organized, communication rules are clear, and teachers have experience in joint planning and reflection, the digital environment becomes a true organizational foundation for professional interaction. This is why researchers emphasize the importance of systemic institutional support for digital transformation rather than merely individual mastery of separate services (Hodges et al., 2026; Soroko & Shymon, 2025).

Thus, the digital educational environment should be understood as a multidimensional space for collective pedagogical activity. It brings together communication tools, resources for collaborative product creation, coordination mechanisms, and opportunities for the analytical support of shared work. Within it, teachers' teamwork takes on new forms, becoming more structured, visible, and reflective. At the same time, this environment places new demands on the teacher's professional role: the ability to work collaboratively, organize collective activity, sustain productive communication, and leverage digital tools to achieve a shared pedagogical outcome. For this reason, the next stage of analysis should focus on how teamwork in a digital educational environment is connected with educational leadership, facilitation, and role distribution in teachers' professional interaction.

1.4. Educational Leadership and Facilitation in Digital Team Interaction

Educational leadership in contemporary pedagogical scholarship is increasingly less likely to be understood solely as administrative influence or the performance of formal managerial functions. Instead, there is growing recognition of leadership as the ability to initiate change, organize joint activity, support professional interaction, guide a group toward a shared goal, and create conditions for the productive participation of others. In this sense, leadership is not exclusively an attribute of the head of an

educational institution. It also appears in everyday pedagogical practice, when a teacher takes responsibility for coordinating shared work, helps the group maintain the substantive coherence of its activity, supports constructive exchange of ideas, and contributes to the achievement of a collective result. In a digital educational environment, such manifestations become especially visible because interaction increasingly takes on an organized, recorded, and tool-mediated character.

For this reason, teacher teamwork in a digital environment cannot be fully understood without reference to the categories of educational leadership and facilitation. If the previous subsections addressed the changing professional role of the teacher and the digital environment as a space for collective activity, it is now important to clarify how coordination of actions is ensured within this space, how participant engagement is sustained, and how a shared result is achieved. It is precisely here that the question of the teacher's leadership function arises. This is not about dominating the group or exercising rigid control, but about the ability to structure interaction, sustain its productivity, and guide the team without undermining the professional autonomy of other participants.

In a digital environment, educational leadership has several specific features. First, it becomes more distributed. In teachers' teamwork, there is not always a single permanent center of influence. Depending on the stage of work, the type of task, and participants' professional competence, leadership functions may shift among team members. One teacher may initiate the topic and formulate the shared task, another may moderate the discussion, a third may organize the structure of digital materials, and a fourth may provide technical or methodological coordination. This approach is consistent with the contemporary understanding of distributed leadership, within which leadership is understood less as a property of a position and more as a way of organizing collective activity.

Second, in a digital environment, leadership takes on a more process-oriented character. In face-to-face interaction, part of the guiding influence can be exerted through nonverbal signals, intonation, and spontaneous adjustments in communication. In digital space, by contrast, the organization of group work depends

to a much greater extent on clarity of structure, transparency of tasks, visibility of roles, and timely feedback. This means that the teacher, as a leader, must be able not only to persuade or inspire, but also to design digital interactions effectively: to determine the sequence of steps, choose appropriate tools, establish communication rules, document agreements, and maintain the team's working rhythm. In this sense, leadership appears as the ability to structure a shared space for activity.

Facilitation becomes especially important in this process. It is useful to view facilitation as a specific professional action aimed at easing, sustaining, and purposefully guiding group interaction. Unlike directive management, facilitation is not limited to giving instructions or exercising unilateral control over the process. Its essence lies in creating conditions in which team members can interact productively, clearly understand the shared goal, participate in discussion, propose solutions, align positions, and take responsibility for the outcome. In digital teamwork, facilitation helps transform formal presence in a shared space into genuine collaboration.

For the teacher, this means possessing a range of facilitation skills. First of all, it involves the ability to formulate a shared goal and make it understandable to all participants. Without this, digital interaction easily breaks down into parallel individual actions that do not produce a coherent outcome. Equally important is the ability to sustain each participant's involvement and avoid situations in which activity is concentrated in only a few individuals while others remain peripheral observers. No less significant is the ability to structure discussion, that is, to distinguish what is essential from what is secondary, bring the group back to the subject of work, summarize interim results, and document decisions. In a digital environment, this is particularly important, since an excess of messages, parallel communication threads, and asynchrony can quickly blur the shared logic of activity.

Another important feature of facilitation is the support of constructive feedback. In a digital educational environment, communication often takes a text-based or hybrid form, which increases the risk of misunderstanding, formality, emotional detachment in responses, or, conversely, excessive fragmentation of discussion. A teacher in a facilitative role must do more than

simply respond to messages; they must shape the quality of communication itself by formulating questions that move the group forward, prompting clarification of positions, supporting well-grounded decisions, encouraging mutual respect, and reducing tension when disagreements arise. In this sense, facilitation becomes not an auxiliary technique, but an important expression of the professional culture of teamwork.

The digital environment makes facilitative activity more transparent and, at the same time, more demanding. In face-to-face interaction, part of the facilitator's work may be carried out intuitively. In digital space, by contrast, it often requires explicit structuring. It is necessary not only to organize a discussion, but also to choose the communication channel, determine where decisions are recorded, establish how a shared document is edited, clarify how task completion is tracked, decide when the team moves from discussion to implementation, and specify deadlines and responsible persons. Thus, facilitation in a digital environment is simultaneously a communicative, organizational, and tool-mediated practice.

It follows from this that educational leadership in digital team interaction should not be interpreted too narrowly. It includes several interrelated dimensions. The first may be called the meaning-oriented dimension: it concerns the ability to define the direction of activity, help the group understand the purpose of shared work, and maintain focus on the goal. The second dimension is organizational and relates to building the structure of team activity, distributing roles, selecting tools, and coordinating stages of work. The third dimension is communicative: it involves sustaining dialogue, providing feedback, fostering mutual understanding, and working through differences. The fourth has a reflective character and is expressed through the ability to analyze the course of shared work, notice difficulties, adjust the interaction format in a timely manner, and stimulate reflection on the experience gained. Together, these dimensions form the leadership-facilitation component of the teacher's team interaction.

It is telling that contemporary studies of teachers' digital competence increasingly include, within their structure, not only operational and technological components but also professional

and innovative components related to school development, professional collaboration, and the improvement of educational practice (Tzafilkou et al., 2023). This means that educational leadership in a digital environment is not external to digital competence. On the contrary, it constitutes one of the forms through which that competence is realized at the level of collective professional activity. A teacher who knows how to use digital services but is unable to organize interactions around them has not yet realized the full potential of the digital environment. Only the combination of instrumental proficiency with leadership and facilitation skills enables a set of technologies to become a space for genuine teamwork.

Another important aspect concerns social uncertainty. Under unstable conditions, teams face increased workload, the need to rapidly change plans of action, reorganize channels of interaction, take participants' emotional states into account, and maintain effectiveness in the face of incomplete certainty. In such situations, facilitative leadership becomes especially important. It helps not only to distribute tasks but also to preserve the team's working coherence, prevent destructive fragmentation of communication, provide timely support to participants, and reduce the disorganizing effect of uncertainty. Thus, leadership in digital team interaction serves not only a productive but also a stabilizing function.

No less significant is the issue of roles in a digital team. As already noted, contemporary pedagogical interaction is rarely built on a rigid hierarchical scheme. At the same time, a lack of clear role definitions can lead to chaos, duplication of actions, unclear responsibility, or conflicts over the boundaries of participation. This is why educational leadership must be linked not simply to the ability to manage, but also to the ability to competently organize the team's role structure. This means being able to define participants' functions in a timely manner, align expectations, make each person's contribution visible, and, at the same time, preserve sufficient flexibility to shift roles as needed. In a digital environment, this can be realized through the structure of a task board, the revision system for shared documents, assignment of responsibility for particular stages, formats for moderating discussions, and other tool-based mechanisms.

From the standpoint of pedagogical ethics, the leadership-facilitation function is also of fundamental importance. A teacher who organizes digital team interaction effectively establishes norms of professional conduct: how disagreement should be expressed, how changes should be commented on, how others' contributions should be acknowledged, how delays or mistakes should be handled, and how conflict situations should be addressed. For this reason, educational leadership in a digital environment is connected not only with effectiveness but also with the formation of a culture of collaboration. If that culture is not supported, even a well-designed technical system will not ensure high-quality teamwork. Facilitation, by contrast, helps move interaction from the plane of purely functional task completion to that of conscious professional partnership.

Thus, educational leadership and facilitation in digital team interaction should be regarded as integral components of the contemporary teacher's professional role. They provide not administrative dominance, but meaningful, organizational, communicative, and reflective structuring of shared activity. In a digital educational environment, it is precisely these qualities that enable transforming a multiplicity of tools and channels of interaction into a coherent space of collaboration in which orientation toward a shared goal, coordination of actions, visibility of participants' contributions, and professional responsibility for the outcome are preserved. This enables moving from a general theoretical understanding of the problem to a more precise clarification of the structure and content of teachers' digital teamwork skills, which are the subject of further analysis in the next section.

2. Structure and Content of Teachers' Digital Teamwork Skills

2.1. The Author's Clarification of the Concept of "Teachers' Digital Teamwork Skills"

Clarifying the concept of teachers' digital teamwork skills is necessary because several lines of inquiry intersect in contemporary scholarship: research on teachers' digital competence, studies on professional collaboration and teamwork,

and work on facilitation, distributed leadership, and the organization of shared activity in digital environments. Each of these lines provides important reference points, yet none alone fully captures the phenomenon at the focus of our analysis. For this reason, there is a need not simply to describe related concepts, but to formulate a working, conceptually coherent understanding of teachers' digital teamwork skills.

First of all, it should be emphasized that this study is not concerned with just any use of digital tools in teachers' professional activity. Nor is it concerned with just any form of group interaction in an educational environment. The focus is on a specific type of professional activity that combines three features. First, the activity is team-based, meaning that it involves a shared goal, coordinated actions, role distribution, and orientation toward a collective outcome. Second, it is digitally mediated, meaning that it takes place through shared documents, digital boards, cloud services, communication platforms, and tools for commenting, planning, and monitoring. Third, this activity has pedagogical content, since it concerns the development, organization, coordination, or improvement of the educational process. Thus, teachers' digital teamwork skills should be understood as a professionally grounded category rather than a purely technical or interpersonal one.

In the broadest sense, teachers' digital teamwork skills can be defined as the educator's ability to engage effectively in coordinated professional interaction with other participants in the educational process within a digital environment for the purpose of jointly planning, organizing, creating, revising, and evaluating educational decisions and products. This definition requires further elaboration. Above all, it points to the action-oriented nature of these skills. The issue is not merely knowledge of digital services or a positive attitude toward collaboration, but the ability to act: to communicate, negotiate, coordinate, edit, structure, facilitate, monitor the progress of shared work, work with digital artifacts, and sustain a productive team process.

It is fundamentally important that these skills not be equated with teachers' overall digital competence. Digital competence is a broader construct that includes work with resources, assessment, safety, professional development, content

creation, innovative activity, and other dimensions (Tzafilkou et al., 2023). By contrast, digital teamwork skills constitute a distinct and more specific segment of professional readiness that becomes visible precisely in situations of shared activity. They are grounded in digital competence, but they are not exhausted by it. A teacher may demonstrate a sufficient level of individual proficiency with digital tools and, at the same time, experience difficulties in teamwork, for example, being unable to distribute tasks, provide meaningful feedback, coordinate the editing of a shared document, or facilitate a group discussion. Thus, digital competence is a foundation, but not a direct synonym for digital teamwork.

These skills should likewise not be reduced to communication alone. Without question, the communicative component is central. However, it covers only part of a broader system of actions. Teachers' digital teamwork involves not only exchanging messages or participating in video meetings, but also the ability to jointly create a product, work with document versions, engage in mutual editing, record decisions, track task completion, meet deadlines, prevent duplication of actions, and maintain the team's working coherence. For this reason, within our approach, digital teamwork skills are best understood as an integrated combination of communicative, cooperative, organizational, and facilitative actions carried out in a digital environment.

Within this definition, the word *skills* is of particular importance. It points to relatively stable, practiced ways of acting that can be reproduced across different, though similar, professional situations. A skill differs from a one-time successful performance in that it has the features of transferability, repeatability, and functional reliability. Thus, when referring to teachers' digital teamwork skills, we mean not accidental successful episodes of interaction, but developed capacities that a teacher can apply in jointly planning lessons, creating interdisciplinary materials, coordinating project activity, organizing methodological collaboration, developing shared approaches to assessment, or designing educational solutions in digital environments.

At the same time, these skills are not purely operational. They cannot be interpreted as the mechanical execution of a set of instructions. They always depend on the goal of the shared activity, the team's composition, the nature of the tools, the type of educational task, and the level of participants' autonomy. For this reason, their structure includes not only the technique of execution, but also the ability to choose an appropriate mode of interaction, align means with the task, change the work format when needed, and move in a timely manner from discussion to implementation and from implementation to reflection. This interpretation is consistent with approaches that view digital pedagogical activity as a combination of technological, pedagogical, professional, and organizational dimensions (Lin et al., 2022; Tzafilkou et al., 2023).

For our study, the connection between digital teamwork and educational leadership is also essential. In real practice, team interaction rarely sustains itself on its own. As a rule, actions are needed to structure the process: someone formulates the goal, initiates discussion, records decisions, reminds the team of deadlines, summarizes interim results, engages less active participants, helps overcome communication breakdowns, or prevents conflict. Thus, digital teamwork skills include the ability to facilitate and exercise micro-leadership, even when the teacher does not hold a formal leadership position. This is precisely what distinguishes digital teamwork from the mere technical co-presence of several individuals on the same platform.

In refining the proposed concept, it is also important to emphasize its outcome-oriented dimension. Team interaction in a digital environment is not an end in itself. It is directed toward creating or improving a shared product or decision. Such a product may take the form of jointly developed instructional materials, the structure of an educational project, an assessment system, an event plan, an integrated course, a set of methodological recommendations, a digital resource, or an agreed pedagogical decision regarding the organization of work with learners. For this reason, digital teamwork skills should be assessed not only by participation in interactions but also by the ability to move the team toward a concrete shared result.

It is precisely from this perspective that, within our approach, the concept of teachers' digital teamwork skills includes several essential features. First, it is goal orientation, that is, subordination to a shared professional purpose. Second, it is coordination, expressed in the ability to align one's own actions with those of other participants. Third, it is instrumental appropriateness, that is, the ability to use digital services in accordance with the logic of the team task rather than in a purely formal way. Fourth, it is role flexibility, whereby a teacher may perform the functions of participant, coordinator, editor, facilitator, or person responsible for a specific segment of the work. Fifth, it is reflectiveness, which enables the analysis of the process of shared work, the identification of difficulties, and the adjustment of modes of interaction. Sixth, it is a responsibility for the shared result rather than only for one's own portion of the work.

In view of the above, the author's clarification of the concept may be formulated as follows: teachers' digital teamwork skills are an integrated set of practiced professional actions that ensure effective interaction between the educator and other participants in the educational process within a digital environment in order to achieve a shared goal through communication, coordination, role distribution, collaborative product creation, facilitation of the group process, and reflective adjustment of shared activity.

This definition has several advantages. First, it does not reduce the concept to technical mastery of tools. Second, it does not dissolve it into the broader concept of digital competence. Third, it includes the organizational and facilitative dimensions, without which team activity in a digital environment remains fragmented. Fourth, it emphasizes the professional and outcome-oriented nature of interaction. This is precisely what makes it possible to use the concept as a methodological foundation for the further structuring of the phenomenon under study.

Within the logic of our study, this means that teachers' digital teamwork skills should be understood not as a homogeneous construct, but as a system of interrelated components. One of these components ensures the quality of digital communication and facilitation; another is connected with the collaborative creation of a digital product; and a third concerns

the organization of the team process, planning, and coordination of actions. For this reason, the next part of the chapter will focus on identifying the structural components of this phenomenon and clarifying their content. The next step is to examine the communication-facilitation component as the first and indispensable element of teachers' digital teamwork skills.

2.2. The Communication-Facilitation Component

The communication-facilitation component is the first and foundational element of teachers' digital teamwork skills, as it enables coordinated professional interaction in a digital environment. Without well-established communication, a team is unable to define a shared goal clearly, distribute roles, sustain the workflow, or achieve a coherent result. At the same time, digital teamwork cannot be reduced merely to exchanging messages or participating in online meetings. For it to function productively, communication must do more than transmit information; it must organize interaction, guide it, sustain participants' engagement, and help the group move toward a shared outcome. For this reason, within this study, the communicative dimension is considered inseparable from the facilitative one.

The communication-facilitation component can be understood as a set of practiced actions and professional behaviors that ensure meaningful digital communication, coordinated interaction, participant engagement in shared work, constructive feedback, aligned decision-making, and the team's movement toward a common goal. In this interpretation, the issue is not merely the technical use of communication channels, but the teacher's ability to make communication functional, pedagogically appropriate, and structurally productive. This means that the component includes both communicative actions proper and facilitative actions that prevent shared interaction from fragmenting and instead preserve its internal coherence.

The need to identify such a component is determined by the specific nature of the digital educational environment. In digital formats, much of the interaction loses the immediate support of nonverbal signals, spontaneous clarification of meaning, and situational correction of misunderstandings, all of which often

occur almost unnoticed in face-to-face communication. Instead, the role of text messages, comments, digital markers, brief reactions, video meetings with a clearly limited time, asynchronous discussion, and the digital recording of decisions becomes stronger. Under such conditions, effective teamwork requires a particularly high degree of communicative precision, well-considered feedback, clarity in task formulation, and the ability to maintain the team's working rhythm even in the absence of constant simultaneous contact. This is why the communication-facilitation component is not auxiliary, but system-forming.

Its importance is also confirmed by contemporary studies of digital pedagogical activity. In research on teachers' digital competence, communication and collaboration occupy a central place because they are the means through which professional interaction, learner support, collaboration with colleagues, and participation in the development of the educational environment are realized (Tzafilkou et al., 2023). Studies also show that technical ICT skills alone do not ensure a positive impact on educational practice unless they are combined with the ability to organize pedagogical interaction, communication, and support for other participants in the process (Lin et al., 2022). For our study, this means that teachers' digital teamwork begins not with the tool itself, but with the ability to fill it with meaningful, shared interaction.

Within the communication-facilitation component, it is useful to distinguish several interrelated elements. The first concerns the initiation and maintenance of digital communication. This refers to the ability to begin discussion in a timely manner, define the topic, engage participants in interaction, sustain a working pace of communication, and create conditions in which communication does not stop after the first contact, but develops into an ongoing professional discussion. In teamwork, this is especially important because passivity at the initial stage or a vague first message often leads to reduced engagement across the entire group. Thus, initiating interaction is not a formal beginning, but an action that sets the tone and structure of subsequent teamwork.

The second element concerns the clarity and structure of communication. In a digital environment, overly general or vague messages make coordination of actions difficult. Productive

teamwork, by contrast, requires statements that clearly communicate meaning, provide understandable reference points, define the expected format of a response or action, and allow others to quickly align their contributions with the overall task. A teacher who possesses this aspect of the communication-facilitation component can formulate tasks not only informatively but also in an organized manner. Such a teacher does not simply inform, but structures shared work through a text, comment, announcement, digital marker, or brief moderating remark.

The third element concerns maintaining meaningful feedback. In digital teams, feedback largely determines the quality of interaction. Formal responses, one-word reactions, or silent editing without explanation often create an impression of fragmentation and weaken the sense of shared work. Meaningful feedback, by contrast, helps participants better understand the logic of the shared decision, feel the value of their own contribution, adjust their actions in time, and maintain trust within the team. For the teacher, this means the ability to provide comments that are constructive, respectful, and at the same time practically useful: to clarify, suggest, justify, summarize, and support. It is precisely this kind of communication that creates the conditions not only for stronger team productivity, but also for the development of a professional culture of collaboration.

The fourth element has a directly facilitative character. It refers to the ability to sustain participants' engagement and keep the group moving toward a result. In digital formats, this includes the ability to notice when the discussion is losing focus, when part of the team is dropping out of interaction, when too many parallel comments are emerging, or when the communication process is no longer leading to a decision. In such situations, the teacher, as facilitator, must bring the team back to the subject of discussion, define the next step, summarize what has been said, move the discussion toward concrete agreements, or invite participation from those whose contributions have remained peripheral. In this sense, facilitation is not a separate option but a way of sustaining communication as a shared activity.

The fifth element concerns the regulation of the communicative atmosphere. In professional interaction, what matters is not only what is said but also how the communication

style is organized. A digital environment can either foster an open and productive atmosphere or intensify detachment, fragmentation, or tension, especially when interaction occurs asynchronously or under time pressure. For this reason, the communication-facilitation component includes maintaining appropriateness, respect, a predictable tone, attentiveness to how disagreement is expressed, tact in correcting mistakes, sensitivity to tension, and the ability to prevent conflict from escalating. For the teacher, this is fundamental, since a professional team functions effectively only when there is at least a minimal level of psychological safety.

The sixth element concerns the recording and alignment of decisions. In teamwork, digital communication cannot be limited to mere discussion. It must lead to a certain degree of clarity: what exactly has been decided, who is responsible for what, in what format the work will continue, what deadlines have been set, and where the agreed result has been recorded. The absence of such a transition from discussion to agreement is often a cause of organizational breakdowns in digital team interaction. Thus, an important indicator of a developed communication-facilitation component is the ability to turn communication into decisions, and decisions into a clearly articulated basis for further action.

To define this component more precisely, it is also useful to refer to empirically observable manifestations. At the practical level, it can be observed through the frequency and quality of the use of interaction channels, the substance of contributions in the team chat, the nature of comments in shared documents, the presence of personalized and constructive feedback, and the participant's ability to moderate a short discussion, ask clarifying questions, summarize interim results, involve others in participation, and identify next steps. These manifestations enable not only a theoretical description of the component but also the determination of its indicators and levels of development in subsequent analysis.

It is also important to emphasize that the communication-facilitation component is not isolated from the other elements of digital teamwork. It is directly connected with the collaborative creation of a digital product, since the quality of communication affects the coordination of editing, the alignment of revisions, and

the making of content-related decisions. It is likewise closely connected with the organizational-projective component, because without clear communication, it is impossible to distribute roles, monitor deadlines, coordinate stages, and sustain the structure of team activity. However, it is the communication-facilitation component that creates the primary conditions for the realization of the others, because it is through this component that the very mechanism of team interaction is formed.

In view of this, the communication-facilitation component can be defined as an integrated system of actions that ensures the initiation, maintenance, structuring, and advancement of teachers' digital professional interaction within a team through meaningful communication, constructive feedback, participant engagement, alignment of decisions, and the maintenance of a productive atmosphere of collaboration. This understanding makes it possible to regard communication not as a technical accompaniment to teamwork, but as its functional core, performing informational, organizational, coordinative, and facilitative functions simultaneously.

Thus, the communication-facilitation component serves as the foundation of teachers' digital teamwork skills, enabling productive, coordinated, and professionally appropriate interaction in a digital environment. Through it, engagement, coordination, support, clarification, alignment, and the movement of shared activity toward a result are realized. The next stage of analysis should be directed toward the second component of this phenomenon, namely the cooperative-productive component, which reflects the teacher's ability not only to interact, but also to participate in the collaborative creation of a digital product.

2.3. The Cooperative-Productive Component

The cooperative-productive component reflects the element of teachers' digital teamwork skills associated not only with participation in interactions but also with the collaborative creation of a concrete outcome in a digital environment. If the communication-facilitation component ensures the possibility of coordinated professional communication, sustained engagement, and the movement of the group toward a decision, then the

cooperative-productive component makes it possible to move this interaction into the sphere of shared activity that results in the creation of an educational product, document, resource, project-based solution, or another outcome of professional value. It is through this component that digital teamwork becomes tangible, and team interaction ceases to be merely a process of discussion.

In teachers' professional activity, this component acquires particular importance because the contemporary digital educational environment increasingly requires not individual, but collective creation of materials and solutions. These may include jointly designed lessons, interdisciplinary tasks, presentations, digital exercises, methodological recommendations, event plans, analytical tables, assessment systems, visual schemes, curated collections of learning resources, models of project-based activity, or other products created not by a single teacher but by a pedagogical team. Under such conditions, what becomes important is not only readiness to participate in collective work, but also the development of specific modes of action that allow one's own contribution to be effectively integrated into a shared digital result.

For this reason, the cooperative-productive component can be understood as a set of practiced actions that ensure the teacher's participation in the collaborative creation, editing, refinement, structuring, and improvement of a digital product within team interaction. In this interpretation, the central issue is not simply the shared presence of several people in a digital environment, but their ability to work on a single professionally significant object in a way that involves aligning content, coordinating actions, transparency of changes, and responsibility for the quality of the result. This means that the cooperative-productive component has, at the same time, an action-oriented, content-related, and outcome-oriented character.

Its identification is based on the fact that teamwork in a digital environment differs fundamentally from mere task division. In many cases, work that appears outwardly collective may in fact remain a set of parallel individual actions, in which each participant completes only their own segment without any real substantive intersection with others. However, such a form of interaction does not yet ensure fully developed digital teamwork.

By contrast, the cooperative-productive component presupposes interdependence of contributions, joint formation of the product's structure, alignment of changes, discussion of quality, adaptation of individual elements to the overall concept, and willingness to work not only on "one's own part," but on the integrity of the shared result as a whole. It is precisely here that the shift from formal cooperation to substantively rich productive interaction becomes visible.

In contemporary approaches to teachers' digital competence, the creation of digital content, the adaptation of resources, and professional work with them are regarded as important dimensions of pedagogical readiness to function in a digital environment (Alom & Ramalingappa, 2025; Tzafilkou et al., 2023). For our study, however, it is important to emphasize that within teamwork, this process becomes more complex. It is not enough for a teacher simply to be able to create a digital resource independently. The teacher must be able to create it with others, taking colleagues' contributions into account, aligning the material's structure with its logic, adapting personal decisions to a shared format, and maintaining the coherence of the final result. Thus, the cooperative-productive component should be understood as a specific manifestation of digital professional competence, specifically in team activity.

Within this component's structure, it is useful to distinguish several interrelated elements. The first concerns the ability to collaborate on the creation of a digital product. This means readiness to work not in an isolated mode, but in an open space of shared work where each participant's contribution is visible, can be continued by others, and is subject to joint discussion. For the teacher, this is reflected in the ability to work with cloud-based documents, boards, spreadsheets, presentations, and collaborative planning and material development platforms, so that their activity is not private editing but part of a team process.

The second element concerns the coordination of editing and change management. In a digital environment, collaborative work on a product almost always involves repeated clarification, commenting, additions, restructuring, versioning, and editing by different participants. Accordingly, the development of the cooperative-productive component is reflected in the ability to

work with revision history, comment on edits, propose changes in an appropriate and transparent way, and do so without disrupting another person's contribution, but instead integrating it into the shared result. This also involves the ability to avoid duplication, chaotic changes, uncoordinated editing, and the loss of important elements of the shared product.

The third element encompasses the substantive alignment of contributions. The collaborative creation of a digital product is impossible without understanding how individual parts relate to one another and how they function within the whole. Therefore, the teacher must not only create their own segment of the material, but also see it within the structure of the overall result. This means the ability to follow a shared logic, align style and format, adapt material to the overall concept, revise individual elements for the sake of coherence, and participate in the joint refinement of the product even beyond the function originally assigned. It is precisely this approach that transforms a sum of separate contributions into an integrated professional result.

The fourth element concerns the integration and adaptation of digital resources. In real practice, teachers' teamwork often involves not the creation of entirely new material from scratch, but the selection, evaluation, combination, adaptation, and reinterpretation of existing resources. In this regard, the cooperative-productive component includes the ability not merely to add links or fragments of materials, but to integrate them meaningfully into a shared product, align them with the team's goal, revise them when necessary, and ensure pedagogical appropriateness, proper attribution, and structural coherence. This is especially important in a digital environment, where access to a large number of ready-made resources makes searching easier, but does not guarantee meaningful use.

The fifth element is connected with productive responsibility. In teacher teamwork, it is not enough to complete one's own part of the task formally. It is necessary to relate one's contribution to the quality of the final result, to be ready to improve what has been created in response to colleagues' comments, to return to earlier stages if this is necessary for the coherence of the product, and to treat the shared result as a zone of responsibility rather than as a mechanical sum of individual fragments. In this sense,

the cooperative-productive component combines technological proficiency with the professional ethics of shared authorship.

The sixth element concerns the ability to engage in shared reflection on the product. The quality of digital teamwork is determined not only by the creation of shared material but also by the willingness to evaluate its strengths and weaknesses, identify inconsistencies, refine quality criteria, relate the product to the original goal, and make revisions when needed. Thus, the cooperative-productive component includes not only the production phase, but also the phase of jointly interpreting and evaluating the result. It is at this stage that the team moves from completing the task to professionally improving the outcome.

At the practical level, the development of this component can be observed through several specific manifestations. These include active participation in collaborative editing of documents, use of comments and suggestion mode, appropriate revision practices, adherence to an agreed format, the ability to integrate one's own material into a shared structure, work with version history, meaningful responses to colleagues' suggestions, and participation in refining the product after interim discussion. Equally revealing is the ability to work in shared presentations, spreadsheets, visual boards, digital collections of resources, and cloud storage spaces without losing the logic of the shared product and without generating organizational chaos.

It is also important to emphasize that the cooperative-productive component is directly connected with the teacher's professional growth. In situations of collaboratively creating a digital product, the teacher does not merely complete a task, but also learns through interaction: by observing colleagues' ways of working, adopting more effective ways of structuring material, learning to formulate content more precisely, seeing alternative styles of organizing a resource, and refining personal understandings of the quality and appropriateness of a digital product. Thus, this component has not only a productive, but also a developmental significance, because through it, teamwork becomes a form of professional learning in action.

At the same time, the cooperative-productive component cannot be regarded as autonomous from the other elements of

digital teamwork. It depends directly on the quality of the communication-facilitation component, because without meaningful communication, it is impossible to align the product's structure, editing modes, and quality criteria. It is likewise closely connected to the organizational-projective component, since the collaborative creation of a digital product requires planning stages, the distribution of functions, temporal coordination, and monitoring progress. However, it is precisely the cooperative-productive component that represents the level at which teamwork takes on its most visible form, because it is embodied in a jointly created outcome.

In view of the above, the cooperative-productive component can be defined as an integrated system of actions that ensures the teacher’s participation in the collaborative creation, substantive alignment, editing, refinement, and reflective improvement of a digital product within team-based professional interaction. This definition shows that teachers’ digital teamwork is realized not only through communication but also through productive joint activity, in which each contribution acquires meaning only within the integrity of the shared result.

Thus, the cooperative-productive component is the second essential element of teachers’ digital teamwork skills. It reflects the teacher’s ability not only to interact with others in a digital environment, but also to build with them a professionally meaningful product while maintaining its coherence, quality, logic, and pedagogical appropriateness. The next stage of the discussion should focus on the organizational-projective component, which ensures planning, role distribution, coordination of stages, and maintenance of the structure of team activity in a digital environment.

2.4. The Organizational-Projective Component

The organizational-projective component reflects that element of teachers’ digital teamwork skills that ensures the structured nature of shared activity, its temporal and substantive coordination, the distribution of roles, the alignment of work stages, and the team’s movement toward a planned result. If the communication-facilitation component creates the conditions for

meaningful interaction, the cooperative-productive component ensures the collaborative creation of a digital product, and the organizational-projective component provides the structural framework for the entire teamwork process, then the organizational-projective component provides that framework. It is through this component that shared activity acquires sequence, predictability, and manageability, and that team interaction does not break down into separate episodes.

In teachers' professional activity, this component becomes especially important because the digital educational environment significantly expands the possibilities for teamwork while simultaneously increasing the risks of disorganization. Open access to shared documents, asynchronous modes of work, a large number of communication channels, parallel tasks, and the flexibility of digital tools can support team productivity only when clear organization is in place. If such an organization is absent, typical difficulties arise: duplication of functions, uncertainty about responsibility, delayed completion of stages, loss of the logic of shared work, overload of particular participants, blurred deadlines, and a decline in the quality of the final result. Thus, the organizational-projective component is not a technical supplement to digital teamwork, but a necessary condition for it.

This component can be understood as a set of practiced actions that ensure the planning, structuring, coordination, distribution, and monitoring of team activity in a digital environment to achieve a shared professional goal. In this interpretation, the issue is not merely formal management of the process, but the teacher's ability to build the logic of shared work, connect separate stages into a coherent sequence, understand the interdependence of tasks, adjust the course of work in a timely manner, and maintain the team's functional coherence. For this reason, this component should be viewed as a combination of organizational culture, project thinking, time discipline, and digitally mediated coordination.

The need to identify such a component is also connected with broader changes in the teacher's professional role. Contemporary pedagogical activity increasingly includes participation in team initiatives, short- and medium-term projects, collaborative planning, interdisciplinary interaction, joint creation

of instructional materials, and coordinated decision-making. Under these conditions, the teacher must be able not only to join an already organized process but also to sustain its structure independently at the level of a micro-team, creative group, methodological association, or shared digital task. Thus, the organizational-projective component is directly linked to micro-leadership, distributed responsibility, and the practical enactment of educational leadership in everyday professional interaction.

Within this component's structure, it is useful to distinguish several interrelated elements. The first concerns the planning of shared activity. This refers to the ability to define the goal of a team task, break it down into stages, outline the logical sequence of actions, set deadlines, and understand the interdependence of individual parts of the work. In a digital environment, this ability is reflected in the capacity to work with project boards, task lists, calendars, trackers, and other tools for visualizing the team's process. What matters here is not the mere use of a service, but the ability to design activities so that each participant can see the overall logic of the work and their own place within it.

The second element covers the distribution of roles and functions. Effective digital teamwork requires not only a shared goal but also a clear division of responsibility. Within this component, the teacher must be able to determine who is responsible for each stage, who coordinates progress, who collects materials, who carries out final editing, who moderates discussion, and who works on visualization or technical formatting. At the same time, the issue is not the rigid fixation of roles, but their functional clarity. It is precisely this that makes it possible to avoid disorder, duplication of actions, and situations in which a task “belongs to everyone” and therefore in practice is completed by no one.

The third element concerns the coordination of stages of shared work. Planning in itself does not guarantee productivity if the team does not maintain a connection between the original plan and actual progress. For this reason, the organizational-projective component includes the ability to track what stage a shared task has reached, which actions have already been completed, what requires further refinement, where delays are emerging, and where the team needs to regroup its efforts. In a digital

environment, this may be realized by updating task statuses, marking completion stages, entering interim results into shared tables, posting comments on project boards, or using other coordination tools. In all cases, however, the essence remains the same: the teacher must view teamwork as a process that requires continuous alignment.

The fourth element concerns the temporal organization of activity. Digital teamwork often occurs asynchronously, with participants working at different times and varying levels of intensity. This expands the possibilities for flexible collaboration but, at the same time, requires a clearer approach to deadlines, intermediate milestones, and the implementation rhythm. Thus, the organizational-projective component includes the ability to work with time frames not formally, but functionally: to set realistic deadlines, make them visible to the team, provide timely reminders about critical points, adjust the plan when changes occur, and relate the pace of work to the actual complexity of the task. In teachers' professional activity, this is especially important because digital collaboration is often combined with heavy workload and multitasking.

The fifth element covers the ability to prevent and manage organizational disruptions. In any team activity, delays, misunderstandings, overlapping functions, uneven distribution of contributions, or changes in implementation conditions may occur. In a digital environment, these difficulties do not disappear and may even become more acute due to asynchronous formats, the lack of immediate feedback, or a disconnect between communication and execution. For this reason, the organizational-projective component includes the ability to notice such disruptions in a timely manner, clarify agreements, redistribute actions, bring the team back to the agreed plan, or simplify the work structure if it proves excessively complex. In this sense, the issue is not organization as such, but flexible organizational sensitivity.

The sixth element concerns the use of digital tools to visualize and sustain the structure of team activity. In contemporary digital teamwork, it is important not simply to reach agreements orally or in a chat, but to document the logic of the activity in a form accessible to all participants. These may include

Kanban boards, responsibility charts, checklists, calendars, shared folders, stage maps, role-distribution templates, or digital status markers. What is fundamental is that such tools perform not a supplementary, but an organizational function. They make shared work transparent, reduce the risk of losing track of agreements, allow participants to navigate the process more quickly, and support a common understanding of the task. Thus, the organizational-projective component includes not only the ability to use such tools, but also the ability to select them in accordance with the specific task's logic.

The seventh element concerns the reflective adjustment of the process. Any project-based format involves not only carrying out work according to plan, but also considering how effective the chosen activity structure actually is. A teacher with a developed organizational-projective component is able not simply to proceed according to the initial scheme, but to assess whether it is working, whether it needs revision, whether particular stages are overloaded, whether some roles remain undefined, or whether the team is losing momentum because of excessive complexity or, conversely, insufficient detail. This kind of reflectiveness is especially important in a digital environment, where changes may occur quickly, and an excess of tools can sometimes complicate rather than facilitate activity.

At the practical level, the development of this component can be observed through several specific manifestations. These include the ability to structure tasks on a digital board, mark work stages, set deadlines, assign responsibility, update completion statuses, relate the course of work to the initial plan, respond to delays, clarify functions, conduct short project discussions, and turn them into operational decisions. Also revealing is the ability to use checklists, calendars, role-distribution matrices, and shared resource storage spaces without losing the task's logic. All of this makes it possible not only to describe the organizational-projective component theoretically, but also to determine its indicators and levels of development in later analysis.

It is important to emphasize that the organizational-projective component is not something external to the pedagogical essence of the teacher’s activity. On the contrary, it is through this component that teamwork acquires professional reliability. In an

educational environment, it is not enough to merely foster a collaborative atmosphere or provide access to shared documents. The team must work within a clear logic, keep sight of its goals, move from intention to implementation in a timely manner, and deliver shared activities to completed results. For this reason, the organizational-projective component is a manifestation of the teacher's professional maturity in a digital environment and a condition for the teacher's educational leadership within the team.

This component is closely connected with the previous elements of digital teamwork. Without the communication-facilitation component, it is impossible to align the plan, distribute roles, and adjust actions. Without the cooperative-productive component, the organization loses its substantive center, since it no longer leads to the creation of a shared result. However, it is precisely the organizational-projective component that brings these elements together into a functionally coherent system, because it provides the framework within which communication becomes work-oriented and the collaborative creation of a product gains sequence and completion.

In view of the above, the organizational-projective component can be defined as an integrated system of actions that ensures planning, distribution of functions, temporal and substantive coordination, maintenance of structure, adjustment of the process, and completion of the teacher's digital teamwork aimed at achieving a shared professional goal. This definition makes it possible to view digital teamwork not only as communication or collaborative product creation, but as a structured process that requires project-based thinking, organizational discipline, and the ability to act under conditions of change.

Thus, the organizational-projective component is the third essential element of teachers' digital teamwork skills. It ensures the internal orderliness of shared activity, makes it transparent, manageable, and outcome-oriented, supports the connection between intention and implementation, and reduces the risks of disorganization in a digital environment. Taken together, the communication-facilitation, cooperative-productive, and organizational-projective components provide grounds for moving

toward a broader synthesis of their interaction within the overall structure of teachers' digital teamwork skills.

2.5. The Interrelationship of the Components and the Logic of Their Development

Teachers' digital teamwork skills do not constitute a mechanical combination of separate abilities, but rather an integrated system of interrelated components, each performing its own function and fully realized only in interaction with the others. For this reason, they should be viewed not in isolation, but as a structurally integrated construct within which the communication-facilitation, cooperative-productive, and organizational-projective components do not merely coexist, but mutually support and reinforce one another. This structuring is consistent with contemporary studies of pedagogical activity in digital environments, which emphasize the combination of several interdependent dimensions of professional action: digital communication, interaction design, collaborative work organization, product creation, and reflective support. This provides grounds for considering teamwork skills not as a single behavioral response but as a systemic, multi-component phenomenon (Amelia et al., 2024; Hrechanyk et al., 2024). Such an approach is fundamental for further analysis because it enables moving from describing separate elements to understanding the internal logic of teachers' digital teamwork as a coherent professional phenomenon.

The first and most evident connection is the one between the communication-facilitation and cooperative-productive components. The collaborative creation of a digital product cannot be effective without high-quality interaction among team members. If communication remains fragmented, unstructured, or merely formal, the team is unable to align on the product's logic, coordinate contributions, respond to changes, and ensure the substantive coherence of the shared result. At the same time, communication itself loses its professional completeness if it is not directed toward a concrete productive outcome. Thus, there is a direct interdependence between these two components: communication provides the conditions for the cooperative

creation of a product, while collaborative work on the product gives communication substance, specificity, and professional direction.

The connection between the communication-facilitation and organizational-projective components is no less close. Planning, coordination of stages, role distribution, and monitoring of implementation cannot be effective without meaningful digital communication, clear agreements, and timely feedback. Even a well-designed organizational scheme loses its effectiveness if the team lacks the skills to sustain productive interaction, clarify tasks, respond to delays, and coordinate adjustments to the process. In turn, communication itself requires an organizational foundation. If stages, roles, deadlines, and the logic of progress are not defined, even active discussion can remain scattered and fail to lead to coordinated decisions. For this reason, the organizational-projective component performs a structuring function in communication, while the communication-facilitation component sustains the viability and flexibility of the team process within the organization.

The cooperative-productive and organizational-projective components are also in a direct, mutually reinforcing relationship. The collaborative creation of a digital product requires not only substantive alignment of contributions but also a clear structure of activities: a sequence of stages, distribution of responsibilities, defined deadlines, transparency of changes, and visibility into the current status of the task. Without such organization, cooperative work quickly loses coherence, and the product becomes fragmented or internally inconsistent. At the same time, the organization itself acquires meaning only when it serves the creation of a concrete shared result. Otherwise, the team risks focusing on technical maintenance of the process rather than sufficient substantive content. Thus, the organizational-projective component creates the framework for productive joint activity, while the cooperative-productive component fills that framework with professionally meaningful content.

Thus, all three components are in a relationship of functional interdependence (Figure 2.1). The communication-facilitation component enables meaningful interaction and sustains participants' engagement. The cooperative-productive component

is responsible for the collaborative creation, alignment, and improvement of the digital product. The organizational-projective component gives team activity structure, sequence, and manageability. The absence or weak development of even one of these components disrupts the integrity of the entire system. If high-quality communication is lacking, the team is unable to coordinate shared activity effectively. If the productive dimension is underdeveloped, interaction yields no concrete result. If organizational structure is absent, even meaningful discussion and readiness for collaboration do not ensure steady movement toward the goal.

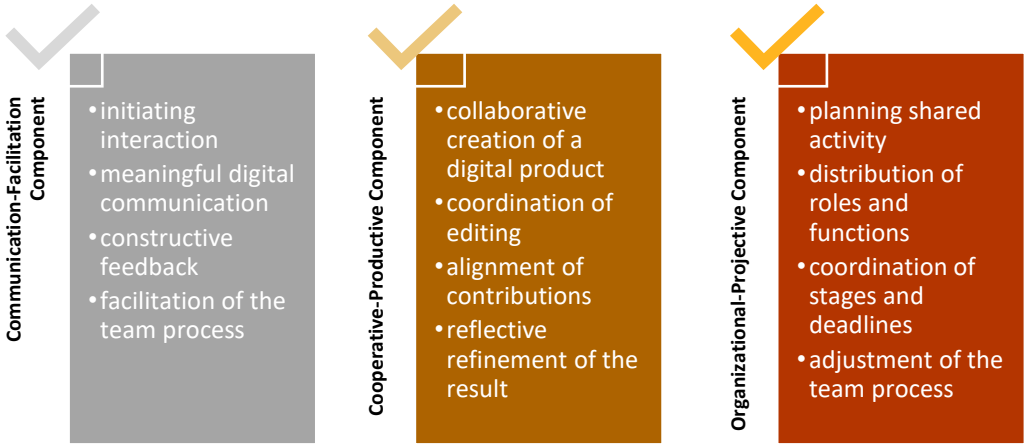

Figure 2.1
Structural Model of Teacher Teamwork

Source: Authors' own work.

The interrelated nature of these components also means that they should not be developed sequentially as fully autonomous stages of professional preparation. Although they were examined separately for analytical clarity, in actual pedagogical practice and, accordingly, in teachers' professional development, they are formed in interaction with one another. For example, working on a shared digital document simultaneously requires communication, coordination of editing, and adherence to a certain organizational logic. Participation in team planning through a digital board requires meaningful discussion, agreement on roles, and the ability to collaboratively create a working product in the form of a task structure or project scheme. For this reason,

the development of teachers' digital teamwork skills must be comprehensive and rely on activities in which teachers simultaneously communicate, collaborate on a shared product, and organize the process.

It is precisely for this reason that short-term or overly narrow digital training formats do not always produce a noticeable effect in preparing teachers for teamwork. If teachers' professional development is reduced merely to familiarization with individual services, a coherent understanding of how these services function within a team process is not formed. If the emphasis is placed only on communication without a productive shared task, experience in the cooperative creation of a result does not develop. If, on the other hand, attention is focused only on project structure or the mechanical use of trackers, but without meaningful interaction and facilitation, teamwork takes on a formal character. Thus, the logic of developing these skills lies not in accumulating isolated micro-skills, but in gradually building the ability to act within an integrated digital team environment.

In this sense, it is useful to speak of a certain internal logic in the development of the components. At the initial level, the teacher usually masters basic forms of digital communication and individual use of particular services. The next important step is the transition to elementary shared activity: exchanging materials, participating in collaborative editing, responding to comments, and performing clearly defined roles. The following step involves working in more complex forms of team organization, where not only the participation and execution of separate actions are required, but also the coordination of stages, facilitation of discussion, alignment of changes, maintenance of the logic of the shared product, and reflective improvement of the process. Thus, the development of digital teamwork skills proceeds from partial instrumental participation to integrated professional collaboration.

It is important to emphasize that this logic of development is not purely linear. In real practice, individual components may develop unevenly. A teacher may be quite confident in using digital communication tools but may experience difficulties facilitating group interaction. Another may be able to work on a shared product, but may not plan stages and distribute roles with sufficient clarity. Still another may organize the process well but

may not always sustain a constructive atmosphere of digital interaction. For this reason, the system of components is important not only for the theoretical description of the phenomenon, but also for subsequent assessment, since it enables identification of both the overall level of skill development and the relatively stronger or weaker elements within its structure.

This leads directly to the next analytical step. If teachers' digital teamwork skills have a complex, internally interconnected structure, their development cannot be described solely in terms of general categories such as "possesses" or "does not possess." A more precise system of assessment is needed, one that makes it possible to determine the exact criteria, indicators, and levels by which the development of each component and of the system as a whole can be identified. Thus, the logic of examining the structure of teachers' digital teamwork skills naturally leads to the development of instruments for their assessment, which is the subject of the next section.

Thus, the communication-facilitation, cooperative-productive, and organizational-projective components form an integrated system in which each component performs its own function, yet can fully realize that function only in interaction with the others. This approach makes it possible to view teachers' digital teamwork not as a sum of disconnected skills, but as an integrated professional capacity for coordinated, structured, productive, and technologically mediated interaction in a digital educational environment. It is precisely this that provides the methodological foundation for further identification of criteria, indicators, and levels of development for the corresponding skills.

3. Criteria, Indicators, and Levels of Development of Teachers' Teamwork Skills in a Digital Educational Environment

3.1. Methodological Foundations for Building the Assessment System

Building an assessment system for teachers' digital teamwork skills requires a clear methodological foundation, since the issue involves a complex professional phenomenon that

cannot be reduced to either separate technical skills or a general impression of a teacher's participation in shared activity. The previous section substantiated that teachers' digital teamwork has an integrated character and includes communication-facilitation, cooperative-productive, and organizational-projective components. This, in turn, makes it necessary to develop an assessment system capable of identifying not only the overall level of development of these skills, but also the structure of their manifestation, the internal links among components, and the strengths and weaknesses of teachers' professional behavior in a digital environment.

A methodologically important point is that the object of assessment is not isolated knowledge of digital tools and not the formal use of services, but the teacher's actual ability to act within conditions of team-based professional interaction. For this reason, the assessment system should be oriented not only toward the declarative level, that is, what the teacher reports about themselves, but also toward the action-oriented level, where specific manifestations of interaction, coordination, collaborative creation of a digital product, process organization, and facilitation of group work are documented. This approach is consistent with contemporary models of teachers' digital competence, which emphasize the need to combine professional, pedagogical, and behavioral dimensions of assessment (Tzafilkou et al., 2023). For our study, this means the assessment system must go beyond traditional questionnaire-based procedures and include methods of documentation that allow observation of the actual functioning of skills in digital teamwork.

One of the basic methodological foundations for constructing such an assessment system is a competence- and action-oriented approach. Its essence lies in the fact that what is assessed is not an isolated set of operations, but the teacher's ability to act effectively in professionally significant situations. For this reason, the focus of the system should not be on individual services or technical techniques, but on the typical actions that constitute the substance of digital teamwork: initiating and sustaining communication, providing constructive feedback, coordinating editing, aligning contributions, planning stages, distributing roles, maintaining deadlines, responding to difficulties, and reflectively

refining the result. This understanding makes it possible to assess the professional adequacy of the relevant skills, rather than merely the fact of familiarity with digital tools.

The second essential methodological foundation is the structured nature of assessment. Since teachers' digital teamwork skills have an internally differentiated structure, the assessment system must reflect that structure rather than dissolve it into a single generalized indicator. Otherwise, the results will have limited interpretive value: a high or medium overall score will not indicate exactly where a teacher's professional strengths or difficulties lie. For this reason, the system should be built using the components identified earlier. This means that the criteria, indicators, and assessment descriptors should correspond to the communication-facilitation, cooperative-productive, and organizational-projective dimensions of the phenomenon under study. Such an approach enables combining the overall integrity of assessment with analytical sensitivity.

The third methodological foundation is the use of multiple data sources. Research on digital competence has repeatedly emphasized that relying solely on self-assessment does not provide a sufficiently reliable picture, since respondents may either overestimate or underestimate their own abilities, basing their judgments not on actual practice, but on a general impression of themselves or on socially desirable responses (Alom & Ramalingappa, 2025; Tzafilkou et al., 2023). This is especially relevant for assessing digital teamwork, because some of the relevant skills are context-dependent and become visible only in actual interaction. Thus, it is methodologically justified to construct the assessment system using multiple data sources. In our case, this means combining self-assessment, observation of performance during a practical task, and analysis of digital artifacts produced during the shared activity. It is precisely this form of triangulation that makes it possible to bring assessment closer to the actual professional functioning of the skills.

The fourth foundation is the combination of process- and outcome-oriented assessment dimensions. In digital teamwork, what matters is not only whether a team has produced a particular product, but also how that product was created. A team may achieve an acceptable result because of the high activity of one

participant and the minimal involvement of the others, or through chaotic, inefficient actions that only accidentally lead to the desired outcome. In such cases, the product itself does not provide complete information about the level of development of the relevant skills. For this reason, the assessment system must take into account both process indicators, which characterize the course of interaction, and outcome indicators, which concern the quality of the shared product or the completeness of the team task. This approach is particularly important for the analysis of digital activity, where the process itself leaves numerous recorded traces: version histories, comments, status changes, board structures, the temporal dynamics of completion, and so forth.

The fifth methodological foundation is contextuality of assessment. Digital teamwork skills do not exist outside specific professional interaction situations. Their manifestation depends on the task type, the tools selected, the team size, the degree of role clarity, time constraints, the product's complexity, and the participants' prior experience. For this reason, the assessment system cannot be abstract or based on test questions artificially detached from practice. It must rely on tasks and procedures that model real or as close to real professional situations as possible. This means that assessment instruments should be embedded in team activities rather than imposed from the outside. That is why, in our study, the practical task is regarded not as an additional element but as one of the central means for identifying the level of development of the skills under investigation.

The sixth foundation is criterion-based clarity. The assessment system must be designed so that each result can be interpreted on the basis of clear criteria and indicators rather than the evaluator's general impression. This is especially important for complex professional phenomena, where the risk of subjectivity is high. In our case, criterion-based clarity means that concrete manifestations must be formulated for each component of digital teamwork skills: what exactly counts as meaningful digital communication, what constitutes evidence of coordinated editing, how the organizational structure of teamwork is identified, what indicates the presence of facilitation, how the coherence of a shared product is assessed, and so forth. In this way, the assessment system gains not only research value but also

methodological value, as it can serve as a tool for feedback and professional development.

The seventh methodological foundation is level-based interpretation of results. For professional development, it is not enough to simply identify the presence or absence of a particular skill. It is necessary to assess its degree of development, the dynamics of its growth, and its potential for further improvement. For this reason, assessment results should be interpreted through a system of levels that reflect the gradual transition from an initial, situational, or unstable manifestation of a skill to its confident, integrated, and professionally productive application. This approach aligns with contemporary frameworks for assessing digital competence, which interpret the outcome as a level of development rather than a binary state of "present or absent" (Tzafilkou et al., 2023). For our study, this allows not only measuring changes after the training intervention but also showing their nature in a more nuanced way.

The eighth foundation is the combination of quantitative and qualitative assessment logics. Although results can be conveniently summarized through scales, scores, or levels, the phenomenon of digital teamwork cannot be fully described by numerical indicators alone. For example, two teachers may receive the same total score while demonstrating different interaction styles: one may be stronger in coordination, while the other is stronger in facilitation or collaborative editing. For this reason, quantitative results should be supplemented by a qualitative description of the nature of the observed manifestations. Such an approach not only increases the interpretive value of the results but also helps avoid excessive simplification of a complex professional phenomenon. In this sense, the assessment system must be analytically flexible: sufficiently structured to allow comparison of results, yet sufficiently substantive to explain their nature.

The ninth important foundation is the developmental character of assessment. Within our study, the assessment system is not limited to a control function. It should not only document the current level of skill development but also lay the foundation for further growth. This means that assessment must perform diagnostic, analytical, and feedback functions: helping the

teacher identify strengths, recognize problematic areas, relate personal practice to clear professional benchmarks, and understand the directions in which improvement is possible. This approach is especially important in the context of short-term training programs, where assessment should be integrated into the learning process rather than reserved for the final stage.

Taking these foundations into account, the assessment system for teachers' digital teamwork skills in our study is constructed as a comprehensive, multi-component, and criterion-based model that draws on several data sources, combines process-oriented and outcome-oriented dimensions, takes the professional context into account, and provides for level-based interpretation of results. Such a design enables assessment not only of the teacher's overall readiness for digital teamwork, but also of its concrete manifestations in real or simulated professional interaction.

It is precisely on this methodological basis that the criteria, indicators, descriptors, and levels of development of teachers' digital teamwork skills can be identified in the sections that follow. The next logical step, therefore, is to specify this system by describing the assessment criteria and indicators in accordance with the phenomenon's structural components.

3.2. Assessment Criteria and Indicators

The identification of assessment criteria and indicators for teachers' digital teamwork skills is a necessary stage in building a coherent diagnostic system, as it is through these that the methodological foundations of assessment take on an operational form. If the previous subsection substantiated the general principles for constructing the assessment system, at this stage, it is important to move toward specifying the exact features through which the development of the phenomenon under study can be identified. Such specification is needed not only for analytical precision, but also to ensure the transparency, repeatability, and practical applicability of the assessment in teachers' professional development. The relevance of this approach is confirmed by studies of teamwork in digital and blended educational formats, where one of the main problems

identified is not a lack of interest in teamwork, but insufficient clarity in the criteria for its instruction and assessment. Therefore, the development of a system of indicators in our study is not merely a methodological step, but also a response to a broader difficulty documented in contemporary digital pedagogy (Espejo et al., 2023; Amayou et al., 2025).

Since, within this study, teachers' digital teamwork skills are understood as an integrated system that includes communication-facilitation, cooperative-productive, and organizational-projective components, the system of criteria and indicators must reflect this very structure. Accordingly, it is advisable to construct the criteria not according to the logic of individual digital tools, but according to the logic of the professional functions that the teacher performs in shared activity. Such an approach allows avoiding a situation in which assessment effectively replaces the professional substance of the activity with a list of technical actions. Instead, the focus falls on the manifestations that characterize the quality of collaboration: readiness to initiate interaction, sustain constructive communication, coordinate contributions, organize teamwork, and jointly bring a digital product to completion. In this sense, the system of criteria should reflect not a set of services, but the internal logic of the teacher's professional teamwork activity (Navio-Marco et al., 2025; Shuppe et al., 2024). This makes it possible to avoid a technocratic narrowing of assessment and to focus on the actual substance of teamwork in a digital educational environment. In this connection, our study identifies three main criteria: communication-facilitation, cooperative-productive, and organizational-projective. Each of them is specified through a system of concrete indicators that reflect observable or documentable manifestations of the corresponding component.

The first is the communication-facilitation criterion, which characterizes the teacher's ability to ensure meaningful digital interaction, sustain constructive communication, engage participants in shared activity, provide feedback, and help move the team toward a common decision. This criterion is of fundamental importance because it is through it that the basic function of interaction is realized, without which neither coordination of actions, nor collaborative product creation, nor

organization of the team process is possible. Its assessment enables identification not merely of the teacher's presence in a digital space, but also of the nature of that teacher's participation in professional interaction.

The main indicators of this criterion should include, first, the initiation and maintenance of digital interaction. This refers to the teacher's ability to initiate professional discussion, define its subject, set a productive tone for communication, sustain its rhythm, and prevent interaction from fading at the outset. The second indicator is the clarity and structure of digital messages, that is, the ability to formulate messages, comments, or instructions so that they are understandable, functionally appropriate, and connected to the logic of the shared task. The third indicator is the quality of feedback, which includes the ability to provide meaningful, constructive, well-grounded, and respectful comments that help other team members adjust or continue their work. The fourth indicator is related to facilitation of the team process, that is, the ability to sustain participants' engagement, summarize interim results, bring the group back to the subject of discussion, and help move from discussion to decision. The fifth indicator is the maintenance of a constructive communicative atmosphere, which includes respect for others' positions, appropriate behavior in situations of disagreement, prevention of communicative tension, and the ability to preserve a productive character of interaction. Taken together, these indicators make it possible to assess the extent to which the teacher is able not merely to participate in digital communication, but to organize it as an instrument of professional teamwork.

The second is the cooperative-productive criterion, which reflects the teacher's ability to engage in the collaborative creation of a digital product, coordinate their own contributions with those of others, and participate in the editing, alignment, and improvement of the shared result. If the first criterion captures the quality of interaction as a process, this criterion moves the assessment into the sphere of collaborative productive activity. It is precisely this criterion that allows us to determine whether the teacher is capable of working within the logic of shared authorship, rather than merely commenting, observing, or completing an isolated part of the task.

Among the main indicators of the cooperative-productive criterion, the first is involvement in the collaborative creation of a digital product. This indicator characterizes the teacher's level of activity and the substantive quality of participation in a shared document, board, presentation, spreadsheet, or other collaboratively developed resource. The second indicator is coordination of editing and management of changes, that is, the ability to work with comments, versions, clarifications, and revisions without losing the logic of the shared product and without generating chaotic changes. The third indicator concerns alignment of one's own contribution with the overall structure of the result. This refers to the ability to relate one's own materials, suggestions, or revisions to the overall goal, format, style, and substantive logic of the product, and to adapt them when necessary. The fourth indicator is the integration and adaptation of digital resources, manifested in the ability to select, reinterpret, and appropriately incorporate ready-made materials into the shared result without undermining its coherence or pedagogical appropriateness. The fifth indicator is the reflective refinement of the product, that is, the teacher's willingness to participate in the collective improvement of the result after receiving comments, engaging in discussion, or completing an interim review. Taken together, these indicators enable assessment of the extent to which the teacher can function in a mode of genuine productive collaboration, where value lies not only in an individual contribution but also in its integration into a coherent shared outcome.

The third is the organizational-projective criterion, which characterizes the teacher's ability to plan team activity, structure its stages, distribute roles, coordinate implementation, sustain the temporal logic of the process, and respond to organizational disruptions. This criterion is especially important in a digital educational environment, where the flexibility of tools and the asynchronous nature of interaction create both broad opportunities and significant risks of disorganization. For this reason, the level of development of the corresponding component is determined not by the number of services used, but by the teacher's ability to ensure the orderliness and completeness of the team process.

The key indicators of the organizational-projective criterion include, first, planning of shared activity, that is, the ability to define the goal, break it down into stages, understand the sequence of actions, and determine the logic of progress toward the result. The second indicator is the distribution of roles and functions, which reflects the ability to identify responsible participants, align functional areas, and maintain a clear structure of participation within the team. The third indicator concerns coordination of implementation stages: the ability to track the status of the task, record completed and problematic segments, and coordinate transitions between stages in a timely manner. The fourth indicator is the temporal organization of activity, which includes the ability to work with deadlines, intermediate time points, the rhythm of implementation, and maintaining the pace of teamwork. The fifth indicator is responsiveness to organizational difficulties and adjustment of the process, including the ability to notice delays, clarify agreements, revise the structure of activity, redistribute functions, or change the sequence of actions when necessary. A sixth indicator may be defined as the use of digital tools to support the structure of team activity, that is, the ability to use boards, trackers, calendars, checklists, spreadsheets, or other visualized forms of organization not formally, but in accordance with the logic of a specific task. It is precisely these indicators that enable us to assess the extent to which the teacher can ensure the organizational viability of shared digital work.

It is important to emphasize that the proposed criteria do not function as three completely isolated dimensions. They are analytically distinct, but in practice, they manifest themselves through interaction. For example, clarity in digital communication supports the coordination of work stages; the quality of editing a shared document is related to both the cooperative-productive and the communication-facilitation dimensions; and timely responses to delays combine organizational-projective and facilitative aspects. At the same time, it is precisely the differentiation by criteria that makes assessment more sensitive and methodologically sound. It allows you to see not only a general impression of the teacher’s work in a team, but also its specific characteristics.

From a methodological perspective, it is worth emphasizing that each indicator should be linked to particular forms of documentation. Thus, the indicators of the communication-facilitation criterion may be identified through the analysis of messages in chats, comments in documents, the substance of feedback, and the nature of participation in discussions. The indicators of the cooperative-productive criterion may be documented through analysis of version history, the structure of the shared product, the quality of integration of contributions, and participation in refining the result. The indicators of the organizational-projective criterion are best identified through the structure of the digital board, task statuses, the distribution of responsibility, the visibility of stages, adherence to deadlines, and the nature of responses to organizational difficulties. In this way, criteria and indicators do not remain an abstract scheme but can be linked to specific data sources, which ensures the validity of the assessment system. Particularly promising in this regard is the use of digital artifacts as an empirical basis for assessment. Revision history, comments, messages, the structure of shared boards, task statuses, and other traces of digital interaction make it possible to move from purely declarative self-description to a more objective analysis of actual teamwork behavior. This logic corresponds to the contemporary understanding of the digital environment as a space where activity not only occurs but also becomes visible for further analysis and pedagogical reflection (Echeverría et al., 2024a).

For clarity and for further use in the study, we summarized the criteria and indicators in Table 3.1. This understanding of the communication-facilitation criterion is consistent with findings from studies on the communicative competence of future professionals in the information and digital educational environment, where the quality of interaction, the structure of messages, engagement in shared discussion, and the maintenance of a productive communicative mode emerge as important indicators of professional growth.

Thus, the communication-facilitation criterion has a robust scholarly foundation and aligns with the actual logic of digital teamwork (Shuppe et al., 2024).

Table 3.1

Criteria and Indicators for Assessing Teachers' Digital Teamwork Skills

Criterion	*Criterion Content*	*Main Indicators*
Communication-Facilitation	Characterizes the teacher's ability to ensure meaningful digital interaction, sustain communication, feedback, and participants' engagement in shared activity	Initiation and maintenance of digital interaction; clarity and structure of messages; quality of feedback; facilitation of the team process; maintenance of a constructive communicative atmosphere
Cooperative-Productive	Reflects the teacher's ability to participate in the collaborative creation, editing, alignment, and improvement of a digital product	Involvement in collaborative product creation; coordination of editing and management of changes; alignment of contributions; integration and adaptation of digital resources; reflective refinement of the result
Organizational-Projective	Characterizes the teacher's ability to plan, structure, coordinate, and adjust team activity in a digital environment	Planning shared activity; distribution of roles and functions; coordination of implementation stages; temporal organization of activity; response to organizational difficulties; use of digital tools to support the structure of teamwork

Source: Authors' own work.

The relevance of the cooperative-productive criterion is likewise confirmed by studies on digital educational practices, which treat the joint development of content, collaborative editing, integration of participants' contributions, and refinement of the result as independent indicators of mature collaboration. In a digital environment, the product becomes not simply an outcome of activity but a materialized expression of how effectively the team has organized its interactions (Balova-Tzvetkova & Panayotova, 2023; Amelia et al., 2024). It is the organizational-projective criterion that most clearly links digital teamwork with

the project culture of contemporary education. Studies of the digital transformation of the educational environment show that the effectiveness of activity depends to a considerable extent on how well access to resources, technical support, coordination of work stages, and management of educational processes are organized. For this reason, the organizational-projective criterion reflects not an auxiliary, but one of the central dimensions of digital interaction (Majdi et al., 2024; Hrechanyk et al., 2024).

Thus, the system of criteria and indicators enables moving from a general description of teachers' digital teamwork skills to their concrete assessment in professionally significant situations. The proposed structure allows identifying both the overall level of development of the relevant skills and the specific manifestations of each component. It is precisely this that provides the basis for further identification of levels of development in teachers' digital teamwork skills, which is the subject of the next subsection.

3.3. Levels of Skill Development

A level-based characterization of the development of teachers' digital teamwork skills is needed not merely to complete the assessment system formally, but above all to provide a meaningful interpretation of the results obtained. If criteria and indicators enable determining the exact features by which the phenomenon under study is identified, levels enable describing the degree of its development, the stability of the corresponding actions, and the nature of their professional functioning in a digital educational environment. It is precisely through the level-based approach that assessment moves beyond the binary logic of the presence or absence of a particular skill and acquires the analytical depth that is especially important for the study of complex integrated skills.

Within our study, it is appropriate to use a four-level scale: initial, basic, advanced, and expert. Such a scale is sufficiently differentiated to reflect the gradual development of digital teamwork skills while remaining sufficiently general to avoid excessive detail, which helps preserve clarity of interpretation. Its use is consistent with the practice of applying level-based models in research on digital competence and teachers' professional

readiness, where a level is treated as an integral characteristic of the degree of development of a professional action rather than as a simple arithmetic sum of separate scores (Tzafilkou et al., 2023). For our approach, this means that each level should be described in terms of the qualitative characteristics of skill manifestation in digital teamwork.

From a methodological standpoint, it is important that the levels in this study should not be treated as rigidly separated states. They reflect the predominant mode of functioning of the skills and enable us to see the extent to which a teacher can act in a digital environment as a team member, and the degree to which those actions are independent, stable, deliberate, integrated, and productive. At the same time, in practice, individual components may be developed unevenly: for example, a teacher may demonstrate an advanced level on the communication-facilitation criterion but only a basic level on the organizational-projective criterion. This is precisely why the level-based characterization should be applied to both the overall assessment and the separate criteria.

The initial level reflects a state in which teachers' digital teamwork skills are manifested only episodically, and the actions themselves are mainly situational, unstable, and fragmented. At this level, participation in teamwork is usually reactive rather than initiative-driven. The teacher may engage in digital communication, use certain services, respond to messages, or perform basic actions in a shared document, but such participation does not yet ensure full-fledged team interaction. Communication often remains formal, feedback is brief or unclear, collaborative work on a digital product is reduced to a minimal contribution, and the organization of the team process is perceived more as an external requirement than as a conscious professional action.

The initial level is also characterized by dependence on external guidance. The teacher requires clear instructions, preassigned roles, carefully specified tasks, and ongoing support from a coordinator, facilitator, or more experienced participants. In situations of uncertainty or when independent initiation of interaction is required, such a teacher often shows passivity, difficulty, or a tendency to limit involvement to the individual completion of their own part of the work without deeper

engagement in the shared process. At this level, digital tools are used mainly instrumentally, without a sufficient understanding of their role in supporting team activity. Thus, the initial level indicates the presence of certain preconditions for digital teamwork, but not yet a developed capacity for its independent and sustained implementation.

The basic level characterizes a state in which the teacher is already able to participate in digital teamwork in typical and relatively structured situations, but their actions still lack sufficient flexibility, stability, and integration. At this level, the educator usually navigates the main channels of digital interaction, maintains work-related communication, participates in collaborative editing, follows assigned roles, and carries out tasks within a given structure. Their participation in teamwork is no longer purely formal, but it still depends largely on clear conditions, a limited range of tools, and the relative simplicity of the task.

The basic level assumes that the teacher can provide meaningful, elementary feedback, work with shared documents, take into account other participants' contributions, and follow the main organizational agreements. At the same time, noticeable difficulties remain at this level in situations that require independent facilitative intervention, more complex coordination of editing, flexible replanning of work, or team organization under changing conditions. The teacher may function productively within a clear digital structure, but is not yet always able to create or reorganize it independently. Thus, the basic level indicates the presence of functionally adequate, but still insufficiently developed, digital teamwork skills that require further strengthening and expansion in real professional practice.

The advanced level reflects a developed ability to engage in effective, relatively independent, and stable digital teamwork across a range of professionally significant situations. At this level, the teacher not only participates in shared activity but also actively supports its quality, coherence, and effectiveness. They are able to initiate and sustain meaningful digital communication, provide constructive feedback, facilitate discussion, coordinate their own contributions with those of others, work on a shared digital

product with attention to its overall logic, and follow the task's organizational structure and time parameters.

The advanced level is characterized by increasing integration of the components. The teacher no longer perceives communication, collaborative editing, and organization as separate technical actions, but acts within the logic of an integrated team process. They are able not only to use digital tools but also to select them based on the task, understand their role in supporting team interaction, respond to challenges, adjust specific stages of work, and contribute to achieving a shared result. At the same time, at this level, the teacher does not yet consistently demonstrate a high degree of leadership initiative or the ability to systematically model and improve others' digital teamwork. Thus, the advanced level indicates professionally mature, effective, and stable digital teamwork that can already serve as a foundation for more complex forms of educational leadership and facilitation.

The expert level characterizes the highest degree of development of teachers' digital teamwork skills, at which the educator not only acts confidently and effectively within a digital team environment but also consciously designs, sustains, improves, and transforms such activity in response to the professional situation. At this level, the communication-facilitation, cooperative-productive, and organizational-projective components function as an integrated system. The teacher does not merely participate in shared work, but serves as a carrier of team culture, an initiator of high-quality interaction, a facilitator of group processes, a coordinator of complex tasks, and a reflective participant in shared professional development.

The expert level is manifested in the educator's ability to adapt digital teamwork flexibly to new conditions, quickly reorganize channels of interaction, sustain the engagement of different participants, prevent organizational and communicative breakdowns, ensure the high quality of the shared digital product, and turn teamwork into a resource for the professional growth of others. At this level, the teacher demonstrates not only confident use of digital tools and stability of professional action, but also the capacity for meta-reflection, that is, reflection on the very logic of teamwork, its improvement, the generalization of experience, and the transfer of successful practices to new tasks. For this reason,

the expert level is associated not only with high effectiveness but also with a pronounced potential for distributed educational leadership.

For greater analytical clarity, a summarized level-based characterization is presented in Table 3.2.

Table 3.2
Levels of Development of Teachers' Digital Teamwork Skills

Level	*General Characterization*	*Features of Manifestation*
Initial	Skills are manifested in a fragmented, situational way, mainly under external guidance	Formal or unstable participation in digital interaction; limited contribution to the shared product; difficulties with coordination, facilitation, and process organization
Basic	The teacher is able to participate in digital teamwork in typical structured situations	Sustains basic communication; performs an assigned role; participates in collaborative editing; follows an established organizational structure, but still depends on external support
Advanced	Skills are sufficiently developed, stable, and functionally adequate for independent teamwork	Initiates and sustains meaningful interaction; coordinates contributions; works on a shared product; follows and partially adjusts the organizational logic of activity
Expert	Skills are integrated, flexible, reflective, and leadership-facilitation oriented	Designs and improves teamwork; flexibly adapts the process; sustains the quality of interaction and product; serves as a carrier of the culture of digital collaboration and distributed leadership

Source: Authors' own work.

Thus, the level-based characterization of teachers' digital teamwork skills enables not only the identification of their level of development but also the understanding of the qualitative nature of their professional participation in a digital team environment. The proposed four-level model allows assessment results to be interpreted both holistically and by component, which is especially important for analyzing the dynamics of change within the framework of a training intervention. For this reason, the next

logical step is to describe the instruments for collecting and recording data that enable the specified criteria, indicators, and levels to be identified in real or simulated professional interactions.

3.4. Instruments for Data Collection and Recording

The effectiveness of the assessment system for teachers' digital teamwork skills depends directly on the appropriateness of the instruments for data collection and recording. Since, within this study, the object of assessment is not only the teacher's perception of their own readiness for digital teamwork, but also their actual ways of acting in a shared digital environment, the instrumentarium must be multi-component and capable of combining the subjective, behavioral, and outcome-oriented dimensions of analysis. For this reason, the data collection system should be based not on a single universal instrument but on a set of complementary tools, each capturing a particular dimension of the phenomenon under study.

Within our approach, the main instruments are an adapted self-assessment questionnaire, a practical team task involving digital interaction, observation of the task performance process, and analysis of digital artifacts produced during the shared activity. This combination makes it possible, on the one hand, to take into account the teacher's reflective view of their own capabilities and, on the other hand, to compare it with actual manifestations in the digital team environment. Methodologically, this corresponds to the logic of data triangulation, in which the phenomenon under study is not reduced to a single source of information, but is examined through several interrelated channels of documentation. Such a design of the instrumentarium is especially important for the analysis of digital teamwork, where some manifestations remain hidden in general declarations and become visible only in real interaction.

The first instrument is the self-assessment questionnaire, which captures the teacher's subjective understanding of their readiness for digital teamwork. It is advisable to construct it as an adapted instrument focused specifically on team-based professional interaction rather than on general digital literacy. In

this sense, drawing on the logic of SELFIE for Teachers, as well as on frameworks of teachers' digital competence, is methodologically appropriate; however, the content of the statements must be specifically focused on the teamwork dimension. This means that the questionnaire items should not only address confidence in using digital services but also the ability to sustain digital communication, work on shared documents, coordinate contributions, follow roles, organize team processes, and respond to interaction-related difficulties.

In terms of structure, such a questionnaire may include three blocks corresponding to the identified components. The first block is aimed at self-assessment of communication-facilitation actions, including the ability to initiate discussion, provide constructive feedback, maintain a productive atmosphere, and facilitate digital interaction. The second block concerns the cooperative-productive dimension: collaborative editing, alignment of changes, adaptation of materials, and participation in refining the product. The third block covers the organizational-projective dimension: planning stages, assigning roles, meeting deadlines, coordinating the process, and addressing challenges. It is important that responses be recorded on a scale that captures the degree of a feature's expression, for example, a four- or five-point scale. In that case, the questionnaire not only provides a general picture of the teacher's self-assessment but also allows comparison of results across separate components.

At the same time, self-assessment cannot serve as the basis for a final conclusion about the level of development of digital teamwork skills. Its function is rather to identify the teacher's reflective position, their view of their own strengths, difficulties, and areas of confidence. For this reason, the second instrument, namely the practical team task, is central to the assessment system. Its advantage lies in modeling a professionally significant situation in which participants must not merely declare but actually demonstrate their digital teamwork skills. It is precisely in such a task that one can observe how the teacher communicates, responds to others' contributions, works on a shared digital product, coordinates the stages of activity, and sustains the organization of the process.

The practical task should be designed to require the simultaneous engagement of all three components. For example, participants may be asked, in micro-groups, to develop a shared educational product in a digital environment using a shared document, a digital planning board, a communication channel, and a specified time limit. It is fundamentally important that the task not be reduced to a mechanical division of parts, but rather that it requires alignment, mutual editing, decision-making, documentation of stages, and presentation of the result. In this design, the practical task becomes not merely a test of technical proficiency but a means of identifying the teacher's actual ability to act within a digital team.

The third instrument is the observation of the process of carrying out the practical task. This allows documentation of aspects of team interaction that are not always fully reflected in the final product or the self-assessment questionnaire. These include, above all, the nature of the teacher's participation in digital communication, initiative, the ability to engage others, ways of providing feedback, responses to difficulties, maintenance of the pace of work, and transitions from discussion to action. Observation should not be unstructured; it should be structured. For this purpose, it is advisable to use an observation chart or rubric that defines a list of features in advance and aligns them with the assessment criteria and indicators.

The advantage of structured observation is that it helps reduce subjectivity in interpretation. The observer records not a general impression of the participant's activity, but specific manifestations: whether the participant initiates discussion, responds meaningfully to others' messages, summarizes interim results, responds to delays, engages in collaborative editing, and sustains a constructive atmosphere. Such an approach creates a connection between theoretically defined indicators and actual behavioral manifestations. For this reason, observation should be regarded as one of the most sensitive instruments within the overall data collection system.

The fourth instrument is the analysis of digital artifacts produced during shared activity. This instrument is particularly valuable for studying digital teamwork, as the digital environment leaves substantial traces of interaction. Such artifacts include

shared documents, revision histories, comments on edits, chat records, the structure of project management boards, task statuses, calendars, responsibility tables, markers of stage completion, and the final digital product. Analysis of these materials makes it possible to trace not only the result itself, but also the logic of its creation: who made changes and how, how transparent the editing process was, how decisions were aligned, whether stages of activity were visible, and whether the team followed an organizational structure.

The analytical value of digital artifacts lies in their relative objectivity. Unlike self-description, they document actual activity, often in chronological sequence. For example, revision history in a shared document allows you to see the degree of a participant's involvement, the nature of their edits, the relationship between their contributions and those of others, and their willingness to refine the text. Comments enable analysis of feedback quality and alignment with change. The structure of a digital board or tracker provides a basis for assessing the organizational-projective dimension: the presence of stages, roles, deadlines, status markers, and responses to changes throughout the work. Thus, digital artifacts are an important source of data that combines the process-oriented and outcome-oriented dimensions of assessment.

It is especially important that all of the instruments named above should be used not in isolation, but in relation to one another. Only in this way can greater validity of conclusions be achieved. For example, if a teacher's self-assessment indicates a high level of confidence in organizing digital teamwork, but difficulties in planning stages or distributing roles are revealed during the practical task and through artifact analysis, the researcher gains grounds for a more precise interpretation of the result. Similarly, if a teacher modestly evaluates their own capabilities but demonstrates stable facilitative and cooperative actions in actual interaction, such a discrepancy also acquires analytical significance. For this reason, the data collection system should be built on the principle of complementarity among instruments.

To summarize the instrumentarium, we have presented it in Table 3.3.

Table 3.3
Instruments for Data Collection and Recording in the Assessment of Teachers' Digital Teamwork Skills

Instrument	*Purpose*	*What It Captures*
Adapted self-assessment questionnaire	Identifying the teacher's reflective view of their own readiness for digital teamwork	Perceptions of one's own ability in digital communication, collaborative editing, and organization of the team process
Practical team task	Modeling a professionally significant situation of shared digital interaction	The actual functioning of skills in the process of teamwork on a shared digital product
Structured observation	Recording behavioral manifestations during task performance	Initiative, nature of communication, facilitation, coordination of actions, response to difficulties, and maintenance of interaction
Analysis of digital artifacts	Identifying process-oriented and outcome-oriented traces of team activity	Revision history, comments, chats, board structure, task statuses, and the final digital product

Source: Authors' own work.

Thus, the proposed instrumentarium enables examination of teachers' digital teamwork skills along several complementary dimensions: as an object of self-assessment, as actual behavior during team interaction, as a way of organizing shared activity, and as the recorded outcome of that activity in a digital environment. It is precisely this design of the data collection and documentation system that ensures sufficient analytical completeness of the assessment and creates a basis for the subsequent description of the methodology for developing the corresponding skills within a training intervention.

4. Methodology for Developing Teachers' Teamwork Skills in a Digital Educational Environment

After providing a theoretical rationale for the essence of teachers' digital teamwork skills and constructing a system for their assessment, the question of how to develop this professional

construct purposefully naturally arises. Whereas the previous sections focused on conceptualizing the phenomenon, clarifying its structure, and defining the criteria, indicators, and levels of its development, this section shifts attention to the practice-oriented dimension of the study. The aim here is to design a methodology suitable for the purposeful development of teachers' digital teamwork skills within a short-term yet substantively rich format of professional preparation.

The need for a special methodology arises because digital teamwork skills do not develop automatically from using digital tools. Access to shared documents, messengers, video communication platforms, or digital boards does not in itself mean that a teacher is ready for high-quality teamwork. In practice, one often encounters situations in which educators are familiar with individual tools but experience difficulties aligning roles, maintaining meaningful communication, collaboratively editing materials, planning work stages, or facilitating digital interaction. This means that the development of the relevant skills requires not technical instruction, but specially organized activity in which digital tools function not as an end in themselves, but as an environment for the shared completion of professionally meaningful tasks.

The methodology proposed in this study is based on the understanding of digital teamwork as an integrated professional capacity formed at the intersection of the communication-facilitation, cooperative-productive, and organizational-projective components. Accordingly, its design presupposes not isolated training in separate skills, but the creation of educational-professional situations in which the teacher must simultaneously communicate, coordinate interaction, participate in the collaborative creation of a digital product, plan work stages, align actions with other participants, and reflectively interpret the results. It is precisely this integration that constitutes the core logic of the methodology.

The general idea of the methodology is that the development of digital teamwork skills occurs most productively not through explaining "how to work in a team correctly," but through involving teachers in a series of specially designed team tasks in a digital environment that models real or near-real professional

situations. In such tasks, digital tools perform not a supplementary but a functionally significant role: they are the means through which communication, role distribution, documentation of stages, collaborative product creation, commenting, clarification of changes, monitoring of progress, and presentation of results occur. For this reason, the methodology is not primarily informational or lecture-based, but rather activity-oriented, training-based, and reflective.

From a methodological perspective, the proposed approach draws on several interrelated frameworks. First is the activity-based approach, according to which professional skills develop through the subject's involvement in specially organized activity rather than through passive absorption of information. Within our study, this means that the teacher develops digital teamwork skills by carrying out team-based digital tasks rather than merely discussing them. Equally important is the competence-based approach, which focuses not on isolated actions but on the ability to act effectively in a professionally significant situation. For this reason, the methodology is oriented not toward individual service training but toward developing comprehensive readiness for digital teamwork. The social constructivist approach is also essential, as these skills develop through joint decision-making, discussion, mutual editing, and the coordination of contributions. Finally, the reflective approach is important as well, since it presupposes reflection not only on the result, but also on the process of team activity itself.

In accordance with this logic, the methodology should be aimed at solving several interrelated tasks. First, it should help teachers understand digital teamwork not as a technical activity, but as a professional one. Second, it should create conditions for teachers' actual involvement in digital team interaction. Third, it should provide opportunities to gain experience in the collaborative creation of a digital product within coordinated roles, deadlines, and responsibilities. Fourth, it should stimulate reflection on one's own actions, difficulties, and ways of overcoming them. And fifth, it should create a basis for documenting changes in the level of development of the corresponding skills.

Structurally, the methodology includes target, content, processual, and outcome-reflective blocks. The target block defines the goal and objectives of developing teachers' digital teamwork skills. The content block covers the professional actions that constitute the focus of purposeful development: communication, facilitation, collaborative creation of a digital product, planning, role distribution, coordination of stages, and responses to difficulties. The procedural block concerns the selection of formats, tools, and task types used to implement the methodology. The outcome-reflective block includes assessing changes, participants' self-analysis, generalizing the experience, and laying a foundation for further professional development.

In practical terms, the methodology is implemented through a series of training sessions that gradually increase the complexity of digital teamwork activities. Their logic lies not in the sequential study of individual tools, but in the transition from initial engagement in digital interaction to more complex forms of collaborative product creation and team-organized activity. At the same time, each session is not isolated but cumulative: new actions build on participants' previous experience while simultaneously requiring greater independence, coordination, and reflection. It is precisely this dynamic that makes it possible to speak not merely of a series of exercises, but of a coherent methodology for skill development.

In addition, an important principle in constructing the methodology is its professional relevance. The tasks offered to participants must be substantively close to the teacher's actual work. These may include designing a fragment of a course, developing an interdisciplinary task, creating the structure of a shared methodological product, developing a coordinated assessment model, preparing a digital collection of resources, or collectively planning an educational event. Such professional relevance increases not only participants' motivation, but also the validity of the methodology itself, since it allows skills to be developed in the very forms in which they will actually be applied in subsequent pedagogical activity.

A particularly important role in the methodology is played by the combination of synchronous and asynchronous interaction formats. Synchronous forms enable practice in initiating

interaction, facilitating discussion, clarifying decisions, and sustaining group dynamics. Asynchronous forms, in turn, develop skills in written digital communication, working with shared documents, documenting agreements, planning, and adhering to deadlines. It is precisely the combination of these two formats that enables the training activity to be brought closer to the real conditions of the contemporary digital educational environment, where teamwork is rarely conducted in a single mode.

Another essential feature of the methodology is its reflective support. Without a stage of reflection, even well-organized teamwork may amount to only a completed task, lacking sufficient professional growth. For this reason, after each training stage, it is advisable to include a brief individual and group reflection during which participants analyze what helped or hindered their teamwork, which digital tools proved most functional, what difficulties arose in coordination, how each person’s role in the team changed, and what requires further improvement. Such a reflective component strengthens awareness of professional development and ensures a connection between the completed activity and its further transfer into real pedagogical practice.

Thus, within our study, the methodology for developing teachers’ teamwork skills in a digital educational environment is understood as a purposeful, structured, and professionally oriented system of training activity built on the integration of digital tools, team tasks, reflection, and assessment. Its purpose is not merely to activate separate digital skills, but to develop the teacher’s integrated capacity for meaningful, productive, and well-organized teamwork in a digital educational environment. The next stage of the discussion should focus on specifying the principles underlying this methodology, as these principles determine its internal logic and ensure the coherence of its practical implementation.

4.1. Principles for Constructing the Methodology

The effectiveness of a methodology for developing teachers’ teamwork skills in a digital educational environment depends to a large extent on the principles underlying it. It is precisely these principles that define the methodology's internal logic and ensure

alignment among its goals, content, organizational formats, instruments, and assessment methods. Without clearly defined principles, even a substantively rich system of training sessions risks becoming a set of separate activities that fail to produce an integrated professional outcome. For this reason, our study's methodology is built on a set of interrelated principles that reflect the nature of teachers' digital teamwork as an integrated professional phenomenon.

The first and foundational principle is professional relevance. Its essence lies in the fact that the development of digital teamwork skills should be based on tasks and situations that are substantively close to the teacher's actual activity. The issue is not abstract teamwork training "in general," but the development of the ability to interact in a digital environment to solve professionally significant pedagogical tasks. These may include collaborative lesson planning, creation of methodological materials, development of an interdisciplinary task, preparation of a digital educational resource, alignment of assessment criteria, or organization of an educational project. Such an orientation ensures not only participants' motivation, but also a high likelihood that the acquired skills will later be transferred into real practice.

The second principle is activity orientation. Digital teamwork skills cannot be developed solely through explanation, demonstration, or discussion. They develop through direct participation in shared digital activity, when the teacher must not only understand the logic of team interaction, but also actually carry it out: communicate, negotiate, work on a shared product, coordinate contributions, respond to difficulties, and follow roles and deadlines. For this reason, the methodology must be organized as a system of actions rather than as a set of messages about actions. This principle ensures a connection between professional learning and the participant's actual behavior in a digital team environment.

The third principle is integration of components. The previous sections showed that teachers' digital teamwork skills include communication-facilitation, cooperative-productive, and organizational-projective components. In real professional practice, these components do not function separately, but

manifest themselves in interaction. For this reason, the methodology should not be structured as a sequence of isolated exercises for separate micro-skills. Instead, it should create situations in which the participant simultaneously communicates, organizes, coordinates, collaborates on a product, and reflects on shared work. It is precisely this integration of components that brings the training activity closer to the real nature of teachers' digital teamwork.

The fourth principle is phased progression and gradual increase in complexity. The development of digital teamwork skills does not occur all at once. It requires movement from simpler forms of participation to more complex ones, from reliance on external organization to greater independence, and from carrying out individual roles to understanding the overall logic of the team process. For this reason, the methodology should provide for a gradual increase in task, tool, and interaction complexity. At the initial stages, it is advisable to focus on involving participants in digital communication and basic coordination, then move on to the collaborative creation of a digital product, and only after that proceed to more complex forms of organization, facilitation, and reflective improvement of the process. Such a principle allows avoiding overload while ensuring development rather than mere repetition of similar actions.

The fifth principle is instrumental appropriateness. Within the methodology, digital tools should be used not for the sake of demonstrating their technical capabilities, but in accordance with the logic of a specific team task. This means that the choice of a shared document, digital board, communication channel, task tracker, calendar, or other service should be functionally justified. An excessive number of tools or their purely formal use may complicate activity rather than support skill development. Thus, the methodology should teach not only how to use services, but also how to select them in light of the goal, structure, and type of teamwork. This is what brings digital training closer to the real conditions of pedagogical practice.

The sixth principle is collaborative product creation. Teacher teamwork in a digital environment should be oriented toward a concrete, jointly created result with professional value. Without this, interaction may remain communicatively active but

professionally unproductive. For this reason, the methodology should include tasks in which the shared digital product is not a secondary byproduct, but the central outcome of team activity. This makes it possible to connect interaction with responsibility for the result and to move teamwork from the level of discussion to that of real professional collaboration.

The seventh principle is distributed responsibility and role flexibility. Team activity becomes productive when participants understand both the shared goal and their own function in achieving it. At the same time, the contemporary digital environment requires not rigid role fixation, but the ability to shift or combine roles as work progresses. For this reason, the methodology should provide both a clear role definition within the team task and the possibility of role variation. The same teacher may, in different situations, act as an initiator, moderator, editor, coordinator, or performer of a particular stage. It is precisely this role dynamic that contributes to the development of deeper experience in teamwork and brings the learning situation closer to actual professional practice.

The eighth principle is reflective support. The development of digital teamwork skills is impossible without participants reflecting on their own experiences. The completion of a task does not in itself guarantee professional growth if no analysis is made of how the interaction was organized, what difficulties arose, which decisions proved effective, where the team lost momentum or coherence, and what requires improvement. For this reason, the methodology should include both individual and group reflection after completing tasks. Such reflection helps transfer experience from the level of situational action to the level of a conscious professional skill.

The ninth principle is the combination of synchronous and asynchronous interaction. Real digital teamwork among teachers is rarely limited to only one format. Some decisions are made during synchronous discussion, while others are implemented asynchronously through shared documents, comments, task boards, or correspondence. For this reason, the methodology should include both formats. This makes it possible to develop different aspects of the skills: the synchronous format is more supportive of facilitation, dynamic communication, and rapid

alignment, whereas the asynchronous format contributes to the development of written digital interaction, planning, documentation of agreements, and coordination of contributions over time. The combination of these two modes makes the methodology more viable and realistic.

The tenth principle is developmental assessment. Within the methodology, assessment should not be reduced merely to control or the final recording of the result. It should help participants see the dynamics of their own development, understand their strengths and problematic areas, relate their own activity to clear criteria, and gain a basis for further improvement. For this reason, assessment should be embedded in the methodology's logic and combine self-assessment, external observation, artifact analysis, and reflective interpretation of changes. In that case, it performs not only a diagnostic, but also a learning function.

The eleventh principle may be defined as the principle of variability in team tasks. Teachers' digital teamwork can be realized in various professional situations: developing materials, planning an event, preparing a joint project, organizing an assessment, creating a digital resource collection, or designing a lesson model. For this reason, the methodology should include tasks that vary in content and organizational form so that participants do not merely rehearse the same pattern, but gain experience in transferring their skills to different pedagogical situations. This increases the stability of the developed skills and reduces the risk of tying them to a single work format.

Finally, the twelfth principle is the principle of safe professional interaction. Teachers' digital teamwork requires not only tools and tasks, but also a learning space in which participants are not afraid to propose ideas, ask clarifying questions, acknowledge difficulties, respond to comments, and revise their own decisions. If interaction is built on a foundation of tension, competition, or evaluative pressure, it constrains genuine skill development. For this reason, the methodology should ensure respectful communication, mutual regard, visibility of each participant's contributions, and the understanding that mistakes are not failures but resources for growth. Such an atmosphere is a necessary condition for facilitation, team reflection, and productive digital collaboration.

Thus, the principles for constructing the methodology reflect not merely separate organizational preferences, but the internal logic of developing teachers' digital teamwork skills. Professional relevance, activity orientation, integration of components, phased progression, instrumental appropriateness, orientation toward a shared product, distributed responsibility, reflective support, the combination of interaction formats, developmental assessment, variability, and a safe professional atmosphere together form a coherent methodological foundation that ensures the practical effectiveness of the proposed system. It is on the basis of these principles that a more concrete description of digital tools, organizational formats, and the series of training sessions through which the methodology for developing teachers' teamwork skills in a digital educational environment is implemented can be further elaborated.

4.2. Digital Tools as a Means of Developing Team Interaction

Within the proposed methodology, digital tools should be viewed not as an independent goal of training, but as a means of organizing, sustaining, and developing teachers' teamwork. This approach is fundamentally important because, in professional training practice, one often observes a shift of emphasis from pedagogical appropriateness to the technical mastery of services. As a result, teachers may become quite confident in using specific platforms while still lacking experience in meaningful digital collaboration. For this reason, within our study, a digital tool is understood not as an object of learning in itself, but as a functional element of shared activity that should support communication, coordination, collaborative product creation, role distribution, and reflective interpretation of the process.

Under this understanding, the selection of tools is determined not by their popularity or by the number of available features, but by their ability to support a particular type of team action. One tool may be more appropriate for synchronously aligning decisions, another for asynchronous collaborative editing, and still another for visualizing work stages, distributing tasks, and tracking the team's progress. Thus, digital tools within the methodology's structure perform not only technical but also

organizational, communicative, productive, and analytical functions. It is precisely their functional differentiation that enables the construction of a coherent environment for the development of teachers' digital teamwork skills.

First, it is useful to distinguish between digital communication tools that support synchronous and asynchronous interaction among team members. This group includes video communication platforms, group chats, messaging channels, forums, commenting tools, and other services through which information is exchanged, tasks are clarified, feedback is provided, and working contact is maintained. Their role in the methodology is not simply to ensure connection among participants, but to create conditions for the development of the communication-facilitation component. It is through these tools that teachers learn to initiate discussion, formulate proposals, maintain a productive tone of interaction, summarize results, ask clarifying questions, and move discussion toward concrete agreements.

It is especially important that digital communication tools enable different modes of interaction. Synchronous means, in particular, videoconferencing and voice-based discussion, are appropriate for rapid alignment of positions, facilitating discussion, presenting interim results, and maintaining team dynamics. Asynchronous means, such as chats, comments, or forums, foster a different type of professional behavior: precision in written formulation, the ability to document decisions, maintaining the logic of discussion over time, and responding to colleagues' messages without all participants being present simultaneously. It is precisely the combination of these formats that enables the development of communicative flexibility, which is necessary in the contemporary digital educational environment.

The second important group consists of tools for the collaborative creation and editing of a digital product. These include cloud-based text documents, presentations, spreadsheets, shared folders, visual design services, and other platforms that allow several participants to work on a single resource. This group of tools is central to the development of the cooperative-productive component. They create the conditions for team interaction to have not only a communicative, but also a substantive character. Through work with such services, teachers

learn to align the structure of the product, coordinate editing, track changes, incorporate comments, adapt their own contributions to the overall logic of the result, and treat the shared digital resource as an object of collective responsibility.

The advantage of this group of tools is that they enable combining the process- and outcome-oriented dimensions of activity. On the one hand, participants create a specific product; on the other hand, the process of its creation becomes visible: one can trace the revision history, see comments, identify the nature of each participant's contribution, and document the dynamics of editing. Within the methodology, this has a dual significance. First, such tools provide a real space for the development of shared authorship. Second, they create a basis for subsequent assessment and reflection. Participants can not only complete the product but also analyze exactly how they arrived at it.

The third group consists of tools for organization and project management, including digital boards, task trackers, calendars, checklists, role-distribution tables, visual maps of activity stages, and similar resources. Their use within the methodology is especially important for the development of the organizational-projective component. With the help of such tools, team activity acquires a clear structure: the work stages, participants' roles, deadlines, current task status, and the interdependence of individual actions become clear. From a methodological perspective, this makes it possible not merely to talk about the importance of planning, but to embed planning directly into participants' activity.

Digital boards and trackers are especially valuable because they enable visualization of the teamwork process. This reduces the risk of vague agreements and helps participants see not only their own segment, but also the overall logic of the shared task. Within the training methodology, such tools are appropriately used to define the stages of a team task, record roles, mark deadlines, track progress, respond to delays, and conduct reflective analysis of the process after the work is completed. In this way, the digital environment becomes not only a space of activity, but also a space for organizing activity, which is especially important for teachers who do not yet have stable experience in digital teamwork.

The fourth group consists of tools for visualization and collective structuring of ideas, including digital boards for brainstorming, idea mapping, collaborative grouping of content, presentation of solution options, and modeling of the structure of the future product. Within the methodology, these tools perform an intermediate but very important function. They connect communication with design, help the team move from chaotic discussion to a shared structure, facilitate the inclusion of all participants, and create conditions for a shared understanding of the task. It is through these tools that teachers can learn to align content, visually record ideas, see connections among elements, and collectively develop a model of the future result.

Such tools are especially appropriate at the initial and intermediate stages of teamwork, when the team is still forming a shared vision or searching for the optimal structure of the future product. From a methodological standpoint, they are valuable because they lower the threshold for entering team interaction: it is easier for participants to join the work through short visual notes, markers, blocks, and diagrams than to move immediately to a complex text-based or project document. In this way, visualization tools support not only productivity but also engagement, which is important for the development of the communication-facilitation component.

A separate group consists of tools for documentation, analysis, and reflection, which enable returning to completed team activities and interpreting them. These may include revision histories, activity logs, comments, digital traces of participation, brief reflection forms, electronic observation journals, or self-analysis templates. Their significance within the methodology lies in their role in turning digital activity into an object of professional analysis. The teacher gains the opportunity to see how interaction unfolded, where difficulties arose, what their participation in the shared work looked like, and whether the chosen tools and coordination methods were effective. This analytical dimension is necessary because teamwork skills develop not only through action, but also through reflective interpretation of that action.

From a methodological point of view, it is important to emphasize that no instrument in itself guarantees the development of the relevant skills. What is decisive is how it is

incorporated into the team task. For example, a shared document may remain merely a place to exchange fragments of text if the team does not work to align the logic and structure. A digital board may become a mere collection of notes if it is not used for actual planning and role distribution. A chat may be full of messages yet professionally ineffective if communication does not lead to decisions or support shared activity. For this reason, the methodology's instrumental richness must be combined with a clear pedagogical logic for each service.

In this connection, it is useful to speak not of separate digital tools, but of a functionally organized digital environment for team interaction. Within the methodology, this environment should include at least four interrelated zones: a communication zone, a collaborative product-creation zone, a process-organization zone, and a reflection zone. Such an approach enables teachers not only to master services but also to see the architecture of digital teamwork as an integrated professional process. It is precisely this that brings the methodology closer to the real conditions of the contemporary educational environment, where professional interaction almost always unfolds simultaneously across several digital spaces.

For clarity and synthesis, it is useful to present the groups of digital tools in a table (Table 4.1).

Table 4.1
Groups of Digital Tools in the Methodology for Developing Teachers' Teamwork Skills

Group of Tools	*Function in the Methodology*	*Examples of Use*
Digital communication tools	Support synchronous and asynchronous interaction, feedback, and facilitation of discussion	Video meetings, group chats, comments, forums, messaging channels
Tools for collaborative creation and editing of the product	Support cooperative-productive activity, shared authorship, and alignment of changes	Cloud-based documents, presentations, spreadsheets, shared folders, and collaborative editing services

Tools for organization and project management	Support planning, role distribution, coordination of stages, and control of deadlines	Digital boards, task trackers, calendars, checklists, and responsibility tables
Tools for visualization and collective structuring of ideas	Help jointly model ideas, structure content, and develop a shared vision	Digital brainstorming boards, idea maps, visual schemes, shared notes
Tools for documentation, analysis, and reflection	Make it possible to interpret the process of team activity and assess its effectiveness	Revision histories, digital artifacts, observation logs, self-analysis forms, and reflection templates

Source: Authors' own work.

Thus, within the proposed methodology, digital tools function not as isolated technical means, but as a functionally organized environment for developing teachers' digital teamwork skills. Their use enables the integration of communication, collaborative product creation, process organization, and reflective interpretation of activity within a unified logic of professional interaction. This provides a basis for moving to a concrete description of the series of training sessions in which these tools are used to purposefully develop the corresponding skills.

4.3. Organization of the Training Series

The practical implementation of the methodology for developing teachers' teamwork skills in a digital educational environment within our study was carried out through a series of three weekly training sessions. This format was chosen in view of the need to combine the intensity of professional immersion with the possibility of gradually increasing the complexity of activity, conducting intermediate reflection, and documenting change. Unlike one-time introductory sessions, a series of interconnected trainings not only stimulates interest in digital team interaction but also creates conditions for the consistent development of individual skill components, their integration, and their testing in real or near-real professional situations.

The logic of organizing the training series was based on a gradual transition from initial involvement in digital team

interaction to more complex forms of collaborative product creation and organization of the team process. At the same time, each training session served a relatively independent function while remaining connected to the previous and subsequent ones. This sequence enabled the construction not of a fragmented set of exercises but of a coherent training pathway in which participants gradually moved from mastering individual forms of digital interaction to the integrated application of the communication-facilitation, cooperative-productive, and organizational-projective components.

The overall goal of the training series was to create conditions for the purposeful development of teachers' digital teamwork skills by involving them in shared professionally oriented activity using digital tools for communication, coordination, collaborative editing, and project management. This goal was specified through several objectives. First, it was necessary to activate participants' understanding of digital teamwork as a professional rather than merely a technical practice. Second, it was important to ensure experience in meaningful digital communication and in facilitating interaction. Third, conditions had to be created for the collaborative development of a digital product in a team-based mode. Fourth, the series was intended to develop initial or more advanced experience in planning, role distribution, coordination of stages, and monitoring of team progress. Fifth, it aimed to stimulate reflective analysis of participants' own roles, difficulties, and results in shared digital activity.

Organizationally, the training series involved teachers working in small groups, ensuring each participant had sufficient involvement in the team activity. It was precisely the micro-group format that was chosen as the most suitable for modeling real shared work, in which each participant makes a visible contribution while also bearing responsibility for the overall result. In addition, work in small groups facilitated observation, analysis of digital artifacts, and subsequent comparison of individual and group manifestations of the skills. In terms of structure, each training session combined a brief introductory stage, a main team task in a digital environment, intermediate points for alignment of actions, and a concluding reflective block.

The content of the training series was designed in accordance with the internal logic of skill development. The first training session focused primarily on the communication-facilitation component. Its task was to involve participants in meaningful digital interaction and to foreground the need for clear communication, constructive feedback, and coordination of discussion. At this stage, it was important not to overload participants with excessive complexity in either the product or the organizational scheme, but to create conditions for an initial understanding that even basic teamwork in a digital environment requires not spontaneous message exchange but structured professional interaction.

The second training session shifted the focus to the cooperative-productive component. At this stage, participants moved from a predominantly communicative mode to the collaborative creation of a digital product, requiring alignment of contributions, coordination of editing, adaptation of materials, and collective refinement of the result. An important feature of the second training was that participants were already building on their previous experience of digital interaction, but now had to act under conditions of greater substantive density and responsibility for the shared result. This made it possible not only to develop the capacity for cooperative work but also to reveal the connection between the quality of communication and the quality of the shared product.

The third training session was aimed at integrating all three components, with a stronger emphasis on the organizational-projective dimension. At this stage, it was no longer sufficient merely to communicate or collaboratively edit a document. Participants had to plan activity stages, assign roles, document tasks, monitor deadlines, and coordinate the team’s progress using digital boards or other project management tools. This training served an integrative function, enabling participants to observe the extent to which they could combine meaningful communication, productive collaborative creation of a result, and the organizational structuring of the process within a coherent model of digital teamwork.

The forms of work used in the training series were selected to align with the content of each stage, but guided by a shared

logic. First and foremost, this involved work in micro-groups on a professionally oriented digital task. It was precisely this format that enabled the real interdependence of participants' actions and laid the basis for the manifestation of the skills under study. In addition, mini-discussions in a shared synchronous format were used, during which teams clarified their approach to the task, presented interim solutions, or received general guidance. An important place was also given to asynchronous digital interaction, in which participants worked with shared documents, comments, boards, spreadsheets, or other resources without constant simultaneous presence. Reflective discussion should also be mentioned separately, as it concluded each training session and was aimed at interpreting experience rather than merely summarizing formal results.

From a methodological perspective, it is important that within the training series, digital tools were used not as a topic for explanation, but as the immediate environment for action. Participants did not complete a separate instructional block devoted to the technical capabilities of the services, but instead worked with them as they carried out the team task. This made it possible to connect each tool directly to its function in team interaction. For example, a shared document was used not only for entering text but also for coordinating contributions and editing. A digital board served not only for visualizing ideas but also for planning and distributing roles. A communication channel performed not merely an informational function but also served as an environment for facilitating, clarifying, and documenting decisions. Such an approach strengthened the connection between training activity and real professional practice.

An essential feature of the training organization was the inclusion of intermediate checkpoints for alignment. This meant that teams did not simply receive a task and report a finished result, but also passed through several moments of pause during which they had to briefly align the current state of the work, identify difficulties, or adjust the plan. These checkpoints were especially important for the development of the organizational-projective component, because they trained participants to view team activity not as a spontaneous process, but as a sequence of stages requiring coordination. At the same time, they created

opportunities for individual participants' facilitative actions to emerge and provided natural conditions for observing the dynamics of teamwork.

No less important was the reflective component of each training session. After completing the main team task, participants had the opportunity to briefly reflect on how the interaction unfolded, which tools proved most functional, what was difficult to coordinate, how roles were distributed, what communicative difficulties arose, and how the team addressed them. In this way, the training acquired not only a practical, but also an analytical character. This is especially important for teachers, since professional development in digital teamwork involves not only accumulating experience but also understanding its structure and transferring it into subsequent practice.

To better systematize the training series, we present them in Table 4.2.

Table 4.2

General Characteristics of the Training Series for Developing Teachers' Digital Teamwork Skills

Training	*Main Focus*	*Content Orientation*	*Leading Forms of Work*
Training 1	Communication-facilitation component	Engagement in digital interaction, meaningful communication, feedback, and initial coordination of actions	Work in micro-groups, synchronous discussion, digital communication, and brief reflection
Training 2	Cooperative-productive component	Collaborative creation of a digital product, coordination of editing, alignment of contributions, refinement of the result	Work with shared documents, team editing, asynchronous interaction, and discussion of the result
Training 3	Integration of components with an emphasis on the organizational-projective dimension	Planning, role distribution, coordination of stages, use of digital boards and trackers, and completion of the team task	Project-based work in micro-groups, digital task management, intermediate alignment points, and final reflection

Source: Authors' own work.

Thus, the series of three weekly training sessions was organized as a coherent system of professionally oriented team tasks within which participants gradually moved from initial involvement in digital interaction to integrated digital teamwork. Such an organization made it possible not only to support the development of individual components of the relevant skills, but also to create conditions for their combination into a coherent professional experience. The next stage of the discussion requires a more specific description of the content of each training session, as this is what allows the internal logic of the methodology to be shown at the level of practical implementation.

4.3.1. The First Training Session

The first training session within the proposed methodology performed both an introductory-activation function and a foundational formative function. Its main purpose was not merely to familiarize participants with the logic of the subsequent work, but above all to involve them in real digital team interaction, where communication functions not as a secondary background element, but as the central mechanism for organizing shared activity. For this reason, the main emphasis of the first training session was on developing the communication-facilitation component, in particular the ability to initiate digital interaction, sustain meaningful discussion, provide constructive feedback, coordinate shared actions, and move from message exchange to an agreed decision.

The methodological relevance of such a starting point is determined by the internal logic of the development of digital teamwork skills. Without a well-formed foundation in digital communication and basic coordination of interaction, the subsequent transition to collaborative product creation and to more complex organizational-projective actions is ineffective. If participants are unable to negotiate, clarify the meaning of a task, respond to colleagues' messages, maintain the flow of discussion, and document preliminary agreements, shared activity quickly becomes chaotic or formal. For this reason, the first training session was designed as a space for practicing the basic logic of digital team interaction.

The goal of the first training session was to create conditions for acquiring an initial integrated experience of digital team communication, within which teachers could understand the importance of message structure, the quality of feedback, the role of facilitation, and the need to coordinate actions in a shared digital environment. This goal was specified through several tasks. First, it was necessary to activate participants' understanding of the difference between ordinary digital communication and professionally organized digital team interaction. Second, the training was intended to develop experience in meaningful discussion of a shared task in a small group. Third, it was meant to create conditions for the emergence and initial mastery of facilitative actions, such as clarifying the goal, summarizing, maintaining engagement, and documenting interim decisions. Fourth, it aimed to lead participants to understand that even at an initial level, digital teamwork requires alignment not only of content, but also of the mode of interaction.

The substantive basis of the training was a professionally oriented team task that did not require an overly complex final product but did require active digital communication, shared discussion, and coordinated action. It was advisable for such a task to have clear pedagogical content, for example, creating a short shared plan for an educational activity, agreeing on the structure of a small methodological product, generating a list of digital solutions for a particular professional situation, or constructing an agreed model of team action in response to a given case. What was essential was that the team should not merely discuss the issue, but arrive at a specific agreed result documented in digital form. Such a task design ensured a connection between communication and a minimal shared product, while avoiding overload from excessive complexity in editing or project management.

Structurally, the first training session consisted of several successive stages. At the initial stage, a brief introductory orientation was provided, during which the purpose of the training, the general rules of team interaction, the time frame, and the digital tools to be used were outlined. It was important that, at this stage, the emphasis be placed not on the technical description of the services, but on the functional role of each service.

Participants needed to understand which tool was used for communication, which for documenting the shared result, and which for brief intermediate alignments. Such an introduction established the framework for the entire session and immediately oriented participants toward perceiving the digital environment as a space of professional interaction rather than merely a set of services.

The second stage involved direct work in micro-groups. At this point, participants received a shared task and began discussing it through the designated digital interaction channel. For the development of the communication-facilitation component, it was important at this stage not to interfere excessively in the team's internal work, but to allow the group to develop its own mode of interaction. This made it possible to reveal the participants' natural communication strategies: who takes the initiative, who tends to wait for instructions, how proposals are formulated, the character of responses to others' messages, and whether there are attempts to summarize positions or document agreements. At the same time, the training moderator could provide brief guidance if the team lost focus too quickly or shifted into chaotic message exchange without moving toward a result.

The third stage involved an intermediate alignment point, during which groups were asked to briefly present the current state of their work or record what they had already achieved. This stage had a dual significance. First, it created a natural point for facilitation, since participants had to summarize the interim result and relate it to the initial task. Second, it was precisely here that the difficulties of digital coordination became visible: unclear wording, lack of documentation of decisions, uneven participation of individual team members, and an excessive tendency toward parallel individual solutions. In this way, intermediate alignment performed not only an organizational but also an instructional function, helping participants see that digital teamwork requires specific attention to the communication mode.

The fourth stage involved completing the team task and presenting the agreed digital result. Within the first training session, this result was intended to be compact and functional. Its value lay not so much in its scope or complexity, but in the fact

that it was the outcome of a shared communicative process. It was at this stage that participants could see to what extent their discussion had led to a genuine shared decision, whether the result was genuinely agreed upon, and whether it still retained traces of individual fragments that had not been integrated. This made it possible to shift attention from the mere fact of communication to its effectiveness.

The final stage of the first training session was reflective. Participants were invited to reflect briefly on how their digital team interactions had occurred, what had facilitated or complicated the shared work, who and how had supported the team's progress, how agreements had been documented, how clear the messages had been, and whether there had been enough constructive feedback. For this purpose, short written responses, electronic reflection forms, or a brief oral discussion in the whole group could be used. The methodological significance of this stage lies in participants' beginning to view their own digital communication as an object of professional analysis rather than a neutral accompaniment to task completion.

Given the content of the first training session, the main activities were micro-group work, synchronous and asynchronous elements of digital communication, brief intermediate alignment points, and a final reflection. It was precisely this combination that enabled the creation of a natural setting for the manifestation of the communication-facilitation component. Within this training, the goal was not to achieve a high level of complexity in either the digital product or project organization. Instead, the main focus was on enabling participants to experience real interdependent communication and to see how the quality of that communication affects the overall result of teamwork.

From a didactic perspective, the first training session served not only as a starting point but also as a diagnostic and orienting stage. It was during this session that participants' initial characteristics of digital team behavior became visible: tendency toward initiative or passivity, dominance or avoidance of participation, orientation toward meaningful discussion or toward formal messaging, capacity for brief facilitative intervention, and willingness to document decisions. This, in turn, made it possible to better understand which difficulties should be addressed in the

following training sessions, where teamwork would take on a more productive and organizationally complex character.

A summary of the structure of the first training session is presented in Table 4.3 below.

Table 4.3
General Characteristics of the First Training Session

Parameter	*Characteristic*
Title	Digital Communication and Coordination of Interaction
Main focus	Development of the communication-facilitation component
Goal	Development of experience in meaningful digital interaction, coordination of discussion, and initial facilitation of the team process
Main tasks	Initiating digital communication; sustaining discussion; providing feedback; documenting agreements; coordinating shared actions
Leading forms of work	Micro-group work, synchronous and asynchronous digital communication, intermediate alignment, and reflection
Expected result	An agreed digital mini-product and initial experience of structured team interaction in a digital environment

Source: Authors' own work.

Thus, the first training session aimed to lay the foundation for digital teamwork: meaningful communication, coordinated interaction, and initial facilitative actions. It created the conditions for moving from general ideas about digital collaboration to actual experience in team discussions and decision alignment in a digital environment. It was precisely this experience that became the basis for the second training session, within which the emphasis shifts from primarily communicative interaction to the collaborative creation of a digital product.

4.3.2. The Second Training Session

The second training session within the proposed methodology aimed to develop the cooperative and productive component of teachers' digital teamwork skills. If the first training session ensured participants' entry into meaningful digital interaction and highlighted the need for clear communication and initial coordination of actions, then at the second stage, the emphasis shifted to the collaborative creation of a digital product,

alignment of contributions, editing of a shared resource, and work with comments and revisions. It was precisely this stage that was needed for the transition from a team as a group that discusses to a team as a group that jointly produces a result in a digital environment.

The methodological relevance of the second training session stems from the fact that teachers' digital teamwork reaches professional completeness only when communication develops into productive collaboration. In contemporary pedagogical practice, this aspect is often lacking: teachers may communicate actively in a digital space, exchange ideas, and discuss possible solutions, yet still lack well-developed experience in collaboratively creating a material or shared document where the task is not merely to express an opinion, but to integrate one's own contribution into a coherent product. For this reason, the second training session was designed so that participants would face the need not only to negotiate, but also to work on a shared digital object, aligning changes in style, structure, and the overall logic of the result.

The goal of the second training session was to create conditions in which teachers could gain experience in collaboratively creating a digital product through team interaction, including coordination of editing, alignment of content, work with versions and comments, and collective refinement of the result. This goal was specified through several tasks. First, participants had to shift from predominantly communicative interaction to cooperative, productive activity. Second, it was necessary to develop experience in collaboratively editing a digital resource under conditions of open contribution by several participants. Third, it was important to highlight the significance of aligning changes, using comments appropriately, and understanding one's own contribution within the integrity of a shared result. Fourth, the training session was intended to lead participants to recognize that the quality of a shared digital product depends not only on individual proficiency but also on the ability to work within the logic of shared authorship.

As the substantive basis of the second training session, it was advisable to choose a team task that required the creation or substantial refinement of a professionally meaningful digital

material. This could include a collaboratively designed fragment of methodological recommendations, the structure of an integrated task, a template for a digital educational resource, a presentation for an instructional event, a curated set of materials with comments and an agreed logic of use, or a model for assessing a particular educational activity. It was essential that the product possess internal coherence and that the team not merely add separate fragments mechanically, but align structure, content, format, and mode of presentation. Only under such conditions does digital editing become a genuinely cooperative and productive activity.

Structurally, the second training session also consisted of several successive stages. At the first stage, a brief introductory orientation was provided, during which participants were informed about the task's content, the requirements for the shared product, the time frame, and the digital tools to be used. Unlike the first training session, the main emphasis here was placed on the rules of collaborative editing: the need to document the logic of changes, to use comments not only for remarks but also for aligning decisions, to take into account the contributions of others, and not to disrupt the coherence of the shared document through spontaneous or uncoordinated revisions. Thus, even before work began, the team received guidance not only on the task's content but also on the culture of shared digital authorship.

The second stage involved direct work in micro-groups on the shared digital product. It was here that participants moved into collaborative editing, adding elements, structuring content, commenting on each other's work, and aligning changes. At this stage, it was especially important to observe how the team organized its work. Some groups might choose a parallel model, in which each participant took responsibility for a separate segment, followed by later alignment. Others might work in a sequential editing mode, in which one participant creates the initial framework, and the others supplement and revise it. A mixed format was also possible. Methodologically, what mattered was not so much which model the team chose, but whether it could maintain the product's coherence and the transparency of interaction during its collaborative creation.

The third stage was followed by an intermediate review of the product's state and a brief alignment on the next steps. This stage had particular value for developing version management skills and coordinating editing. It was precisely here that participants could encounter typical difficulties: duplication of content, excessive fragmentation of the text, inconsistency of style, lack of alignment among separate parts, or the need to shorten or redistribute material. At such a moment, the team had to do more than simply notice these problems. It had to jointly develop a way to resolve them. In this way, intermediate alignment served not merely as a checkpoint, but as a learning moment in which the connection between communication, collaborative editing, and the quality of the result became visible.

The fourth stage involved the final refinement of the product. At this step, it was important not to rush toward the final form, but to ensure collaborative editing based on comments, clarifications, and interim analyses already received. It was here that the cooperative-productive component appeared most clearly in its more developed form: participants did not merely add their own elements, but returned to material already created, improved it, aligned the final logic with the team, and assumed responsibility for the coherence of the result. Particular attention was appropriately paid to whether teachers could perceive the shared product as collective rather than as a sum of individual parts, each defended only by its author.

The fifth stage had a presentation-reflective character. Teams presented the digital product they had created and briefly explained how collaborative editing had been organized, which tools had proven most functional, the difficulties they had encountered in aligning changes, and whether they had needed to revert to earlier versions or revise the material’s structure. Such a presentation was important not only as a demonstration of the result, but also as a way to make the process of shared digital authorship itself visible. It was at this stage that participants began to understand that a high-quality digital product in team-based work results not only from content competence but also from a culture of editing, alignment, and shared responsibility.

From a methodological perspective, the second training session had several fundamentally important features. First, it

enabled the team to shift its work from a predominantly communicative level to joint action on a digital object. Second, it made visible the phenomenon of version management, which in ordinary practice often remains spontaneous or underestimated. Third, it demonstrated that cooperation in a digital environment cannot be reduced to the technical possibility of editing one document, but requires alignment of structure, transparency of revisions, meaningful commenting, and shared decision-making regarding the product. It was precisely this set of actions that constituted the content of the cooperative-productive component, the development of which stood at the center of the second training session.

In terms of work formats, the leading forms included micro-group activity on a shared document or another digital resource, use of comments and suggestion mode, brief intermediate alignment points, and a final presentation with elements of reflection. When needed, synchronous interaction could be combined with an asynchronous stage between parts of the training, allowing participants to refine the product outside the immediate meeting. This brought the work format even closer to real pedagogical practice, where collaborative creation of digital materials often continues over time and requires a combination of different modes of interaction.

It is equally important that the second training session also perform a diagnostic and prognostic function with regard to the transition to the third stage. It was during collaborative product creation that it became clear to what extent participants were ready not only to interact, but also to organize activity as a process: who was able to track the logic of the work, who coordinated editing, who tended to assume the role of integrator, and who required a clearer external structure. This laid a natural foundation for the third training session, which focused on project management, role distribution, and stage coordination in a digital environment.

To summarize the content of the second training session, it is presented in Table 4.4.

Table 4.4
General Characteristics of the Second Training Session

Parameter	*Characteristic*
Title	Collaborative Content Creation and Version Management
Main focus	Development of the cooperative-productive component
Goal	Development of experience in collaborative creation of a digital product, coordination of editing, alignment of changes, and collective refinement of the result
Main tasks	Engagement in shared digital authorship; work with a shared document; alignment of contributions; use of comments and revisions; maintaining the coherence of the shared product
Leading forms of work	Micro-group work on a shared product, team editing, intermediate alignments, presentation of the result, and reflection
Expected result	A collaboratively created digital product and developed experience of cooperative interaction under conditions of open editing and alignment of versions

Source: Authors' own work.

Thus, the second training session was aimed at developing teachers' ability to act within the logic of shared digital authorship, align contributions, work with revisions, and manage a shared product as an object of collective responsibility. It was precisely this stage that ensured the transition from digital communication as the basis of interaction to cooperative-productive activity as the central form of teamwork. This experience became the foundation for the third training session, within which participants were expected to integrate the communicative and productive dimensions within an organizationally structured project-based format.

4.3.3. The Third Training Session

The third training session within the proposed methodology served both an integrative and a concluding function. If the first training session supported participants' entry into digital teamwork through communication and initial coordination, and the second moved that interaction into the collaborative creation of a digital product, then the third stage aimed to combine all previously activated skills within a coherent team-based project

format. For this reason, the main emphasis of the third training session was on the organizational-projective component, although, in essence, it involved integrating the communication-facilitation and cooperative-productive dimensions within a single shared task.

The methodological relevance of this final stage lies in the fact that, in real professional practice, teachers' digital teamwork is rarely limited to communication alone or to collaborative editing of a single resource. In most cases, it involves some form of project-based organization: defining a goal, breaking the work into stages, distributing functions, aligning deadlines, documenting task status, addressing challenges, and ultimately bringing the shared task to completion. It is precisely this dimension that is often lacking in short-term digital training for teachers, where teams learn to use tools but do not gain experience in structured team activities. Thus, the third training session was designed to address this gap by making the digital board and related tools not an object of demonstration, but an environment for the real organization of the team process.

The goal of the third training session was to develop participants' experience in organizing and carrying out team activity in a digital environment on the basis of project logic, including planning, role distribution, coordination of stages, use of digital boards or trackers to visualize the process, and completion of the work in the form of an agreed shared result. This goal was specified through several objectives. First, participants needed to learn how to transform a shared task into a structured set of stages and actions. Second, it was important to activate experience in distributing roles and responsibilities. Third, participants needed to practice documenting team progress using digital boards, status labels, deadlines, and responsible persons. Fourth, situations had to be created in which the team would need to respond to organizational difficulties and adjust the process without losing the shared goal. Fifth, it was important to ensure the integration of all three components of digital teamwork within a single task.

As the substantive basis for the third training session, it was advisable to use a team project task that was structurally more complex than those in the previous two sessions and required not

only the creation of a shared product but also the explicit organization of the process. For example, participants could be asked, in micro-groups, to design a model of a short-term educational project, a structure for team preparation of a particular educational event, a digital plan for an interdisciplinary activity, or an algorithm for collaborative work on a methodological product. It was essential that the task involve several stages, require visualization of those stages on a digital board, specify role distribution, set deadlines, and produce a final result to be presented in an agreed format. Only such a design makes it possible to move team activity into a project-based logic.

Structurally, the third training session consisted of several interrelated stages. At the first stage, an introductory orientation took place, during which participants received the task, the time frame, a general understanding of the expected outcome, and a brief explanation of how to use the digital board or tracker. Unlike the previous training sessions, special emphasis was placed here on the fact that the board was not an additional visualization tool, but performed an organizational function. Participants were expected to perceive it as a space in which the stages of team activity, responsible persons, current task status, coordination points, and, if necessary, process adjustments were displayed. Thus, even before active work began, a project-based framework for the entire team activity was established.

The second stage involved initial planning in micro-groups. At this point, teams had to define the task's goal, break it down into subtasks, identify the main work stages, and represent them on the digital board. This stage was key to developing the organizational-projective component, as it translated a general understanding of the task into an explicit structure for shared activity. In practice, this was precisely the moment when typical difficulties became visible: a tendency to move immediately to execution without sufficient planning, lack of clarity in defining stages, overly general formulations, or, conversely, overloading the board with minor actions that made it difficult to see the whole. Work at this stage allowed participants to see, for the first time, that project logic requires not only enthusiasm but also structural thinking.

The third stage was connected with the distribution of roles and responsibilities. Once the general structure of the work had appeared on the board, the team had to determine who would be responsible for individual stages, who would coordinate interim transitions, who would work on content, who would be responsible for final formatting, and who would monitor time boundaries. The methodological value of this stage lies in moving participants beyond the informal understanding that "everyone does everything." Instead, they had to relate their own actions to the shared structure and make each person's contribution visible to the others. At the same time, it was important to preserve flexibility: roles were not meant to become rigid constraints, but they had to be sufficiently clear to ensure the process's functional organization.

The fourth stage consisted of direct work on the project task in the digital environment. At this point, teams were not only creating a substantive result but were also constantly sharing their work on the digital board, updating statuses, documenting completed and problematic areas, and adjusting the sequence of actions. It was here that all three components of digital teamwork were integrated. The communication-facilitation component manifested as a need for continual alignment, brief clarifications, maintenance of interaction, and support for group dynamics. The cooperative-productive component was realized through collaborative creation of the digital result. The organizational-projective component appeared through planning, coordination, and visualized process management. In this way, the training session acquired a character as close as possible to real professional practice.

The fifth stage was devoted to intermediate monitoring and process adjustment. This was a deliberately organized pause during which teams had to assess not only what had already been accomplished, but also compare the actual state of the work with the initial plan and identify possible delays, overloads, or misalignment. This stage was especially important for developing the ability to respond to organizational difficulties. In real team practice, it is precisely the ability to adjust the process, rather than merely plan it at the outset, that distinguishes a more mature level of team competence. During the training session, this allowed

participants to experience not an idealized but a realistic process management, where the activity's structure is not fixed once and for all but requires clarification in response to the actual course of events.

The sixth stage involved completing the team task and preparing an agreed final result. At this point, the digital board functioned not only as an organizational tool but also as a representation of the completed work's logic. The team could see how the individual stages had been completed, which decisions had been made, what had been adjusted, and how this had affected the final product. Thus, the results of the training session took two forms simultaneously: a substantive digital result and an organized process of achieving it, documented in the digital environment.

The final, seventh stage had a presentation-reflective character. Teams presented not only the result of their work, but also briefly explained how the team activity had been organized, how the digital board had been used, which roles had proven most significant, where difficulties in coordination had arisen, how the plan had changed during the work, and what had helped bring the task to completion. This format was fundamentally important because it shifted participants' attention away from the product alone and toward the process of achieving it. It was precisely this that created the basis for a deeper understanding of the organizational-projective component as an integral part of digital teamwork.

From a methodological perspective, the third training session had the greatest integrative potential. It made it possible not merely to activate communication, editing, or planning separately, but to unite them into a coherent experience of structured team activity in a digital environment. For this reason, this training session was the one most closely aligned with the real conditions of contemporary teachers' professional practice, in which team interaction almost always unfolds as a combination of communication, product creation, and project management.

No less important is the fact that the third training session created especially favorable conditions for evaluating the methodology's outcomes. It was precisely at this stage that it

became most feasible to observe the extent to which participants could act as a team in a digital environment rather than as a group of separate performers. The quality of communication, transparency of organization, the logic of the shared product, the nature of facilitation, attitudes toward deadlines, the distribution of responsibility, and the ability to adjust activity all became visible. All of this made the third training session not only the concluding formative stage, but also an important point of final diagnostic observation.

To systematize the content of the third training session, its summarized characteristics are presented in Table 4.5.

Table 4.5
General Characteristics of the Third Training Session

Parameter	*Characteristic*
Title	Digital Boards and Team Project Management
Main focus	Integration of components with a stronger emphasis on the organizational-projective dimension
Goal	Development of experience in planning, role distribution, coordination of stages, and management of team activity in a digital environment
Main tasks	Structuring the task; visualizing stages of work; distributing roles and functions; documenting deadlines and statuses; adjusting the process; integrating communication, shared product creation, and organization
Leading forms of work	Micro-group project work, use of a digital board or tracker, intermediate monitoring, presentation of process and result, reflection
Expected result	An agreed digital result and developed experience of organized teamwork in a digital environment on the basis of project logic

Source: Authors' own work.

Thus, the third training session ensured the integration of the communication-facilitation, cooperative-productive, and organizational-projective components within a coherent form of project-organized digital teamwork. It was precisely this stage that enabled the individual skills activated in the previous stages to mature into a more mature form of professional interaction, where digital tools are used not fragmentarily but as a unified environment for planning, coordination, creating results, and reflection. After examining the structure of the three training

sessions, the logical next step is to synthesize the pedagogical conditions that ensure the effectiveness of the proposed methodology.

4.4. Pedagogical Conditions for the Effectiveness of the Methodology

The effectiveness of the methodology for developing teachers' teamwork skills in a digital educational environment depends not only on the content of the training tasks or on the selection of digital tools. What is decisive is the set of pedagogical conditions under which this methodology is implemented. It is precisely these conditions that determine whether digital team activity will become genuinely developmental for participants or remain a formal completion of exercises in a shared online space. For this reason, within our study, pedagogical conditions should be understood as specially created circumstances and organizational-methodological characteristics of the educational process that ensure the purposeful and effective development of teachers' digital teamwork skills.

The first such condition is the professional and substantive motivation of team activity. Digital interaction among teachers becomes developmental only when it is built around tasks that participants perceive as substantively significant for their professional practice. If tasks are artificial or detached from pedagogical reality, participants may formally master individual tools, but they will not engage in genuine teamwork. By contrast, professionally relevant tasks stimulate a responsible attitude toward the shared result, activate teachers' own experience, encourage the exchange of practical solutions, and make digital teamwork personally and professionally meaningful. For this reason, the content of the training sessions should be connected with typical professional situations in which teachers genuinely need coordination, shared planning, alignment of actions, and collaborative creation of digital materials.

The second pedagogical condition is the organization of activity on the basis of real interdependence among participants. Teamwork does not develop when each person performs only their own part in isolation, and the sense of togetherness is merely

external. To develop the relevant skills, it is necessary to create tasks in which the progress of one participant is linked to the actions of others, and in which the final result cannot be achieved without alignment of contributions, agreement on decisions, and coordination of stages. Only under such conditions does the digital environment begin to function as a space of team activity rather than as a technical channel for parallel individual work. It is precisely real interdependence among participants that makes meaningful communication, facilitation, collaborative editing, process visualization, and role distribution necessary.

The third condition is the functionally appropriate use of digital tools. Within the methodology, digital services should be selected not based on technological novelty or diversity, but rather on the types of actions that need to be developed. Communication tools should support meaningful interaction and feedback, collaborative editing services should support cooperative product creation, and digital boards or trackers should support project-based organization of activity. If tools are used randomly or excessively, they may complicate teamwork, overload participants, and shift attention away from the professional task toward technical difficulties. Thus, the effectiveness of the methodology depends to a large extent on whether the digital environment is not merely available, but functionally organized and pedagogically justified.

The fourth condition is the combination of synchronous and asynchronous interaction formats. The development of digital teamwork skills requires experience in participating in different modes of team activity. Synchronous formats are important for practicing facilitation of discussion, rapid alignment of decisions, brief coordination of actions, and maintenance of group dynamics. Asynchronous formats, by contrast, make it possible to develop written digital communication, document agreements, work with shared documents, plan, and distribute tasks over time. If the methodology is limited to only one of these formats, skill development remains partial. For this reason, their combination is an important pedagogical condition that brings training activity closer to the real conditions of the contemporary digital educational environment.

The fifth condition is the presence of a structured yet flexible team process. In order to develop digital teamwork skills, participants must act under conditions in which, on the one hand, there are clear frameworks, stages, time references, roles, and criteria for the result, while on the other hand, there remains space for independent alignment, decision-making, and adjustment of the process. An excessively rigid structure turns teamwork into mere execution of instructions and reduces opportunities for initiative and facilitation. By contrast, a complete absence of structure leads to chaos and overload. For this reason, the methodology is most effective when participants work within a sufficiently organized, but not overly regulated, process.

The sixth pedagogical condition is reflective support of team activity. The development of digital teamwork skills cannot be reduced to the accumulation of experience in shared digital tasks. That experience must become the subject of reflection. Reflection allows participants to see how they communicated, what helped or hindered collaborative editing, how roles were distributed, why coordination difficulties arose, which tools were truly functional, and which only made the work more complicated. Without such reflection, activity may remain situational and fail to reach the level of a conscious professional skill. For this reason, it is important that each training session conclude with individual and group reflection on both the process and the results.

The seventh condition is the combination of formative and developmental assessment. Within the methodology, the assessment should perform not only a controlling, but also a supportive function. Participants should have the opportunity to relate their own activity to clear criteria, identify strengths and difficulties, and recognize the dynamics of their own development. For this reason, the effectiveness of the methodology increases when self-assessment, observation, analysis of digital artifacts, and brief feedback are integrated into the learning process rather than postponed until the final stage. Under such conditions, assessment becomes a means of professional self-understanding and further skill development.

The eighth condition is the creation of a safe atmosphere of professional interaction. Digital teamwork requires participants to be open to collaboration, willing to express proposals, respond to

colleagues' revisions, acknowledge difficulties, revise their own decisions, and take part in the joint refinement of the result. If the environment is perceived as overly evaluative, conflictual, or psychologically unsafe, participants may avoid active interaction, limit their contributions to the minimum, or tend to individualize their work. By contrast, an atmosphere of mutual respect, appropriateness, and professional support creates conditions for facilitation, responsible feedback, and genuine shared authorship. For this reason, psychological safety is not a background feature, but a full pedagogical condition for the effectiveness of the methodology.

The ninth condition may be defined as the gradual increase in the complexity of content and modes of teamwork. The effectiveness of the methodology increases as participants move from relatively simple forms of digital interaction to more complex, integrated forms of activity. At first, they learn to negotiate, sustain communication, and record interim decisions; then they move on to collaborative product creation; and later to full project-based organization of teamwork. It is precisely this dynamic that helps avoid both overload at the outset and stagnation later. For this reason, phased progression and logical increase in complexity are not only principles of the methodology, but also independent pedagogical conditions for its effectiveness.

The tenth condition is the visibility of both process and result within the digital environment. One of the advantages of digital tools is the ability to document not only the final product but also the course of shared work itself: comments, revisions, status changes, stages on the board, version history, and the task structure. The effectiveness of the methodology increases when these digital traces serve not only as a resource for assessment but also for learning. Visibility into the process helps participants become aware of their own role, see the contributions of others, understand the team's movement, and identify points at which interaction was productive or, conversely, difficult. For this reason, the digital environment should be organized so that the process of activity is available for analysis and reflection.

To summarize the pedagogical conditions that ensure the effectiveness of the methodology, they are presented in Table 4.6.

Table 4.6

Pedagogical Conditions for the Effectiveness of the Methodology for Developing Teachers' Teamwork Skills in a Digital Educational Environment

Pedagogical condition	*Content of the condition*
Professional and substantive motivation of tasks	Orientation of team activity toward real pedagogical situations and professionally significant outcomes
Real interdependence among participants	Design tasks so that the achievement of the result requires alignment of contributions and shared decisions
Functionally appropriate use of digital tools	Selection of services in accordance with the logic of communication, collaborative editing, planning, and coordination
Combination of synchronous and asynchronous formats	Creation of experience in different modes of digital teamwork
Structured but flexible organization of the process	Presence of clear frameworks, stages, roles, and deadlines while preserving space for independent alignment
Reflective support	Systematic reflection by participants on the process, difficulties, and results of team activity
Developmental assessment	Use of self-assessment, observation, and artifact analysis as means of supporting professional growth
Safe atmosphere of professional interaction	Ensuring respect, appropriateness, openness to revisions, discussion, and collaborative refinement
Gradual increase in the complexity of activity	Movement from basic digital interaction to integrated project-organized teamwork
Visibility of process and result	Use of digital traces of activity for analysis, reflection, and assessment of teamwork

Source: Authors' own work.

Thus, the effectiveness of the methodology for developing teachers' teamwork skills in a digital educational environment is ensured not by a single factor, but by a set of interrelated pedagogical conditions. It is these conditions that create the foundation for transforming digital tools into a means of professional interaction and training tasks into a space for the real development of the communication-facilitation, cooperative-productive, and organizational-projective components. After substantiating the methodology and its effectiveness conditions,

the next logical step is to analyze the pilot experiment in which it was tested.

5. Pilot Experiment on the Development of Teachers' Teamwork Skills in a Digital Educational Environment

5.1. Purpose and Objectives of the Pilot Experiment

After providing a theoretical rationale for the essence of teachers' digital teamwork skills, defining their structure, constructing an assessment system, and developing a methodology for their growth, the next logical stage of the study was its practical testing. For this purpose, a pilot experiment was organized. Its aim was not so much to confirm a completed model through large-scale statistical measurement, but rather to test the functionality of the proposed methodology, the sensitivity of the diagnostic instruments, and the overall possibility of purposefully developing teachers' digital teamwork skills within a short-term training program. Such a pilot-testing format is consistent with the logic of contemporary research on pedagogical innovations, in which initial testing of a new methodology primarily aims to assess its functionality, methodological appropriateness, and potential for further scaling. This is especially important in areas where teamwork and the digital environment intersect within a single field of inquiry, since in such cases it is necessary to examine not only the final outcome, but also how the very organization of collaborative activity functions (Amelia et al., 2024; Espejo et al., 2023). This research format is methodologically justified because it allows combining the testing of instruments, the initial identification of change dynamics, and the clarification of aspects of the methodology that require further elaboration within a broader research design.

The pilot nature of the experiment also shaped the study's specific logic. The focus was not on comparing large samples or identifying universal patterns, but on determining whether the developed methodology enabled the activation and development of the communication-facilitation, cooperative-productive, and organizational-projective components of teachers' digital teamwork skills. Accordingly, the pilot experiment performed several interrelated functions. The formulation of precisely this

research question is also justified by the fact that existing studies indicate different levels of sensitivity among the components of teamwork to pedagogical interventions. Communicative and organizational practices may change most rapidly, whereas stable cooperation, trust, depth of alignment of contributions, and a culture of shared responsibility require longer-term development. For this reason, a component-based analysis within a pilot study is a methodologically strong decision (Navio-Marco et al., 2025; Xu et al., 2026). First, it enabled verification of the extent to which the theoretical propositions were confirmed in participants' actual professional interactions. Second, it allowed us to determine whether the proposed assessment system was sufficiently sensitive to capture change. Third, it created a basis for interpreting which elements of the methodology proved most effective and which required further refinement.

After the theoretical substantiation of the essence of teachers' digital teamwork skills, the identification of their structure, the construction of an assessment system, and the development of a methodology for their growth, the logical next stage of the study was its practical testing. For this purpose, a pilot experiment was organized. Its aim was not so much to confirm a finished model through large-scale statistical measurement, but rather to test the feasibility of developing teachers' digital teamwork skills within a specially organized series of training sessions based on the use of digital tools for collaborative communication, editing, and project management, as well as to identify the dynamics of change in the development of these skills based on two assessment points. This formulation of the aim reflects the experiment's dual nature. On the one hand, it had a formative orientation, since it involved a purposeful intervention through the training methodology. On the other hand, it had a diagnostic orientation, since it was intended to document changes and analyze their character.

In accordance with this aim, several main objectives of the pilot experiment were identified. First, it was necessary to determine the initial features of participants' digital teamwork during the first training session, including the nature of their communication, the level of coordination of actions, and their ability to collaboratively create a product and organize the

process. The second objective was to pilot the series of three weekly training sessions as an integrated methodology for developing the skills under study. The third objective involved collecting and comparing data obtained after the first and third training sessions to identify changes in the development of the corresponding components. The fourth objective was to test the functionality of the assessment instruments, which included self-assessment, observation, and analysis of digital artifacts. The fifth objective concerned the interpretation of the pilot experiment results to further refine the methodology and design a broader study.

The pilot experiment was designed as a short-term formative study comprising three weekly training sessions. This format was chosen for several reasons. First, it enabled a relatively intensive intervention without placing excessive time or organizational demands on participants. Second, the three-week sequence created an opportunity to unfold the three substantive emphases of the methodology in a consistent manner: digital communication, collaborative creation of a digital product, and project-organized teamwork. Third, such an organization enabled us to conduct two assessment points, structured as "after the first training session" and "after the third training session," which allowed us to evaluate not only the final state but also the dynamics of skill development during participation in the training series.

A distinctive feature of the research design was that measurement was conducted not at the beginning of the program, but after the first and third training sessions. This approach is methodologically justified in this case because the first training session performed both diagnostic and activation functions. It made it possible to identify participants' actual initial features of digital teamwork, already under conditions of active participation, rather than only through abstract self-reports. For this reason, the first assessment point after the initial training session captured the state of the skills at the stage of first entry into digital teamwork, whereas the second assessment point after completion of the entire series made it possible to evaluate the changes that had occurred as a result of participating in the three interconnected training sessions.

In terms of content, the experiment was organized around three interrelated lines. The first line was formative and included the training sessions themselves as a system of activity-based interventions. The second line was diagnostic and involved the use of a set of instruments to collect data on the manifestations of digital teamwork skills. The third line was analytical and reflective, including the interpretation of the results obtained, the comparison of data from different sources, and the identification of the characteristics of team interaction that underwent the most pronounced changes. This combination made it possible to view the pilot experiment not as a purely formal test, but as a space for the simultaneous implementation, observation, and interpretation of the methodology.

The participants in the experiment worked in small teams, which was of fundamental importance for preserving the real interdependence of their actions. It was precisely the micro-group format that made it possible to observe the character of each teacher's teamwork behavior without dissolving it in an overly large group and without reducing the activity to an individual response to a task. Work in small teams also facilitated the recording of communicative manifestations, editing actions, role distribution, and the use of digital boards or shared documents. Methodologically, this created favorable conditions for both skill development and subsequent analysis.

An important organizational aspect was also that all three training sessions were conducted within a unified digital environment. This meant that participants worked with tools that enabled communication, collaborative editing, planning, visualization of stages, and analysis of digital artifacts. Thus, the experiment tested not an individual digital service, but the very possibility of creating a functionally organized environment within which teachers could develop teamwork skills. It was precisely this coherence of the digital environment that made the experiment as close as possible to the real conditions of professional interaction.

From a research perspective, it is important to emphasize that the pilot experiment used several data sources. After the first and third training sessions, self-assessment results were recorded, structured observations of work in micro-groups were conducted, and the digital artifacts produced during the shared

activity were analyzed. Such an organization of data collection made it possible to move beyond general impressions of participation in the training sessions and to observe specific manifestations of change: in the character of communication, the quality of feedback, the ways of editing a shared product, the level of organization of the process, the use of digital boards, and the team's ability to adjust its own activity.

For greater clarity, the pilot experiment's organization is summarized in Table 5.1.

Table 5.1
General Organization of the Pilot Experiment

Parameter	*Characteristic*
Type of study	Pilot formative experiment
Aim	testing the possibility of developing teachers' digital teamwork skills within a series of training sessions and identifying the dynamics of change
Duration	Three weeks
Format of intervention	A series of three weekly training sessions
Main content emphases	Digital communication and coordination of interaction; collaborative creation of a digital product; project-organized teamwork
Format of work	Micro-group activity in a digital environment
Assessment points	After the first training session, after the third training session
Data sources	Self-assessment, structured observation, and analysis of digital artifacts
Purpose of the results	Evaluation of dynamics, piloting of the methodology, refinement of the instruments, and clarification of prospects for further research

Source: Authors' own work.

Thus, the pilot experiment was organized as a short-term formative test of the methodology for developing teachers' digital teamwork skills in a functionally organized digital environment. Its aim was not only to document change but also to test the methodology's viability, the logic of its staged implementation, and the sensitivity of the assessment system developed. Such an organization laid the groundwork for further specification of the sample's characteristics and the experiment's conditions, which is the subject of the next subsection.

5.2. Organization and Characteristics of the Sample

In the 2025 pilot experiment, the participants were future master's students in secondary education at Sumy State Pedagogical University. The total number of participants was 26. In terms of gender composition, the group included 18 men and 8 women. The average age of the participants was 22 years. This composition of the sample makes it suitable for a pilot study, as it involved learners at the stage of professional formation, already engaged in preparation for pedagogical activity, and at the same time sufficiently open to mastering new formats of digital interaction in the educational environment.

The choice of this particular category of participants was methodologically justified. Future master's students in secondary education already have some experience in educational and professional interactions, working with digital resources, and participating in shared educational tasks, yet their digital teamwork skills remain open to purposeful development. For this reason, such a sample is suitable for piloting a methodology aimed not at a retrospective description of established professional practice, but at developing skills significant for future pedagogical activity. In this sense, the pilot experiment was oriented not only toward documenting the current state of digital teamwork but also toward testing the extent to which these skills can be purposefully activated within a short-term training program.

The conditions of the experiment were determined by the logic of the study itself and, at the same time, corresponded to the nature of the phenomenon under investigation. All training sessions were conducted online. This was of fundamental importance, since the object of the study was precisely teachers' digital teamwork skills; therefore, the interaction itself had to take place in a digital educational environment rather than merely simulate some of its elements. The online format enabled the practical use of digital communication channels, collaborative editing tools, visual work-stage tools, and digital boards for team planning. As a result, participants did not simply discuss the possibilities of digital interaction, but acted directly within the environment that served as the space for developing the skills under study.

To organize the training sessions and team activity, platforms and tools functionally suited to different types of teamwork were used. The main synchronous interaction platform was Zoom, which supported shared meetings, short introductory sessions, intermediate alignment, and final reflective discussions. Messengers were used for rapid, asynchronous communication, through which participants maintained contact, clarified individual actions, aligned on decisions, and exchanged short messages between synchronous work stages. For visualization of shared activities, planning, structuring ideas, and coordinating stages, digital boards such as Miro and related tools were used. It was precisely this combination of platforms that made it possible to create a multi-component digital environment in which the communication-facilitation, cooperative-productive, and organizational-projective dimensions of team activity were naturally combined.

From a methodological perspective, the online format had another significant advantage. It ensured the visibility of digital traces of activity, which was important for subsequent analysis. Comments, revision history, the structure of shared boards, communication on digital channels, the logic of task progression, and documentation of work stages provided material for analyzing digital artifacts as a data source within the pilot experiment. Thus, the conditions of implementation not only corresponded to the nature of the training work but also strengthened the research possibilities of the assessment procedure itself.

It is important to emphasize that the pilot experiment was conducted in accordance with the relevant ethical requirements. Ethical consent for participation in the study was obtained from all participants. This means they were informed about the nature of the experiment, its educational and research purposes, the format of participation, the use of the results for scholarly purposes, and the voluntary nature of their involvement. Compliance with this condition is fundamentally important, since the study documented not only final products of activity, but also features of teamwork, communication, work with shared digital resources, and other manifestations of professional behavior in a digital environment.

In addition to individual participant consent, the pilot experiment was approved by the university’s academic council.

This gives the study additional institutional legitimacy and indicates its compliance with the academic and organizational requirements of the higher education institution. In this case, the experiment is regarded not as a local initiative of an individual teacher or researcher, but as a scientifically grounded and institutionally recognized form of research-based educational activity.

Given the sample composition and implementation conditions, it is appropriate to note that the pilot experiment's results do not claim broad statistical representativeness across all categories of teachers or learners. However, for the purposes of a pilot study, this sample is entirely sufficient, as it allows testing the internal logic of the methodology, assessing the sensitivity of the data collection instruments, identifying typical difficulties, and detecting initial positive changes in the dynamics of digital teamwork skills. This research position corresponds to the nature of a pilot experiment as a stage of piloting rather than the final verification of a model on a large sample.

To summarize the participants' characteristics and the experimental conditions, they are presented in Table 5.2.

Table 5.2
Characteristics of the Participants and Conditions of the Pilot Experiment

Parameter	*Characteristic*
Year of implementation	2025
Site	Sumy State Pedagogical University
Participant category	future master's students in secondary education
Total number of participants	26
Gender composition	18 men, 8 women
Average age	22 years
Format	online
Main digital tools	Zoom, messengers, Miro-type shared boards, and other digital tools for team interaction
Ethical conditions	Ethical consent obtained from participants
Institutional approval	The experiment approved by the university's academic council

Source: Authors' own work.

Thus, the pilot experiment was conducted under conditions of online interaction with master ’s-level learners who were at the stage of active professional development and were engaged in teamwork in a digital environment through functionally selected platforms and services. Compliance with ethical requirements and institutional approval ensured an appropriate organizational foundation for the study. This creates the basis for moving to the next subsection, which specifies the diagnostic instruments and assessment procedure used within the pilot experiment.

5.3. Diagnostic tools and assessment procedure

The diagnostic block of the pilot experiment was constructed in accordance with the methodological foundations substantiated in Chapter 3, namely the principles of multiple data sources, the combination of process-oriented and outcome-oriented dimensions, criterion-based clarity, and level-based interpretation of results. Since the object of assessment was teachers’ digital teamwork skills as a complex, integrated construct, the diagnostic instrumentarium could not be limited to a single data-collection method. For this reason, the pilot experiment employed a set of complementary instruments that enabled capturing both participants’ reflective self-perception and the actual manifestations of their activity in a digital team environment.

The diagnostic instrumentarium included three main tools: an adapted self-assessment questionnaire, structured observation of performance during team tasks, and analysis of digital artifacts produced during teamwork. This combination was selected as the most appropriate for assessing digital teamwork skills in the context of a pilot study. On the one hand, it enabled participants to identify their subjective views of their readiness for digital team interaction. On the other hand, it allowed these perceptions to be compared with actual behavior, the nature of interaction, and the material traces of shared activity in a digital environment.

The first instrument was an adapted self-assessment questionnaire designed to assess participants' self-evaluations of their digital teamwork abilities. Its function was not to determine the final level of skill development, but rather to document participants’ reflective perception of their own role in the team,

their confidence in using digital tools, and their readiness for shared activity. The structure of the questionnaire corresponded to the three identified components of the phenomenon under study. Accordingly, it included statements related to the communication-facilitation, cooperative-productive, and organizational-projective dimensions of digital teamwork.

The first block included statements related to the ability to initiate digital interaction, sustain meaningful discussion, provide constructive feedback, facilitate shared communication, and contribute to decision alignment. The second block covered participation in the collaborative creation of a digital product, coordination of editing, alignment of changes, adaptation of digital resources, and readiness for joint refinement of the result. The third block concerned planning work stages, distributing roles, meeting deadlines, tracking task progress, and adjusting difficulties in the team process. To record responses, a scale of manifestation intensity was used, allowing participants to evaluate the degree of their own confidence or the regularity of the corresponding actions. This design not only enabled obtaining an overall result but also allowed identifying the specific features of self-assessment across the separate components.

The second instrument was a structured observation of participants' work during the training tasks. This instrument was particularly important for the study because it enabled the documentation of actual manifestations of digital teamwork in a direct activity context. Observation was conducted not in a free-form manner, but on the basis of a previously developed observation chart that included behavioral indicators linked to the assessment criteria. This approach helped reduce excessive subjectivity and made the data documentation process more transparent and comparable.

Within the communication-facilitation criterion, the following manifestations were observed: initiation of digital discussion, substantive quality of contributions, ability to clarify positions, provision of constructive feedback, summarizing interim results, and maintenance of a productive atmosphere of interaction. Within the cooperative-productive criterion, the following were documented: involvement in collaborative editing, coordination of one's own contribution with those of others, work with comments,

participation in refining the result, and orientation toward the coherence of the shared product. Within the organizational-projective criterion, attention was focused on the ability to structure the task, align work stages, document roles, follow time markers, respond to disruptions, and use digital boards or other means of process visualization. It was precisely this level of detail in the behavioral indicators that enabled alignment of the observations with the previously substantiated system of criteria and indicators.

The third instrument was the analysis of digital artifacts, which played a particularly important role in this study because the digital environment enabled the documentation of both results and the course of shared activity in a relatively stable form. These digital artifacts included shared documents, revision histories, comments on edits, messages in team channels, the structure of task-management boards, stage-completion statuses, and the final digital products created by the teams. Analysis of these materials made it possible not only to see the final result, but also to trace how it had been created: the intensity of participation, the transparency of editing, whether substantive commenting took place, how the logic of project organization was represented, and whether roles and stages of work were visible.

Within the analysis of digital artifacts, particular attention was paid to three aspects. The first concerned the procedural visibility of teamwork, that is, the extent to which participants' actions were documented in the digital environment as an interconnected process. The second aspect concerned the degree of integration of the shared product, namely, whether the final result appeared as a coherent collective output rather than as a mechanical sum of separate fragments. The third aspect concerned the organizational orderliness of digital activity, in particular the presence of stages, the structure of the board, the marking of tasks, and the visibility of the team's progress logic. This constituted the particular value of artifact analysis as an instrument that combined both the outcome-oriented and process-oriented dimensions of assessment.

The assessment procedure in the pilot experiment was organized around two assessment points: after the first and after the third training sessions. Such an arrangement made it possible

to compare not abstract pre-experimental expectations with final results, but two states of skill development during participants' actual inclusion in digital teamwork. The first assessment point, conducted after the initial training session, reflected the level of skills at the stage of first engagement in digital interaction, when participants had already gained experience of real work in micro-groups but had not yet completed the full cycle of formative intervention. The second assessment point, conducted after the third training session, documented the state upon completion of the entire series and enabled identification of changes resulting from participation in the methodologically organized training process.

At each assessment point, the procedure included several successive steps. First, participants completed the self-assessment questionnaire, which documented their reflective perceptions of their readiness for digital teamwork at each stage. Next, a structured observation was conducted during the team task embedded in the training process, enabling identification of the actual manifestations of the skills under study. After the team activity, the digital artifacts created by the teams were analyzed. This sequence enabled comparison of participants' self-perceptions, behavior, and the results of the shared activity, thereby ensuring greater objectivity in the conclusions.

A four-level model substantiated in the previous subsection was used to interpret the results: initial, basic, advanced, and expert levels. Data from self-assessment, observation, and artifact analysis were compared, enabling the determination of both the overall level of development of digital teamwork skills and the specific manifestations of the individual components. At the same time, it is important that, within this pilot study, the levels be interpreted not as rigidly fixed states but as the predominant pattern of a participant's professional behavior in the digital team environment at a given stage of the experiment. This made it possible not only to identify changes, but also to describe them qualitatively.

From a methodological perspective, it is important to emphasize that the assessment procedure had not only a diagnostic, but also a developmental function. Participation in self-assessment, comparing one's own actions against the criteria, the

visibility of team interaction, and subsequent reflection increased participants' awareness of what high-quality digital teamwork actually means. Thus, the assessment procedure was integrated into the methodology's logic as an important component rather than as an external control mechanism.

The diagnostic instrumentarium and assessment procedure are summarized in Table 5.3.

Table 5.3
Diagnostic Instrumentarium and Assessment Procedure in the Pilot Experiment

Diagnostic component	*Characteristic*
Self-assessment	An adapted questionnaire aimed at identifying participants' subjective evaluation of their own digital teamwork skills across the three components
Observation	Structured recording of behavioral manifestations during the performance of team tasks in a digital environment
Analysis of digital artifacts	Analysis of shared documents, revision histories, comments, messages, digital boards, and final products
Assessment point 1	Conducted after the first training session
Assessment point 2	Conducted after the third training session
Logic of comparison	Comparison of the results of the two assessment points by criteria, indicators, and levels of development
Interpretive result	Identification of the dynamics of development of digital teamwork skills overall and across individual components

Source: Authors' own work.

Thus, the diagnostic instrumentarium for the pilot experiment was constructed as a system of complementary tools that enabled documentation of teachers' digital teamwork skills at the levels of self-assessment, actual behavior, and digital traces of shared activity. The two-stage assessment procedure, conducted after the first and third training sessions, enabled identification not only of the current state of development of the relevant skills, but also of their growth dynamics during participation in the methodologically organized training series.

This lays the groundwork for analyzing the results of the first assessment point, namely the characterization of the state of digital teamwork skills after the first training session.

5.4. Results after the first training session

The first assessment point, conducted after completion of the first training session, made it possible to document the state of digital teamwork skills that had developed at the stage of participants' initial engagement in specially organized digital team interaction. Its significance lies in the fact that it reflects not an abstract "baseline" level determined outside activity, but the initial state of the skills after the first experience of real work in micro-groups using digital communication channels, collaborative alignment, and elementary coordination of actions. For this reason, the results of this assessment have particular analytical value: they reveal which skills are most readily accessible to rapid activation and which still require purposeful development in subsequent training stages.

Overall, the results from the first training session showed that participants entered digital team interaction quickly, at the level of basic communicative actions. In most micro-groups, there was active engagement in discussion, attempts to define a shared goal, maintenance of contact through digital channels, and alignment of initial decisions. This provides grounds for concluding that the digital team task's format already activates a certain potential for interaction at the outset, especially when the task has a clear professional meaning and requires an agreed result. At the same time, the results of the first assessment indicated that such activity was not always sufficiently structured, and that communication, although quite lively, often remained unstable in terms of the depth of facilitation, clarity in documenting decisions, and the maintenance of the logic of shared progress.

The most pronounced results after the first training session were observed within the communication-facilitation component. This proved to be the component most sensitive to the initial training intervention. Participants generally demonstrated readiness to engage in digital interaction, respond to one another's messages, sustain discussion, and participate in brief position

alignment. In most teams, active communication was observed, though it was often uneven: initiative was usually taken by one or several participants, while others joined mainly reactively. This suggests that, even in the first training session, elements of micro-leadership and facilitation begin to emerge, though they are not yet a stable characteristic of the whole team and often depend on the individual activity of particular participants.

According to self-assessment data, most participants rated their digital communication ability as moderate to sufficient after the first training session. As a rule, they indicated they could participate in shared discussions, respond to digital messages, and sustain team interaction. However, comparing these data with the observation results showed that confidence in one's own communication did not always indicate a sufficient level of structure. In actual interaction, there was often a lack of summarizing statements, clear transitions from discussion to decision, meaningful documentation of agreements, and deliberate inclusion of less active participants. Thus, after the first training session, one can speak of a clear activation of communicative interaction, but not yet of its full facilitative maturity.

The results related to the quality of feedback were also revealing. In many cases, participants responded quite willingly to colleagues' messages and suggestions, yet these responses were often brief, confirmatory, or situationally supportive. Constructive feedback, which not only approves but also clarifies, proposes, justifies, or helps improve a shared decision, was still unstable after the first training session. This indicates that basic communicative openness develops more quickly than a culture of meaningful digital interaction. At the same time, even at this stage, some examples of facilitation-valuable behavior could be observed: attempts to summarize what had been said, bring the group back to the task, clarify a proposal, or formulate an interim decision. These manifestations can be regarded as early indicators of the development of the communication-facilitation component.

The cooperative-productive component after the first training session proved less developed than the communication-facilitation component, which is entirely natural. Since the first training was oriented primarily toward interaction, coordination,

and alignment rather than toward complex collaborative editing, the results in this dimension reflected more an initial readiness for collective result creation than a stable command of the corresponding actions. Analysis of digital artifacts showed that teams arrived at a shared mini-product, but in most cases, it still bore signs of being assembled from separate fragments rather than constituting a fully integrated digital outcome. This means that participants were already beginning to act according to the logic of shared creation, but were not yet sufficiently confident in coordinating contributions, style, and the product's structure.

This was especially evident when it was necessary to quickly document a collective decision in a shared digital space. Some groups chose the path of dividing elementary tasks, where individual participants proposed fragments of content that were then mechanically combined. Such an approach enabled an acceptable result but did not yet indicate sufficiently developed cooperative-productive interaction. At the same time, in some teams, attempts at substantive alignment of the product were already noticeable: participants returned to earlier formulations, revised them in line with the overall logic, asked clarifying questions about content, and tried to make the result more coherent. It is precisely such manifestations that can be regarded as the first signs of the emergence of the cooperative-productive component.

The organizational-projective component after the first training session proved to be the least pronounced, which is consistent with the study's logic. At the initial stage, participants were mainly focused on the very act of interaction and on finding a shared solution, whereas in the planning stages, explicit role distribution, deadline setting, or structured progress tracking had not yet taken a stable form. Observation of teamwork showed that some organizational decisions were made implicitly or spontaneously: someone began acting as an initiator, someone summarized, and others joined the work, following the logic already established. Such a format is typical of the initial stage of team interaction, when the organization is not yet understood as a separate and necessary dimension of activity.

At the same time, the first training session already revealed preconditions for further development of this component. In a

number of teams, attempts appeared to define the sequence of actions, clarify who would document the result, who would formulate the final version, who would track messages, or who would initiate brief alignment points. Although these actions did not yet have a fully project-based character, they indicated that the need for organizational structuring was already being recognized at the stage of the first digital team experience. For this reason, the low degree of expression of the organizational-projective component after the first training session should not be treated as a weakness of the methodology, but rather as an important diagnostic signal regarding the direction of further work.

If the results of the first assessment point are summarized in level-based terms, it can be stated that after the first training session, the initial and basic levels of development of digital teamwork skills predominated. The initial level manifested in cases where digital interaction was mainly reactive, unstable, and dependent on external organizational support. The basic level appeared in those cases where participants were already able to take part in shared discussion, maintain elementary coordination, and arrive at a simple shared result within a clear task structure. The advanced level after the first training session was represented only by isolated manifestations, mainly in the communication-facilitation dimension, where some participants demonstrated the ability not only to participate, but also to sustain the logic of group interaction. The expert level did not appear at this stage, which is natural for the initial stage of a formative experiment.

The results of the comparison among the three data sources are also of particular value. Self-assessment after the first training session was often somewhat higher than what followed from observation and analysis of digital artifacts. This suggests that initial engagement in digital teamwork creates in participants a sense of readiness, yet actual behavior does not always confirm this readiness at the level of stable and coordinated actions. At the same time, such a discrepancy is not a negative phenomenon. On the contrary, it demonstrates the importance of combining self-assessment with activity-based diagnostic methods. It is precisely because of this combination that the first assessment point provided not only a general impression of participants' engagement, but also a more precise picture of which components

of digital teamwork had already begun to develop and which still remained within the zone of proximal development.

A summary of the results after the first training session is presented in Table 5.4.

Table 5.4
Summarized Characteristics of the Results After the First Training Session

Component	*General characteristics of manifestation*	*Preliminary conclusion*
Communication-facilitation	Participants actively engage in digital discussion, respond to messages, and attempt to align decisions, but facilitation remains unstable	The component proved to be the most sensitive to the initial training intervention
Cooperative-productive	Teams are able to create a shared mini-product, but integration of contributions and coordination of editing remains insufficiently expressed	An initial readiness for shared digital authorship has been formed
Organizational-projective	Planning, role distribution, and structured coordination appear fragmentarily and mostly implicitly	The component requires further purposeful development
Overall level	initial and basic levels predominate	A starting foundation has been formed for the further development of skills within the subsequent training sessions

Source: Authors' own work.

Thus, the results of the first training session showed that, even at the initial stage of specially organized digital teamwork, participants begin to activate basic forms of interaction, primarily in the communication-facilitation dimension. At the same time, the cooperative-productive and especially the organizational-projective components do not yet reach a sufficient level of stability and structure. This confirms the appropriateness of

constructing the training series according to a logic of gradual increase in complexity and creates the basis for analyzing how these components change after completion of the entire program. It is precisely this that constitutes the subject of the next subsection.

5.5. Results after the third training session

The second assessment point, conducted after completion of the third training session, enabled documentation of teachers' digital teamwork skills after they had completed the full series of formative sessions. Unlike the first assessment point, which reflected the level of development of these skills at the stage of participants' initial engagement in digital team interaction, the second made it possible to evaluate the extent to which the purposeful training work had contributed to the development of the components under study and whether those components had acquired greater stability, awareness, and integration. For this reason, the results after the third training session have a summative character within the pilot experiment, although they do not claim to provide a final or exhaustive confirmation of the methodology's effectiveness on a broader scale.

Overall, the results of the second assessment point showed positive dynamics in the development of digital teamwork skills. Compared with the data collected after the first training session, participants demonstrated more structured, purposeful, and professionally meaningful interaction in the digital environment. This was evident not merely in increased activity or confidence, but above all in a change in the quality of teamwork itself: communication became less situational and more meaningfully organized, the collaborative creation of digital products became more coherent, and the organization of the process ceased to be spontaneous and increasingly relied on explicit mechanisms of planning, role distribution, and coordination. These changes make it possible to conclude that the series of training sessions performed not only an activating, but also a genuinely developmental function.

The most noticeable changes after the third training session were observed in the communication-facilitation component.

Whereas after the first training session, participants' digital interaction was already quite active but often remained uneven and not always sufficiently structured, after completion of the full series, the quality of team communication was clearly higher. Participants more often formulated messages not simply as reactions, but as elements of shared movement toward a decision. Interaction became more purposeful: the number of substantive clarifications, brief summaries, suggestions for the next step, attempts to bring the discussion back to the task, and efforts to involve less active participants all increased. In some teams, one could already observe not merely situational, but fairly stable facilitative actions.

The changes in the quality of feedback were especially revealing. After the first training session, feedback was often brief, supportive, or confirmatory. After the third training session, however, comments increasingly served a constructive, task-oriented function: participants clarified content, proposed ways to improve it, justified the appropriateness of changes, aligned formulations, and helped the team achieve substantive coherence. This indicates that digital communication had begun to perform not only an informational but also a coordinating and facilitating function. Accordingly, one may speak of a significant proportion of participants transitioning from the basic to a more stable advanced level within this component.

The dynamics of the cooperative-productive component are no less important. After the third training session, the collaboratively created digital products in most teams became much more coherent in structure, logic, and style. Analysis of digital artifacts showed that participants were less inclined to mechanically combine separate fragments and more often acted within the logic of collective editing, changing alignment, and refining the result as a shared product. The ability to work with revisions, comments, and earlier versions, to return to previously created material, and to adjust it in accordance with the overall logic of the task became more evident. In this way, the digital product increasingly acquired the features of genuine shared authorship rather than merely a sum of individual contributions.

It is also significant that not only technical but also substantive coordination of contributions increased. Participants

more often related their own actions to what others had already done, duplicated content less frequently, paid closer attention to the consistency of format, and better recognized the need to adapt their own material to the integrity of the shared result. This provides grounds for stating that after the third training session, the cooperative-productive component no longer amounted merely to readiness to "add something of one's own," but had begun to develop into the ability to jointly construct and improve a digital product. This type of change is of particular methodological importance because it indicates the formation in participants not only of digital activity, but also of a culture of shared digital authorship.

The most substantial dynamics were observed in the organizational-projective component. This component had been the least pronounced after the first training session, but after the third, it showed the most visible growth. Participants demonstrated the ability to structure tasks, distribute roles, mark stages of work, use digital boards or other tools to visualize the process, and relate the actual course of activity to the initial plan much more often. Unlike the initial stage, when the organization often remained implicit, by the end of the training series, it had increasingly become a conscious and visible element of teamwork.

Particular attention should be drawn to the fact that teams not only began planning but also began adjusting their own processes. During the third training task, participants in a number of cases independently returned to the digital board, updated statuses, clarified roles, revised the sequence of actions, or responded to delays without external intervention. This is an important indicator of the transition from initial dependence on external structure to more autonomous organization of team activity. It is precisely this ability to coordinate and adjust the process on an ongoing basis that may be regarded as one of the most significant signs of development in the organizational-projective component.

Comparison of the three data sources after the third training session also showed that participants' self-assessments became more closely aligned with actual behavior than they had after the first assessment point. Whereas at the initial stage some participants assessed their abilities somewhat more highly than

was confirmed by observation and analysis of digital artifacts, by the end of the program, this discrepancy had decreased. This may indicate an increase in reflective adequacy: participants began to understand more clearly what high-quality digital teamwork actually means and to align their own actions more accurately with the relevant criteria. Such a change is no less important than the development of behavioral manifestations themselves, because it reflects a transition from an intuitive to a more conscious attitude toward digital team interaction.

In level-based terms, the results after the third training session indicate that the predominance of the initial level decreased, while the positions of the basic and advanced levels strengthened. A significant proportion of participants, after completing the training series, already demonstrated the ability not only to take part in digital teamwork within a given structure, but also to sustain its substantive logic, coordinate their own contribution with others, engage in collaborative editing, and partially organize the process. The expert level did not become widespread even at this stage, which is natural given the study's pilot character, the short duration of the intervention, and the characteristics of the sample. At the same time, the behavior of certain participants already showed elements approaching that level, especially in facilitating the team, maintaining the process's logic, and flexibly organizing shared activity.

The overall pattern of results after the third training session allows several substantive conclusions to be drawn. First, within a short-term program, the communication-facilitation component develops most quickly, though its sustained quality requires systematic teacher involvement in meaningful team interaction. Second, the cooperative-productive component develops when participants are given the opportunity to work not on a formal task, but on a shared digital product that requires alignment and refinement. Third, the organizational-projective component is especially sensitive to methodically organized tasks involving digital boards, trackers, and explicit project logic. This means that precisely this type of activity is the most productive for developing structured digital teamwork.

A summary of the results of the second assessment point is presented in Table 5.5.

Table 5.5
Summarized Characteristics of the Results After the Third Training Session

Component	*General characteristics of manifestation*	*Final conclusion*
Communication-facilitation	Interaction became more meaningful and structured; the quality of feedback and facilitative actions increased	The component acquired a more stable and more conscious character
Cooperative-productive	Shared digital products became more coherent and aligned; coordination of editing and refinement increased	The capacity for collective digital authorship was strengthened
Organizational-projective	There was a visible increase in planning, role distribution, use of digital boards, and process adjustment	This component demonstrated the most pronounced positive dynamics
Overall level	The proportion at the initial level decreased, while the basic and advanced levels strengthened	The series of training sessions contributed to the development of an integrated capacity for digital teamwork

Source: Authors' own work.

Thus, the results after the third training session demonstrated positive changes across all three components of teachers' digital teamwork skills. Participants became more confident in working as a team in the digital environment, and their interactions became more structured, coherent, and effective. This creates the basis for a direct comparison of the two assessment points and for a generalized analysis of the dynamics of change, which constitutes the subject of the next subsection.

5.6. Comparative analysis of the results from two time points

The comparative analysis of results from the two assessment points revealed a clear positive trend in the development of digital teamwork skills among participants in the

pilot experiment. The analysis used the individual scores of 26 participants across three components: communication and facilitation, collaborative creation of digital content, and team project management. All indicators were recorded on a four-point scale, where 1 corresponded to the initial level, 2 to the basic level, 3 to the advanced level, and 4 to the expert level. The first assessment point was conducted after the first training session, and the second after the third.

At the descriptive statistics level, mean values increased across all three components. For the communication and facilitation component, the mean score increased from 2.04 to 3.12, representing a gain of 1.08 points. For the collaborative creation of the content component, the mean score also rose from 1.77 to 2.85, again by 1.08 points. The largest increase was recorded for the team project management component: the mean score rose from 1.77 to 3.04, an increase of 1.27 points. In the aggregate dimension, the mean integrated indicator across the three components increased from 5.58 to 9.00 points out of a maximum possible 12, indicating an average gain of 3.42 points.

Median values also indicated a positive shift. For each separate component, the median increased from 2 to 3, while the overall median increased from 6 to 9 points. This means that the changes affected not only a few more successful participants, but the group as a whole. In other words, after completing the training series, the typical participant no longer demonstrated an initial-basic level but rather a predominantly basic-advanced or advanced level of digital teamwork. The distribution of total scores also shifted toward higher values: whereas after the first training session, individual totals ranged from 3 to 8 points, after the third, they ranged from 6 to 12 points.

Analysis of individual dynamics confirmed the stability of the positive changes. For the communication and facilitation component, improvement was demonstrated by 24 of the 26 participants (92.3%); the remaining 2 participants maintained the same level, and no decline was observed. The same pattern was observed for the collaborative content creation component: 24 participants (92.3%) improved their results, while 2 remained at the previous level. For the team project management component, growth was observed among all 26 participants (100% of the

sample). In the aggregate dimension, the overall score increased for every participant.

The changes are also visible in the redistribution of levels. For the communication-facilitation component, after the first assessment point, the group included 6 participants at the initial level, 13 at the basic level, and 7 at the advanced level; after the third assessment point, the initial level disappeared, the basic level remained in only 5 participants, while 13 participants reached the advanced level, and 8 reached the expert level. For the cooperative-productive component, the number of participants at the initial level decreased from 9 to 0, at the basic level from 14 to 9, while the advanced level increased from 3 to 12, and the expert level included 5 participants. For the organizational-projective component, the initial level decreased from 8 to 0, the basic level from 16 to 4, while the advanced level rose from 2 to 17 participants, and the expert level to 5 participants. This redistribution confirms that the most pronounced changes occurred precisely in the components that were weakest at the start, especially the organizational-projective one.

For brief statistical verification of the dynamics, a paired pre-post analysis was appropriate. Given that the scale was ordinal with four levels, the most appropriate procedure was the nonparametric Wilcoxon signed-rank test for dependent samples. It showed statistically significant changes across all three components and for the total score: for communication and facilitation, $p = 0.000004$; for collaborative content creation, $p = 0.000004$; for team project management, $p = 0.000003$; and for the total score, $p = 0.000005$. Thus, the probability that the observed changes were random is extremely low. An additional paired t-test also confirmed the statistical significance of the differences; however, in this study, it is more appropriate to treat it as supplementary rather than primary, precisely because of the ordinal nature of the scale. The results of both approaches converge and indicate a reliable positive dynamic.

The data obtained allow several general conclusions to be drawn. First, the series of three training sessions proved sufficient to achieve noticeable growth across all three components of digital teamwork, even within a short-term pilot format. Second, the organizational-projective component proved the most sensitive to

the training intervention, as evidenced by the largest mean gain and by the fact that all participants showed progress. Third, the communication-facilitation and cooperative-productive components also increased substantially, although their development was somewhat more even. Fourth, the results confirm that the combination of meaningful digital communication, collaborative product creation, and project-based organization of activity is methodologically productive for developing an integrated capacity for teamwork in a digital educational environment.

The summarized quantitative data are presented in Table 5.6.

Table 5.6
Comparative Results of the Two Assessment Points

Indicator	*After the 1st training session*	*After the 3rd training session*	*Gain*
Communication and facilitation, mean score	2.04	3.12	+1.08
Collaborative content creation, mean score	1.77	2.85	+1.08
Team project management, mean score	1.77	3.04	+1.27
Total indicator, mean score	5.58	9.00	+3.42
Total indicator, median	6	9	+3

Source: Authors' own work.

Thus, the comparative analysis of the two assessment points demonstrated a statistically significant positive dynamic across all components of digital teamwork skills. The most pronounced growth occurred in the organizational-projective dimension, although substantial changes were also recorded in the communication-facilitation and cooperative-productive components. This provides grounds for considering the piloted methodology an effective means of developing digital teamwork among future master's students in secondary education in online interaction.

5.7. Interpretation of Results and Limitations of the Pilot Study

The results of the pilot experiment provide grounds for stating that the proposed methodology for developing teachers' digital teamwork skills is methodologically well-grounded and practically workable. The positive dynamics recorded across all three components indicate not merely an increase in participants' activity in the digital environment, but also qualitative changes in the nature of their teamwork. This means that the series of three weekly training sessions created conditions not simply for episodic use of digital services, but for the development of more structured, conscious, and effective shared activity in which communication, collaborative product creation, and project-based organization of the process are combined.

First, the results confirm the validity of the initial theoretical proposition regarding the integrated nature of digital teamwork skills. Within the pilot study, it became clear that the communication-facilitation, cooperative-productive, and organizational-projective components do not develop in isolation. Growth in the quality of digital communication was accompanied by better coordination during collaborative product creation, while a more structured process organization strengthened the meaningfulness of interaction and the alignment of contributions. For this reason, the results obtained should be interpreted not as a sum of separate improvements, but rather as a manifestation of the gradual formation of an integrated capacity to act as a team member in a digital educational environment.

It is especially revealing that the largest increase was recorded in the organizational-projective component. This may have several explanations. First, this component was the least developed at the initial stage, and therefore, its potential for change was the greatest. Second, the third training session, built around the use of digital boards, visualization of stages, role distribution, and process adjustment, directly activated those actions that had previously remained implicit or situational for most participants. Third, for future master's students in secondary education, the very idea of project-organized teamwork in a digital environment was likely new and therefore especially sensitive to purposeful formative intervention. In this sense, the results

suggest that the organizational-projective dimension is among the most promising avenues for further improving teachers' professional preparation.

No less important is the interpretation of the growth of the communication-facilitation component. Although this component proved the most readily activated, it only acquired greater structure and awareness after completion of the entire program. The data obtained indicate that digital communication within a team develops from a simple activity and mutual responsiveness into a more meaningful facilitative interaction in which summaries, clarifications, support for the logic of the discussion, constructive feedback, and orientation toward a shared decision begin to appear. This means that communication skills in a digital environment should be understood not merely as technical readiness to communicate, but as a professionally significant capacity to sustain the team process.

The cooperative-productive component also showed substantial growth, allowing an important conclusion to be drawn about the role of the shared digital product in preparing future teachers. It was precisely work on an agreed result that could not be produced through individual effort alone that proved methodologically productive for the transition from formal interaction to genuine collaboration. Collaborative editing, commenting, alignment of structure, and refinement of the digital product gave participants experience of collective authorship that has direct relevance for future pedagogical practice. In this regard, the results of the study confirm that digital teamwork skills are most effectively developed when the team works not around abstract discussion but around a shared, professionally meaningful result.

Another significant outcome is the convergence between participants' self-assessments and their actual behavior, as documented through observations and analyses of digital artifacts. At the initial stage, there was a certain discrepancy between subjective confidence and the actual quality of team interaction. After the program, this discrepancy decreased, suggesting an increase in reflective maturity among participants. They not only began to act more effectively in the digital team environment, but also came to better understand what high-quality teamwork

actually entails. This has particular value because it indicates growth in awareness and, therefore, strengthens the likelihood that the acquired experience will transfer into real professional practice.

The results of the pilot experiment should be considered in the broader field of contemporary research on teachers' digital competence, teachers' professional development, and collaborative activity in a digital educational environment. The overall positive dynamics recorded across all three components of digital teamwork skills are consistent with the conclusions of researchers who emphasize that teachers' professional readiness for digital activity develops most productively not through isolated mastery of tools, but through participation in systematic, practice-oriented, and collaborative formats of professional learning. This conclusion is articulated in the systematic review by Amemasor et al. (2025), which stresses that the most effective professional development programs combine practical digital training, collaborative environments, mentoring, and institutional support. In this sense, the results of our pilot study confirm the effectiveness of an approach in which the development of teachers' digital teamwork is built on real, shared activity rather than merely on instructional familiarization with platforms.

The data obtained also align with the conclusions of Hodges et al. (2026), who highlight the long-standing deficit in systematic teacher preparation for digital teaching and emphasize the fragmented nature of many initiatives in this area. Our results show that even a short-term, substantively and methodologically coherent series of training sessions can produce a pronounced developmental effect. This provides grounds for arguing that the problem lies not only in the amount of digital training, but also in its internal logic. If professional development is organized around integrating communication, collaborative product creation, and project-based activity, even a relatively short format can be meaningful. At the same time, our results do not contradict the position of Hodges et al. (2026), but rather reinforce it: a short-term positive effect should be treated as an argument for systematically embedding such practices into teacher education programs, not as proof that isolated interventions are sufficient.

It is important that our study's results align with contemporary approaches to understanding teachers' digital competence as a multidimensional professional construct. In particular, Tzafilkou et al. (2023) argue that digital competence should be assessed not only through technical actions but also through pedagogical, professional, and innovative elements. In our study, we further developed this logic: we effectively isolated the teamwork dimension of teachers' digital professional activity and showed that it cannot be adequately captured when assessment is limited to a general evaluation of digital readiness. The positive dynamics across the three components confirm the value of such a specification. In other words, the pilot experiment's results indicate that digital teamwork warrants consideration as a separate structural dimension of teachers' professional competence.

A similar line of reasoning is supported by the conclusions of García-Delgado et al. (2023), who, based on a study of teachers at different educational levels in Spain, identified a predominantly intermediate level of digital competence and emphasized the need to strengthen it from initial preparation through continuing professional development. Our results add an important nuance to this argument: even when the overall level of digital readiness appears acceptable, the teamwork dimension of the activity often remains underdeveloped, especially in organizing the shared process. It is precisely for this reason that, in our study, the organizational-projective component showed the greatest increase. Such dynamics suggest that, in ordinary educational preparation, this particular dimension of digital interaction remains insufficiently articulated and rarely becomes the object of purposeful development.

The conclusion about the importance of institutional and cultural factors in teachers' professional digital development is also supported by our study. Masoumi and Noroozi (2023), in their analysis of the development of professional digital competence among teachers in the early stages of their careers, show that it is substantially influenced by institutional culture, resource availability, managerial support, mentoring, and workload. In our pilot study, these factors were not themselves the direct subject of measurement. However, the results indirectly confirm their

significance. In particular, the positive dynamics among participants became possible because the training sessions were organized in a functionally structured digital environment, with clear task structure, time frames, accessible tools, and reflective support. This means that teachers' digital teamwork develops not only as an individual capacity, but also as the result of an interaction between personal effort and institutionally organized conditions.

The results obtained are also consistent with the conclusions of Lin et al. (2022), who demonstrate that digital pedagogical competence is an important mediator between ICT skills, data literacy, and learners' actual empowerment. In our study, this logic appears in a different but related form: the technical affordances of digital platforms alone do not ensure effective team interaction unless embedded in pedagogically meaningful activity. The training series was effective not because participants simply worked in Zoom or Miro, but because these tools were integrated into the logic of a shared professional task requiring communication, alignment, collaborative editing, and project coordination. Thus, our study provides additional support for the thesis that digital competence acquires real value only when combined with pedagogical functionality.

Particular attention should also be given to comparing our results with studies on collaborative and team-based learning. Brannan et al. (2019) show that team-based learning creates systematic conditions for engaging participants in solving meaningful problems in small groups and contributes to the development of critical thinking. Although their study does not directly concern teachers' digital teamwork, it is important for interpreting our results because it confirms the fundamental productivity of the small-team format. In our experiment, it was precisely the micro-group organization that proved most suitable for making each participant's contribution visible, for shaping the character of the role distribution, and for the modes of communication and coordination. This makes it possible to argue that small teams are not only a convenient organizational format, but also an important condition for the development of digital teamwork as a professional capacity.

In a similar way, the results of our study resonate with the conclusions of Kuznetsova et al. (2023), who showed that virtual team building has a positive effect on communication, motivation, a sense of cohesion, and interest in shared work, although it does not entirely eliminate the advantages of the face-to-face format. Our experiment was also conducted entirely online, and the results confirm that the digital environment can be sufficiently productive for developing teamwork, provided that the activity is specially organized. At the same time, our data somewhat extend this position, as they show not only the communicative or motivational effects of online interaction, but also the development of the ability to collaboratively create a product and to organize a team process in project form. This makes it possible to speak of virtual teamwork not merely as a compensatory format in conditions of distance, but as a distinct, professionally valuable practice.

Results from team analytics studies are also important for interpreting our findings. Echeverría et al. (2024a), analyzing TeamSlides as a multimodal dashboard for supporting teacher-guided reflection, showed that digital analytics can substantially enhance discussion and reflective practice, although it also creates risks of interpretive difficulty. In our study, we did not use complex analytical dashboards, but our approach to analyzing digital artifacts, revision histories, comments, and board structures aligned with theirs. This allows an important conclusion to be drawn: digital traces of team activity have not only diagnostic, but also educational value. Their use for reflection may be a promising direction for further development of the methodology, especially in later stages of research.

The findings of Abildinova et al. (2024) also have interpretive value, as they emphasize that active teaching methods and digital integration are more effective when they foster genuine participation rather than passive absorption of material. Our experiment, in essence, confirmed this thesis in the context of preparing future teachers. The positive dynamics across all three components were driven not by expanding the amount of information about teamwork, but by participants acting as a team in the digital environment while carrying out professionally relevant tasks. This once again demonstrates that, in preparation

for digital teamwork, the decisive factor is the activity-based format itself.

At the same time, the results of the pilot study should be interpreted in light of its limitations. First, it should be noted that this was a small, purposeful sample consisting of 26 future master's students in secondary education from one higher education institution. Such a sample is sufficient for pilot testing the methodology, but it does not provide grounds for broad generalizations about all categories of teachers or learners. For this reason, the results should be viewed as evidence of the proposed approach's promise rather than as final proof of its universal effectiveness under any conditions.

The second limitation is the short duration of the formative intervention. The series of three training sessions enabled the identification of positive dynamics, but it does not allow conclusions about the stability of the acquired changes in the medium- or long-term. The question remains open as to the extent to which the developed skills will be retained after completion of the program, whether they will transfer to new professional situations without special support, and whether they require further reinforcement in longer learning formats. For this reason, a promising direction for future research is delayed measurement or the development of a longer professional development program.

The third limitation concerns the research design. Measurements were conducted after the first and third training sessions, so there was no separate pre-experimental assessment before any formative activity began. This approach was methodologically justified in the pilot format because the first training session performed a diagnostic and activation function. Nevertheless, it limits the possibility of a more rigorous comparison with a fully pre-formative state. In a broader study, it would be advisable to combine initial, intermediate, final, and, if possible, delayed assessment points to provide a more detailed picture of the dynamics of development.

The fourth limitation is the absence of a control group. Within the pilot study, the main task was to test the methodology and document initial changes, rather than to provide strict

experimental proof of causal relationships. However, to further deepen the study, it would be advisable to include a control group working in a traditional format or in another digital learning model. This would make it possible to show more convincingly the specific contribution of the proposed methodology itself to the development of digital teamwork skills.

The fifth limitation concerns the context-dependent nature of the results. All training sessions were conducted online using specific digital tools such as Zoom, messengers, shared Miro-type boards, and other services. On the one hand, this strengthens the ecological validity of the study, since the work did indeed take place in a digital environment. On the other hand, the results may partly depend on how convenient, understandable, or appealing these specific tools proved to be for this particular group of participants. In further research, it would be advisable to test the extent to which the methodology's effect is maintained when other platforms are used or under blended interaction conditions.

Despite these limitations, the pilot study fulfilled its main function. It confirmed that digital teamwork skills can be the object of purposeful development, that the developed system of criteria, indicators, and levels is workable, and that the combination of digital communication, collaborative product creation, and project-based organization of activity is methodologically productive for developing the corresponding professional skills. In addition, the study enabled refining the methodology's most sensitive points, observing differences in the dynamics of individual components, and outlining directions for further improvement.

Thus, the results of the pilot study make it possible to consider the proposed methodology a promising means of developing digital teamwork skills among future teachers, while at the same time maintaining research caution regarding the scale of generalizations. The positive dynamics observed across all three components confirm the effectiveness of an integrated approach to developing digital team interaction, while the identified limitations indicate directions for further, more extensive research. On this basis, one may move to practical recommendations for developing teachers’ teamwork in a digital educational environment. More generally, the results of our pilot

study not only align with the available scientific evidence but also refine it in several respects. First, they make it possible to specify teachers' digital teamwork as a separate object of research and professional development. Second, they show that the most productive methodology is an integrated one that combines meaningful digital communication, collaborative product creation, and project-based organization of activity. Third, they confirm that even a short series of training sessions can produce a statistically significant developmental effect when based on professionally relevant tasks and a structured digital environment. Fourth, they point to the promise of further studies involving a larger sample, the inclusion of a control group, the use of delayed assessments, and the expansion of the analytical potential of digital artifacts.

6. Practical recommendations for fostering teamwork among teachers in a digital educational environment

The theoretical substantiation of the structure of teachers' digital teamwork skills, the results of the pilot experiment, and the analysis of the dynamics of change provide grounds for moving to the practical level of generalization. Whereas the previous sections focused on the essence of the phenomenon under study, its components, the assessment system, and the possibilities for its purposeful development, this section shifts the emphasis to the practical implementation of the findings in educational activity. What is meant here are those recommendations that may be used to support and develop teachers' teamwork in a digital educational environment at the level of the educational institution, the system of professional development, and individual pedagogical practice.

The need for such recommendations stems from the fact that digital teamwork does not arise automatically from access to platforms, messengers, cloud services, or digital boards. Its development requires not only technical possibilities, but also an appropriate organizational culture, specially created conditions for professional collaboration, methodological support, time for shared planning, and an understanding that the digital environment is a space not only for individual, but also for collective pedagogical activity. For this reason, practical recommendations should not concern only one separate level, but

should encompass the entire complex of conditions within which teachers' teamwork is formed and implemented.

The results of the pilot experiment showed that the most significant positive changes occur when digital teamwork is organized around professionally meaningful tasks, when functionally appropriate tools are used for communication, collaborative product creation, and project coordination, and when participants have the opportunity to work in small groups, pass through the stages of planning, mutual alignment, editing, and reflection. This means that practical recommendations should be based not on general calls for digitalization or cooperation, but on concrete mechanisms for organizing shared activity.

Within this section, the recommendations are presented in three interrelated directions. The first concerns educational institutions and their managerial level, since it is at this level that organizational conditions, institutional rules, digital infrastructure, and a culture of professional interaction are created. The second direction concerns the system of in-service training and professional development, where special learning formats oriented toward the formation of digital teamwork as a distinct professional capacity may be embedded. The third direction concerns the teacher and their own professional practice, because even with institutional support and appropriate development programs, the decisive importance still lies in the teacher's personal readiness for teamwork, self-analysis, and the transfer of acquired modes of action into the real educational process.

Thus, the practical recommendations presented below are intended not merely to summarize the study's results, but to transform them into a set of guidelines for effectively improving teachers' digital teamwork. For this reason, it is first advisable to turn to recommendations for educational institutions and their leaders, since without institutional support, the individual and group efforts of teachers often remain fragmentary and unstable.

6.1. Recommendations for Educational Institutions

The development of teachers' teamwork in a digital educational environment depends to a large extent on the degree

to which the educational institution creates organizational, technical, and methodological conditions for this. It is precisely the institutional level that determines whether teachers' digital interaction will remain random and situational or acquire the character of a stable professional practice. For this reason, recommendations for educational institutions and their leaders should encompass not only issues of technical provision, but also a wider circle of aspects: organization of shared activity, regulation of digital interaction, support of pedagogical teams, creation of a culture of collaboration, and recognition of teamwork as a meaningful component of the teacher's professional activity.

First of all, educational institutions should regard teachers' digital teamwork not as a secondary supplement to individual activity, but as a norm of contemporary professional interaction. This means that managerial decisions, internal regulations, methodological work, and the organization of the educational process should all embody an understanding of shared planning, the collective creation of materials, the coordination of digital interaction, and the exchange of professional resources as ordinary and expected forms of activity. If, however, an individualized model of professional work dominates, even the presence of digital platforms will not ensure the real development of teamwork. For this reason, the first practical step should be to institutionalize the value of pedagogical collaboration in a digital environment.

The second important direction is the creation of a functionally organized digital environment. Educational institutions should avoid situations in which teachers are forced to use a large number of uncoordinated platforms, messengers, and services in parallel, without a clear application logic. Such digital fragmentation does not support teamwork and, on the contrary, often makes it more difficult. Instead, it is advisable to define an agreed set of tools for the main types of activity: one for synchronous interaction, one for collaborative editing, and one for planning and project support. This does not mean excessive standardization, but it does require a clean digital environment in which pedagogical teams can work without constantly losing time to technical switching or to clarifying which tool to use for which purpose.

The third recommendation concerns the organization of time for team interaction. One of the main obstacles to the development of teachers' teamwork is not only a lack of tools but also a lack of time specifically allocated for shared planning, alignment, and refinement of materials. If teamwork takes place only "in passing," in the intervals between main duties, it usually remains superficial. Therefore, school leaders should provide organizational formats that give teachers' shared work temporal legitimacy: methodological sessions, digital workshops, team consultations, brief coordination meetings, and shared blocks for developing materials or reflectively discussing common decisions. Without such managerial recognition of time, digital teamwork risks remaining fragmentary.

The fourth direction is support for small pedagogical teams as the most productive format of digital collaboration. The pilot experiment showed that the micro-group format creates the best conditions for the visibility of each participant's contribution, a clear role distribution, collaborative product creation, and the organization of the team process. For this reason, educational institutions should develop not only general forms of collective work, but also small pedagogical teams organized around a common course, a subject module, an interdisciplinary theme, an educational direction, a digital resource, or an educational project. Such teams are best suited to the development of stable digital teamwork skills.

The fifth important step is the stimulation of collaborative creation of digital products. In educational institutions, teachers' digital interactions are often limited to messages, files, and brief coordination actions. Yet teamwork develops most intensively when teachers have a shared professional result for which they are jointly responsible. Leaders should support precisely such formats: collaborative creation of methodological materials, assessment templates, digital collections of resources, integrated tasks, scenarios for educational events, interdisciplinary modules, visual schemes, or instructional presentations. In this case, the digital environment begins to function not only as a channel of communication but as a space of collective pedagogical authorship.

The sixth recommendation is the introduction of simple mechanisms for organizing team activity in a project-based manner. What is meant here is not formal overloading of teachers with management elements, but the use of accessible digital tools to document stages, tasks, roles, and deadlines. Even an elementary digital board with designated responsible persons and status indicators can substantially increase transparency in teamwork. Therefore, educational institutions should support the use of such tools in pedagogical teams' activities while avoiding their bureaucratization. The value of digital boards and trackers lies not in reporting, but in helping the team see the structure of its own work and respond in a timely way to difficulties.

The seventh recommendation is tied to the need to foster a culture of digital communication and feedback. High-quality teamwork depends not only on the task content but also on how teachers communicate in the digital environment: whether they can formulate messages clearly, provide constructive feedback, respond appropriately to revisions, and maintain a productive atmosphere without excessive tension. For this reason, leaders should encourage such forms of methodological work in which not only results are discussed, but also the modes of digital interaction themselves. This may include analyzing a shared project, examining examples of digital communication, discussing typical difficulties in teamwork, and developing common rules for using comments, messages, and shared documents.

The eighth direction concerns methodological support and mentoring. Not all teachers enter digital teamwork with the same level of readiness. Some may use platforms quite confidently, but experience difficulties with facilitating group interaction or with project planning. Others, on the contrary, may have good organizational skills but feel uncertain in working with shared documents or digital boards. For this reason, it is advisable to create mechanisms of internal mentoring, in which more experienced participants can help colleagues not only technically, but also methodologically, showing how a digital tool is embedded in the logic of real team activity.

The ninth recommendation is the use of a developmental assessment of digital team activity. Educational institutions should avoid an approach that assesses digital teamwork solely by the

presence of a final product or by the mere fact of participation. Instead, attention should also be paid to process-oriented features: the character of communication, coherence of actions, transparency of role distribution, the ability to collaboratively refine the result, and the use of digital traces for reflection. Such an assessment allows us not to punish imperfection but to support the team's development, highlighting strengths and areas for improvement.

The tenth recommendation is to create an atmosphere of professional safety and trust. Digital teamwork develops effectively only when teachers are not afraid to express proposals, ask questions, acknowledge difficulties, revise previously proposed decisions, and collectively refine the result. If the digital environment within the institution is used primarily as an instrument of control or criticism, teachers begin to avoid open interaction, limit their contributions to the minimum, and gravitate toward individual autonomy. Therefore, leaders should support a culture of professional partnership in which digital tools strengthen collaboration rather than create tension.

Thus, the development of teachers' teamwork in a digital educational environment requires not so much individual technical solutions as a coherent organizational policy at the educational institution level. It is at the institutional level that conditions should be created under which teachers' digital interaction acquires a systemic character, rests on a functionally organized environment, is supported in terms of time and methodology, and becomes part of professional culture. The next logical step is to consider recommendations for the in-service training system, since it is precisely this system that can ensure the purposeful development of the corresponding skills on a broader professional scale.

6.2. Recommendations for the System of In-Service Training

The system of in-service teacher training should regard the development of digital teamwork skills not as a side effect of digitalization, but as a separate direction of professional development. Such a need is subject to the fact that traditional forms of in-service training often focus either on subject content,

on mastery of particular digital tools, or on general issues of teaching methodology. At the same time, the teacher's ability to work in a digital environment as a team member, facilitator, co-author of a shared product, and co-organizer of a team process often remains outside focused attention. For this reason, the professional development system should move from episodic inclusion of digital collaboration elements to the purposeful development of the corresponding skills.

First of all, it is advisable to recommend inclusion of the topic of digital teamwork in the content of professional development programs as a separate substantive module. What is meant here is not merely training in the use of videoconferencing platforms, shared documents, or digital boards, but understanding how these tools function within the logic of team interaction. Professional development programs should specifically address digital communication, facilitation, collaborative editing, role distribution, coordination across work stages, project-based organization of activities, and reflective analysis of digital artifacts. Without such substantive specification, digital teamwork will remain a diffuse notion and will not acquire the status of a clearly defined professional capacity.

The second important direction is the reorientation of professional development formats from predominantly lecture- and information-based to activity-based. The experience of the pilot study shows that digital teamwork skills develop not through explanation of their importance, but through involving teachers in specially organized shared activity. For this reason, professional development programs should include training, micro-projects, practical sessions on collaborative creation of digital products, and short cycles of team tasks in which participants do not merely listen about digital collaboration, but actually practice it. Such an approach is much more productive for the formation of stable modes of action than demonstration of individual services without immersion in shared professional work.

The third recommendation is to construct professional development programs according to a logic of gradual increases in complexity. Professional growth in this area should not begin immediately with complex project formats if participants do not yet have sufficient confidence in digital team communication. It is

advisable to first develop the ability to sustain meaningful interaction, provide constructive feedback, and make simple decisions, then move to collaborative creation of a digital product, and only then to full organization of the team process through the use of boards, trackers, roles, and temporal coordination. Such staging ensures not only a clear learning trajectory but also reduces the risk of overloading teachers with varying prior digital interaction experiences.

The fourth direction concerns reliance on professionally relevant tasks. In-service training programs should offer teachers not artificial exercises, but such forms of work that directly reproduce situations typical of their own practice. These may include collaborative development of a learning module, creation of an integrated task, design of assessment criteria, preparation of a digital collection of resources, development of a plan for an educational event, or alignment of a team-based model of learner support. It is precisely through such tasks that digital teamwork acquires professional meaning for the teacher. It ceases to be perceived as a formal training activity and is understood as a way to solve real pedagogical problems.

The fifth recommendation is the mandatory inclusion of various digital interaction formats in professional development programs, above all, synchronous and asynchronous ones. Teachers should learn to act in conditions of live online discussion, where rapid alignment and facilitation are needed, as well as in asynchronous mode, where particular importance lies in the precision of messages, written coordination, work with comments, adherence to deadlines, and documentation of changes. If a professional development program is oriented only toward synchronous webinars, it does not form a full experience of digital teamwork. By contrast, the combination of different interaction modes makes learning more closely aligned with real pedagogical practice.

The sixth important step is the use of professional development not only for communication tools but also for collaborative editing and project management services. Many digital literacy programs focus mainly on meeting platforms or on separate electronic resources. Yet for the development of teamwork as such, this is not enough. Teachers should, in

practice, work with shared documents, Miro-type boards, planning services, role-distribution tables, and team-project templates. This is needed not for the sake of technical variety, but because different tools correspond to different types of team action. The professional development system should help teachers see this correspondence and consciously choose a tool for a particular professional task.

The seventh recommendation is to introduce a reflective component as a mandatory part of programs. Professional development in the area of digital teamwork cannot be effective if participants merely complete tasks without reflecting on how they actually acted. After shared work, teachers should analyze which communication practices were productive, where difficulties arose, how roles were distributed, whether the team managed to preserve the integrity of the product, and what helped or hindered progress. Such reflection transfers experience from the level of a one-time activity to that of a conscious professional skill. For this reason, it is advisable to include short analytical sessions, self-assessment, peer assessment, analysis of digital artifacts, and shared discussion of the course of team activity in professional development programs.

The eighth direction concerns the need for a differentiated approach. Participants in professional development programs may differ substantially in experience of digital interaction, confidence in working with tools, readiness for facilitation, project thinking, or collaborative editing. For this reason, it is desirable to avoid identical requirements and identical pace for everyone without exception. It is advisable to provide variable trajectories for task completion, different levels of complexity, the option to choose a role in the team, supportive materials for those who need greater guidance, and, at the same time, more complex tasks for those who already have sufficient experience. Such an approach not only increases the effectiveness of learning but also reduces the risk of merely formal inclusion of some participants in team activity.

The ninth recommendation is the use of developmental assessment in professional development programs. The system of professional growth should not be limited to certifying participation or assigning a final score. It is also advisable to assess the process of team interaction itself: the quality of digital

communication, the nature of feedback, coherence of contributions, the ability to organize project-based work, and the use of digital boards and shared documents. Such an assessment should be supportive rather than punitive. Its function is to help the teacher see which aspects of digital teamwork have already become a professional strength and which still require further growth.

The tenth recommendation concerns the professional development of trainers and instructors. It is impossible to teach teachers digital teamwork in a format in which the organizers themselves work mainly individually, without facilitation, collaborative editing, or project logic. For this reason, trainers should not only know about these skills but also demonstrate them in their own practice. The very organization of the program should be a model of the digital team interaction that it seeks to develop. This means that participants should see examples of meaningful digital communication, carefully organized environments, structured tasks, transparent roles, and a reflective summary of results.

Separately, it is worth recommending that the professional development system orient itself not toward one-time short events, but toward cyclical or modular formats of professional learning. Such formats make it possible to combine initial immersion, practice, application in real conditions, and renewed reflection on experience. A short webinar may raise awareness, but it rarely forms stable digital teamwork skills. By contrast, a modular course or a series of interconnected sessions creates the possibility for gradual growth, repetition of actions in new situations, and documentation of the dynamics of change. In this respect, the pilot study results confirm the effectiveness of a serial training format.

Thus, the system of in-service teacher training should regard digital teamwork as a separate and methodologically significant object of professional development. For this purpose, it is necessary to integrate the corresponding topic into educational programs, orient them toward activity-based formats, use professionally relevant tasks, combine synchronous and asynchronous interaction, apply tools for collaborative editing and project management, provide reflective support, differentiated

assistance, and developmental assessment. Only under such conditions can in-service training become not a source of isolated technical knowledge, but a space for the real formation of the teacher's ability to engage in meaningful, organized, and effective teamwork in a digital educational environment.

6.3. Recommendations for Teachers' Self-Development

Despite the significance of institutional support and the in-service training system, the development of digital teamwork skills depends to a large extent on the teacher's professional stance. It is precisely the individual readiness for collaboration, openness to shared creation of a product, ability to reflect on one's own role in the team, and desire to improve ways of digital interaction that determine whether the digital environment becomes for the teacher a space of real professional cooperation. For this reason, practical recommendations for teachers' self-development should aim not only at mastering specific skills, but also at forming a stable orientation toward teamwork as an integral component of contemporary pedagogical activity.

First of all, teachers should purposefully develop in themselves an understanding that digital teamwork is a distinct professional capacity rather than a secondary consequence of technological proficiency. This means it is worthwhile to consciously distinguish between situations in which digital tools are used only for individual work and those in which they genuinely support shared planning, coordination, the creation of materials, mutual editing, and project interaction. Such understanding is important in itself because it helps the teacher move from a technical attitude toward digital platforms to a professional-pedagogical understanding of their possibilities.

The second important direction of self-development is the formation of a habit of reflective analysis of one's own digital interaction. Teachers should regularly ask themselves not only whether the shared task was completed, but also how exactly the teamwork unfolded. Was the communication genuinely meaningful? Was it possible to provide constructive feedback? Were the roles clear? Did the shared work amount only to a mechanical combination of separate parts? Were the digital tools

used in a functionally appropriate way? Such reflection gradually forms a more conscious attitude toward one's own teamwork behavior and enables one to see not only obvious successes but also hidden problematic areas.

The third recommendation is that teachers should not limit their own digital development to individual mastery of services. A much more productive approach is one in which a digital tool is mastered immediately within team logic. If a teacher is learning to use a shared document, it is advisable not simply to create an individual file, but to work with a colleague on a shared text using comments, revision mode, and version alignment. If a digital board is being explored, it is worthwhile to use it at once for planning a micro-project, distributing roles, or collaboratively structuring ideas. Such practice gives much more for the development of digital teamwork than individual testing of a platform's functions outside the context of shared activity.

The fourth direction of self-development is the conscious improvement of digital communicative culture. Teachers should pay attention to the clarity of their own messages, the appropriateness and meaningfulness of their comments, the way they formulate disagreement, the quality of their feedback, and their ability to summarize and document decisions. In the digital environment, communication often determines the success or failure of shared work. For this reason, it is worth working not only on the technical speed of reaction but also on the ability to make communication functional, appropriate, productive, and oriented toward a shared result. Particularly important is the habit of not leaving shared activity at the level of "we will agree later," but of moving discussion toward documented decisions, deadlines, and clear next steps.

The fifth recommendation concerns developing readiness for shared authorship. For many teachers, an individual logic of material creation, in which one's own product is perceived as completely autonomous, is more natural. However, the digital educational environment increasingly requires readiness to work in an open, collaborative mode of creation and editing. For this reason, teachers should gradually develop the ability to work with colleagues' comments, agree on changes, adapt their own fragments to a shared structure, return to previously created

material, and improve it in line with the logic of a collective result. This not only expands digital professional possibilities but also fosters a culture of partnership, which is important for contemporary pedagogical activity.

The sixth recommendation is the conscious mastering of elementary project logic in the digital environment. Teachers should learn to see a team task not only as a topic for discussion, but also as a process with stages, roles, time boundaries, interim results, and a need for coordination. For this purpose, even in small shared tasks, it is useful to employ simple planning tools: digital boards, lists of actions, labels of responsibility, documentation of deadlines, and updates of completion status. Such practice gradually forms the organizational-projective component of digital teamwork and reduces dependence on external coordination.

The seventh direction concerns the teacher's participation in professional digital communities. Self-development in the sphere of digital teamwork is significantly strengthened when the teacher has experience of regular participation in professional groups, networks, communities of practice, or temporary teams working toward a concrete result. Such communities may be subject-specific, interdisciplinary, methodological, or project-based. Their value lies in creating a natural environment for shared planning, idea discussion, resource exchange, mutual editing, and collective decision-making. For this reason, professional communities should be regarded not only as a channel of information exchange but also as an environment for the development of digital teamwork skills. Such discussions help communities not only produce results but also become spaces of professional learning for one another. This is precisely their special value for the development of digital teamwork.

Thus, teachers' self-development in the sphere of digital teamwork requires a conscious orientation toward collaboration, reflection on one's own digital behavior, readiness for shared authorship, gradual mastery of project logic, and involvement in professional digital communities. At the same time, these professional communities themselves should become not merely environments for exchanging opinions, but spaces for the real joint production of professionally meaningful digital results. Only

such a combination of individual self-development and collective practice can ensure the stable growth of teachers' digital teamwork skills as a component of contemporary educational leadership.

Conclusions

The study provides grounds for considering teachers' digital teamwork skills as a distinct, integrated professional construct that cannot be reduced to either general digital competence or to isolated skills in using platforms, messengers, or shared documents. It has been substantiated that, under conditions of social uncertainty, the digital educational environment becomes not only a technical resource for supporting the educational process, but also a space of collective pedagogical activity in which the teacher is required to demonstrate the ability to engage in meaningful communication, collaboratively create a digital product, coordinate stages of work, facilitate interaction, distribute responsibility, and sustain a shared professional result. For this reason, teachers' teamwork in a digital environment should be understood as a component of contemporary educational leadership, manifested in everyday professional interaction rather than confined to the boundaries of formal managerial roles.

In the course of the study, the author's understanding of teachers' digital teamwork skills was clarified as an integrated set of practiced professional actions that ensure the effective interaction of the teacher with other participants in the educational process in a digital environment in order to achieve a common goal through communication, coordination, role distribution, collaborative product creation, facilitation of the group process, and reflective adjustment of shared activity. On this basis, three interrelated structural components were identified. The communication-facilitation component reflects the ability to initiate and sustain meaningful digital interaction, provide constructive feedback, and promote the group's progress toward a shared decision. The cooperative-productive component encompasses participation in the collaborative creation of a digital product, coordination of editing, alignment of contributions, and

refinement of the result. The organizational-projective component is connected to planning, role distribution, coordination of stages, time management of activities, and process adjustment in a digital environment. It has been demonstrated that the interaction among these three components is precisely what ensures the integrity of teachers' digital teamwork.

An important result of the study was the substantiation of an assessment system for teachers' digital teamwork skills. It is built on the principles of the competence-activity approach, structurality, multiplicity of data sources, the combination of process and outcome dimensions, criterion-based clarity, and level-based interpretation of results. Three assessment criteria corresponding to the structure of the phenomenon under study were identified: communication-facilitation, cooperative-productive, and organizational-projective. For each criterion, a system of indicators was outlined to document the actual manifestations of digital team interaction. A four-level model for interpreting results was proposed: initial, basic, advanced, and expert levels. This model enables not only the determination of the presence or absence of particular skills, but also the description of their degree of development, the stability of their manifestation, and the qualitative character of the teacher's professional behavior in a digital environment.

Based on theoretical generalizations, a methodology for developing teachers' teamwork skills in a digital educational environment was designed. It was constructed as a purposeful system of training activity based on professionally relevant tasks, integrated use of digital tools, micro-group interaction, the combination of synchronous and asynchronous formats, reflective support, and developmental assessment. The methodology's logic was implemented through a series of three weekly training sessions, in which the emphasis was successively placed on digital communication and coordination of interaction, collaborative content creation and version management, and the use of digital boards for project-based organization of teamwork. It was established that such staging is methodologically productive because it enables movement from initial engagement in team interaction to more complex, integrated, and professionally mature forms of it.

The pilot experiment conducted in 2025 with master's-level learners in Secondary Education at Makarenko Sumy State Pedagogical University confirmed the workability of the proposed methodology. The study involved 26 participants, and assessment was conducted after the first and third training sessions using self-assessment, structured observation, and analysis of digital artifacts. A comparative analysis of the two assessment points demonstrated statistically significant positive dynamics across all three components of digital teamwork skills. The mean score for the communication and facilitation component increased from 2.04 to 3.12, for the collaborative creation of digital content component from 1.77 to 2.85, and for the team project management component from 1.77 to 3.04. The overall mean indicator increased from 5.58 to 9.00 points. The most substantial changes occurred in the organizational-projective component, which provides grounds for regarding it as especially sensitive to a specifically organized training intervention. At the same time, the results confirmed that this component develops only in interaction with the communication-facilitation and cooperative-productive dimensions.

Interpretation of the pilot study results enabled identification not only of positive dynamics but also of several significant methodological conclusions. Within a short-term program, the communication-facilitation component activates most quickly, though its transition to a stable, mature level requires systematic inclusion of participants in meaningful digital interaction. The cooperative-productive component develops best when participants work on a real shared digital product rather than merely on a discussion task. The organizational-projective component is especially strengthened when teamwork has an explicit structure, visualized stages, roles, deadlines, and mechanisms for ongoing adjustment. At the same time, the study has certain limitations connected with the small sample, the short duration of the formative intervention, the absence of a control group, and the local context of online interaction. This does not diminish the significance of the obtained results, but it does define the limits of their generalization and indicates prospects for further extended research.

Based on the analysis, practical recommendations were formulated for three levels of educational practice. For educational institutions and school leaders, the need was substantiated for institutional recognition of digital teamwork as an important component of the teacher's professional activity, for the creation of a functionally organized digital environment, for the allocation of time for team interaction, for support of small pedagogical teams, and for developmental assessment of the process of shared activity. For the system of in-service teacher education, it was recommended to include digital teamwork in the content of professional development programs, to use activity-based formats, to incorporate professionally relevant tasks, to use modular learning logic, to combine synchronous and asynchronous formats, and to provide reflective support. For teachers' self-development and professional communities, the importance of reflective analysis of one's own digital behavior, gradual mastery of shared authorship, project logic, participation in digital professional communities, and orientation not only toward information exchange, but toward the collaborative production of professionally meaningful digital results was emphasized.

Thus, the study confirmed that the development of teachers' teamwork skills in a digital educational environment is a pedagogically grounded, methodologically feasible, and practically significant direction of professional preparation and development. Conditions of social uncertainty, digitalization, and the growing role of distributed educational leadership make these skills not auxiliary, but necessary for contemporary pedagogical activity. For this reason, their further study, methodological improvement, and inclusion in the system of professional teacher education constitute a promising and socially justified direction for the development of contemporary education.

References

Abildinova, G. M., Ormankulova, R. S., Tursyn, A. T., Tastanbekkyzy, A. A., Makhambetova, A. K., Rakhmetova, M. M., … & Shapalakova, M. T. (2024). Professional training of future teachers for implementing active learning methods and integrating digital technologies. *Contemporary Educational Technology, 16*(2), ep501. https://doi.org/10.30935/cedtech/14574

Abildinova, G., Abdykerimova, E., Assainova, A., Mukhtarkyzy, K., & Abykenova, D. (2024). Preparing educators for the digital age: Teacher perceptions of active teaching methods and digital integration. *Frontiers in Education, 9*, Article 1473766. https://doi.org/10.3389/feduc.2024.1473766

Alom, M. M., & Ramalingappa, V. (2025). Development and validation of a digital literacy scale and the evaluation of post-graduate teacher educators' digital literacy. *International Journal of Information and Education Technology, 15*(10). https://doi.org/10.18178/ijiet.2025.15.10.2421

Amayou, G. A., Herrera-Pavo, M. Á., Reyes de Cózar, S., & Velázquez-Iturbide, J. Á. (2025). Collaborative learning and teamwork strategies in the future teachers' initial training. *Education Sciences, 15*(1), 86. https://doi.org/10.3390/educsci15010086

Amelia, S., Riyandi, A., Solehudin, A., & Hidayat, W. (2024). Improving teachers' competence in digital age adaptation through digital pedagogy workshops. *Jurnal Penelitian Pendidikan IPA, 10*(5), 3049–3056. https://doi.org/10.29303/jppipa.v10i5.8163

Amemasor, J., Opoku, M. P., Agormedah, E. K., Baffour-Koduah, D., Asare-Nuamah, P., Nketsia, W., & Ofori, M. A. (2025). Professional development of teachers in using digital technologies and active learning strategies: Evidence from Ghana. *Cogent Education, 12*(1), 2486693. https://doi.org/10.1080/2331186X.2025.2486693

Amemasor, S. K., Oppong, S. O., Ghansah, B., Benuwa, B.-B., & Essel, D. (2025). A systematic review on the impact of teacher professional development on digital instructional integration and teaching practices. *Frontiers in Education, 10*, Article 1541031. https://doi.org/10.3389/feduc.2025.1541031

Balova-Tzvetkova, S., & Panayotova, M. (2023). Educational practices in teaching humanities and EU studies in a digital environment. *Pedagogika-Pedagogy, 95*(4), 483–499. https://doi.org/10.53656/ped2023-4.05

Bohoslavskyi, S. V., Semenikhina, O. V., & Yurchenko, A. O. (2025). Porivnialnyi analiz ukrainskykh ta yevropeiskykh praktyk orhanizatsii tsyfrovoho osvitnoho seredovyshcha [Comparative analysis of Ukrainian and European practices of organizing the digital educational environment]. *Naukovyi visnyk Pivdennoukrainskoho natsionalnoho pedahohichnoho universytetu imeni K. D. Ushynskoho*, 2(151), 38-42. https://doi.org/10.24195/2617-6688-2025-2-6

Brannan, L., Parrish, C. W., & Szatkowski, H. D. (2019). Team-based learning. In *Handbook of research on critical thinking strategies in pre-service learning environments* (pp. 89-108). IGI Global. https://doi.org/10.4018/978-1-5225-7823-9.CH005

Echeverría, V., Maldonado-Mahauad, J., Baars, M., Timms, M. J., Schnaubert, L., & Buckingham Shum, S. (2024a). Teacher-led team reflection with multimodal team dashboards. *Journal of Learning Analytics, 11*(1), 184–202. https://doi.org/10.18608/jla.2024.8195

Echeverría, V., Yan, L., Zhao, L., Abel, S., Alfredo, R., Dix, S., Jaggard, H., Wotherspoon, R., Osborne, A., Buckingham Shum, S., Gašević, D., & Martínez-Maldonado, R. (2024b). TeamSlides: A multimodal teamwork analytics dashboard for teacher-guided reflection in a physical learning space. In *Proceedings of the 14th International Learning Analytics and Knowledge Conference*. ACM. https://doi.org/10.1145/3636555.3636857

Espejo, R., Tena, A. R., & Martínez, J. R. (2023). Teamwork as a competence in virtual learning environments: Proposal of activities in the university context. *Pixel-Bit. Revista de Medios y Educación, 66*, 199–224. https://doi.org/10.12795/pixelbit.97311

García-Delgado, M. Á., Rodríguez-Cano, S., Delgado-Benito, V., & di Giusto-Valle, C. (2023). Digital teaching competence among teachers of different educational stages in Spain. *Education Sciences, 13*(6), Article 581. https://doi.org/10.3390/educsci13060581

Hodges, C. D., Barbour, M., & Pratt, K. (2026). The persistent deficit: Historical gaps in the preparation of K-12 educators for digital teaching. *Journal of Online Learning Research*. https://doi.org/10.70725/361467zxvzis

Holovnia, Y., Lisnychenko, A., Dovhaliuk, T., Falshtynska, Y., & Samoilenko, I. (2024). The role of digital competencies in creating an inclusive educational environment. *Synesis, 16*(1). https://seer.ucp.br/seer/index.php/synesis/article/download/2955/3748/11423

Hrechanyk, N., Eganov, A., Bandura, V., Aramyan, A., & He, S. (2024). Digital educational environments: Strategies and tools for training competent professionals. *Amazonia Investiga, 13*(76), 202–216. https://doi.org/10.34069/AI/2024.76.04.16

Kuznetsova, M., Gura, D., & Vorona-Slivinskaya, L. (2023). Virtual team building in an intelligent collaborative learning environment. *Journal of Information Technology Education: Research, 22*, 495-517. https://doi.org/10.28945/5089

Lin, R., Yang, J., Jiang, F., & Li, J. (2022). Does teacher's data literacy and digital teaching competence influence empowering students in the classroom? Evidence from China. *Education and Information Technologies, 27*, 10537-10557. https://doi.org/10.1007/s10639-022-11274-3

Majdi, H. S., Kzir, M. H., & Ghazi, M. A. (2024). The impact of digital transformation on the educational environment of private universities. *Revista Iberoamericana de Psicología del Ejercicio y el Deporte, 19*(2), 238–241. https://dialnet.unirioja.es/descarga/articulo/9622563.pdf

Masoumi, D., & Noroozi, O. (2023). Developing early career teachers' professional digital competence: A systematic literature review. *Journal of Education for Teaching, 49*(6), 1057-1072. https://doi.org/10.1080/02607476.2023.2229006

Navio-Marco, J., Ruiz-Gómez, L. M., & Sevilla-Sevilla, C. (2025). Perceptions of teamwork among education students in online and hybrid universities. *Education Sciences, 15*(6), 644. https://doi.org/10.3390/educsci15060644

Nychkalo, N., Muranova, N., Voliarska, O., & Matulcikova, M. (2024). Integration of Ukrainian children and youth using digital tools in the educational environment of Slovakia. *Information Technologies and Learning Tools, 101*(3), 150–163. https://doi.org/10.33407/itlt.v101i3.5657

Popovych, I. S., Blynova, O. Y., Artemieva, H. R., Kovalova, O. O., Halian, I. M., & Piletska, L. S. (2024). Research on the types of future teachers' self-realisation under conditions of a digital educational environment. *Revista de Cercetare si Interventie Sociala, 84*, 55–70.

Rudenko, Y., Ahadzhanov-Honsales, K., Ahadzhanova, S., Batalova, A., Diemientiev, Y., & Semenikhina, O. (2024). Interactive boards as digital tools in the modern educational process. In *2024 47th MIPRO ICT and Electronics Convention (MIPRO)* (pp. 329-333). IEEE. https://doi.org/10.1109/MIPRO60963.2024.10569393

Rudenko, Y., Zhurba, K., Bekh, I., Petrenko, S., Bobokalo, A., & Semenikhina, O. (2025). Using dashboards in the development of students' analytical thinking. In *2025 48th MIPRO ICT and Electronics Convention (MIPRO)* (pp. 406-411). IEEE. https://doi.org/10.1109/MIPRO65660.2025.11131997

Semenog, O., Hrona, N., Khomych, T., Stasiuk, T., Yurchenko, A., & Semenikhina, O. (2024). Communicative tasks as a means of developing the emotional intelligence of students. *International Journal of Modern Education and Computer Science, 16*(4), 46-57. https://doi.org/10.5815/ijmecs.2024.04.04

Shuppe, L., Koval, V., Sotska, H., Trynus, O., & Melnyk, A. (2024). Communicative competence of future specialists in the information and digital educational environment. *Amazonia Investiga, 13*(77), 188–200. https://doi.org/10.34069/AI/2024.77.05.14

Soroko, N., & Shymon, O. (2025). Teachers' readiness to use digital tools in a STEAM-oriented educational environment. *Educational Analytics of Ukraine, 2025*(1), 28-42. https://doi.org/10.32987/2617-8532-2025-1-28-42

Tzafilkou, K., Perifanou, M. A., & Economides, A. A. (2023). Assessing teachers' digital competence in primary and secondary education: Applying a new instrument to integrate pedagogical and professional elements for digital education. *Education and Information Technologies, 28*, 10551-10583. https://doi.org/10.1007/s10639-023-11848-9

Xu, J., Yuan, C., Gu, X., Zhang, X., & Van de Vliert, E. (2026). Fostering teachers' teamwork behavior: The roles of organizational justice and knowledge sharing. *Current Psychology, 45*, 17453–17463. https://doi.org/10.1007/s12144-024-06275-x

Yurchenko, A., Drushlyak, M., Khvorostina, Y., Ostroha, M., Ponomarenko, V., & Semenikhina, O. (2024a). The impact of team competitions on the development of soft skills in youth. In *2024 47th MIPRO ICT and Electronics Convention (MIPRO)* (pp. 323-328). IEEE. https://doi.org/10.1109/MIPRO60963.2024.10569574

Yurchenko A., Momot P., & Semenikhina O. (2024b). On the development of teachers' information and digital culture using computer visualization. *Education. Innovation. Practice, 12*(6), 93–99. https://doi.org/10.31110/2616-650X-vol12i6-014

Yurchenko, A., Momot, R., Ostroha, M., & Semenikhina, O. (2025c). Visualization of knowledge by web technology in the formation of pre-service computer science teachers' critical thinking. *Physical and Mathematical Education, 40*(5), 80-88.https://doi.org/10.31110/fmo2025.v40i5-11

Yurchenko, A., Riznyk, V., Shamonia, V., & Semenikhina, O. (2025b). Mutual synergistic effects of visual approach and SMART education. *Educological Discourse, 49*(2), 6-14. https://doi.org/10.28925/2312-5829/2025.2.1

Chapter 8. ARTIFICIAL INTELLIGENCE IN ESPORTS AS A CASE OF DIGITAL TRANSFORMATION IN PHYSICAL CULTURE EDUCATION

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***Abstract**. This chapter aims to systematize and analyze scientific publications on the use of artificial intelligence and machine learning in esports to identify major research trends and development directions, and to interpret this field as a case of digital transformation in physical culture education under conditions of social uncertainty. Based on a focused selection process, 81 scientific papers indexed in the Web of Science Core Collection from 2008 to the first quarter of 2026 were analyzed. The review identifies eight major thematic areas that reflect the current integration of intelligent technologies into the esports ecosystem: match outcome prediction, player-performance and behavior analysis, AI agents and game automation, physiology, health and emotional-state monitoring, spectator experience and media support, social interaction and communication, business and economic applications, and dataset development. The findings show that AI in esports extends beyond isolated technical solutions and reveals a technologically dense professional environment shaped by predictive systems, biometric monitoring, data-driven decision-making, and algorithmically mediated evaluation. In this perspective, esports is considered not only as a distinct competitive domain but also as a concentrated analytical case that helps clarify broader changes relevant to physical culture education. The chapter argues that the identified tendencies point to the growing importance of data literacy, AI literacy, ethical awareness, adaptive judgment, and professional resilience in the preparation of future specialists. The results contribute to both the systematization of research on AI in esports and the broader discussion of leadership and educational adaptation in digitally transformed environments.*

***Keywords**: esports; artificial intelligence; machine learning; systematic review; digital transformation.*

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Introduction

The digital transformation of education increasingly extends beyond the adoption of isolated technologies and is now associated with deeper changes in professional preparation, decision-making models, assessment practices, and the distribution of expertise between humans and intelligent systems. This shift is especially visible in domains where professional performance depends on rapid data interpretation, continuous adaptation, and technologically mediated action. In such fields, education is compelled to respond not only to innovation itself but also to social uncertainty, that is, to unstable skill demands, accelerated obsolescence of tools, and the growing need to prepare learners for roles that are being reconfigured by artificial intelligence. International policy and research literature increasingly frames AI not as a narrow technical add-on but as a force that may alter how education systems define competencies, support decision-making, and prepare individuals for work in evolving environments (OECD, 2024; OECD, 2026; UNESCO, 2023).

Within this broader transformation, physical culture education deserves particular attention. It is no longer limited to training in motor skills, coaching methods, or performance management in their conventional forms. The expansion of AI-based monitoring, predictive modeling, biometric assessment, video analytics, and adaptive feedback systems is changing how performance is measured, interpreted, and improved in sport-related settings. Recent scholarship shows that AI is already reshaping sports education and training through individualized learning paths, real-time feedback, data-driven evaluation, and more personalized instructional adjustment. At the same time, this shift generates new educational demands: future professionals must be able to interpret algorithmic outputs, work with digital performance data, understand the limits of automated recommendations, and make responsible decisions in environments where technological systems increasingly influence training and assessment (Gao et al., 2025).

Esports provides a particularly revealing case for analyzing these changes. Although it emerged outside traditional educational structures, it has evolved into a technologically

saturated professional field in which AI is used for outcome prediction, player-performance analysis, behavioral profiling, physiological monitoring, automated decision support, media production, and strategic modeling. Because esports operates under conditions of rapid patch cycles, unstable meta-configurations, and constant platform-level change, it offers a concentrated example of what professional activity looks like when knowledge becomes quickly outdated and when human expertise is increasingly intertwined with algorithmic systems. In that sense, esports can be interpreted not only as a specialized competitive domain but also as an analytical lens through which broader transformations in physical culture education become more visible. The review-based mapping of AI applications in esports, therefore, has value beyond the industry itself: it helps identify the types of competencies, vulnerabilities, and leadership responses that may become increasingly relevant across digitally transformed sport and education environments.

This perspective also foregrounds the issue of resilience. In this chapter, resilience is understood not merely as psychological endurance but as a professional and educational capacity to maintain meaningful action in conditions of technological volatility, informational overload, ethical ambiguity, and shifting performance criteria. Such a view is important because the integration of AI into sport-related practice creates not only new opportunities but also new tensions concerning privacy, explainability, bias, accountability, and the governance of biometric and behavioral data. A recent scoping review on the ethical implications of AI in sport shows that privacy and data ethics, fairness and bias, transparency, and accountability are now among the most persistent concerns in this area. This means that educational leadership in physical culture and sport can no longer focus exclusively on performance enhancement. It must also address the conditions under which digital tools are adopted, interpreted, and regulated, as well as how future professionals are prepared to act responsibly in the face of uncertainty (Kim et al., 2025; OECD, 2024; UNESCO, 2023).

Against this background, the analysis of scientific publications on artificial intelligence in esports can be treated as a case within a broader case: on the one hand, it systematizes a

rapidly growing research field; on the other, it opens a pathway for interpreting esports as a high-intensity manifestation of digital transformation in physical culture education. Such a reading allows the review to preserve its analytical integrity while extending its significance to questions of educational adaptation, interdisciplinary training, professional resilience, and leadership under conditions of social uncertainty.

Research Questions:

RQ1. What major directions of artificial intelligence application in esports are represented in contemporary scientific literature, and how are these directions distributed across the current research field?

RQ2. How can the case of AI integration in esports be interpreted as an indicator of digital transformation in physical culture education and as a basis for rethinking leadership, professional resilience, and educational adaptation under conditions of social uncertainty?

Research Results

AI in esports: analysis of current research and development prospects

The literature search was conducted in the Web of Science Core Collection (WoS CC) bibliometric database for the period from 2008 to the first quarter of 2026. The decision to use WoS CC as the sole database was based on several considerations: 1) WoS CC maintains rigorous quality standards through selective indexing of high-impact journals, ensuring the inclusion of peer-reviewed, high-quality research; 2) it provides comprehensive coverage across multiple disciplines relevant to this study, including computer science, sports science, and human-computer interaction; 3) its citation indexing capabilities enable advanced bibliometric analysis; 4) preliminary searches in other databases (Scopus, PubMED) revealed substantial overlap in core publications, with WoS CC capturing the majority of seminal works in this emerging field.

The following search query was applied:

(("artificial intelligence" OR "machine learning" OR "AI") AND (esports OR "e-sports" OR "electronic sports")).

The screening process followed a systematic two-stage approach:

Stage 1. Initial screening (n=121). All 121 articles retrieved from the initial search underwent title and abstract screening by two independent reviewers. At this stage, articles were assessed for their relevance to AI/ML applications in esports using the inclusion/exclusion criteria (Table 1). Disagreements between reviewers were resolved through discussion and, when necessary, consultation with a third reviewer.

Table 1
Inclusion and Exclusion Criteria

Inclusion criteria:	*Exclusion criteria:*
• Peer-reviewed journal articles and conference proceedings indexed in WoS CC • Publications explicitly addressing AI or machine learning applications in esports contexts • Studies focusing on competitive gaming environments (professional, semi-professional, or amateur esports) • Empirical research, systematic reviews, technical implementations, or theoretical frameworks • Publications in English • Time frame: January 2008 to March 2026	• Non-peer-reviewed materials (editorials, opinion pieces, news articles) • Studies addressing recreational gaming without a competitive esports context • Publications focused solely on game development or design without AI/ML components • Duplicate publications (same study published in multiple venues) • Studies where AI/esports appeared only tangentially in keywords without substantive discussion • Non-English publications (due to resource constraints for accurate translation and interpretation)

Source: developed by the authors based on the inclusion and exclusion criteria applied in the WoS Core Collection search strategy.

Stage 2. Full-text assessment (n=81). Articles passing the initial screening underwent full-text review to confirm eligibility.

Duplicate detection was performed through both automated and manual methods:

1. WoS built-in duplicate detection algorithms identified initial duplicates
2. Manual verification through cross-referencing DOIs, author lists, and publication dates
3. When multiple publications reported the same study (e.g., conference paper and subsequent journal article), the most comprehensive version was retained, typically favoring journal publications over conference proceedings due to extended peer review and methodological detail

No duplicate publications were identified in the final dataset, as WoS CC's indexing protocols effectively prevent duplicate entries for the same work.

The quality of each publication was assessed on the following dimensions:

For empirical studies: methodological rigor (sample size adequacy, appropriate statistical methods); clarity of research design and reproducibility; transparency in data collection and analysis procedures; acknowledgment of limitations;

For technical/computational studies: clarity of ai/ml methodology and implementation details; benchmark comparisons or validation procedures; reproducibility (code availability, dataset accessibility); discussion of generalizability and limitations;

For review articles: systematic search methodology; transparency in inclusion/exclusion criteria; synthesis approach and theoretical framework.

Based on the search results, a co-occurrence network map was created to visualize the thematic structure of the field using VOSviewer 1.6.18 (VOSviewer version 1.6.18, 2021), a software tool for constructing and visualizing bibliometric networks (Fig. 1). The analysis employed keyword co-occurrence and direct citation analysis methods to identify conceptual clusters within the literature.

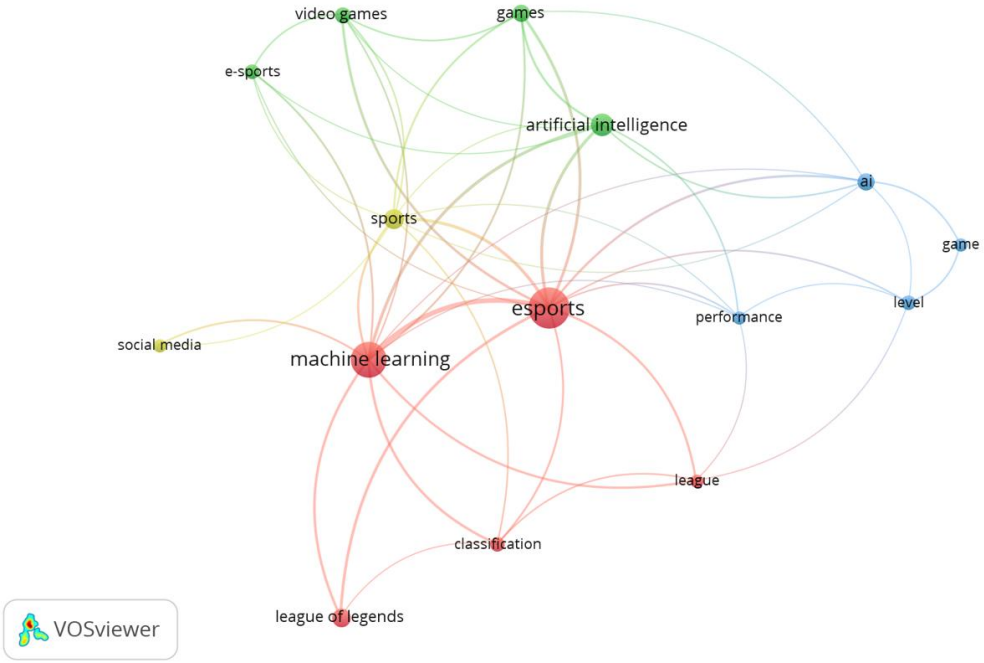

Figure 1

Areas of application of artificial intelligence technologies in esports (analysis of related words, visualization of cluster density, weight – citations)

Source: own research based on data obtained from Web of Science Core Collection and analyzed using VOSviewer (02.02.2026).

The network is built on the basis of 15 elements – keywords. The size of the keywords corresponds to the number of references obtained, and the spatial proximity reflects the strength of the relationship between the subjects. They are grouped into 4 clusters:

Cluster 1 (5 items): classification, esports, league, league of legends, machine learning;

Cluster 2 (4 items): artificial intelligence, e-sports, games, video games;

Cluster 3 (4 items): ai, game, level, performance;

Cluster 4 (2 items): social media, sports.

Analysis of publications by category showed that the largest number of works are represented in the following categories: Computer Science – Artificial Intelligence (40), Software

Engineering (34), Information Systems (27), Interdisciplinary Applications (24), Theory & Methods (24), Cybernetics (13); Engineering – Electrical & Electronic (18); Telecommunications (12).

The provided bar chart illustrates the temporal progression of scholarly interest in the application of artificial intelligence within the esports domain from 2008 to the first quarter of 2026 (Fig. 2).

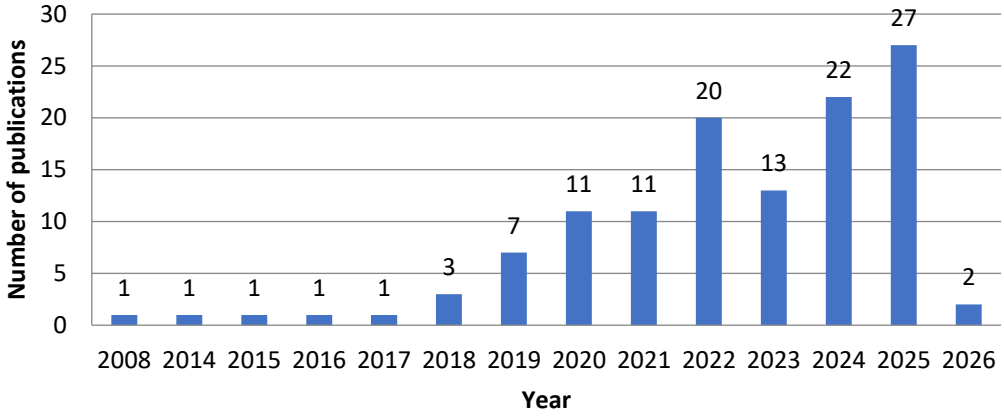

Figure 2
Dynamics of publications by year

Source: Authors' own work.

The data reveal a distinct shift from a nascent field to a rapidly accelerating area of interdisciplinary research. Between 2008 and 2018, only 6.61% of the total number of articles were published. The highest percentage of articles, accounting for 67.77%, was published during the period from 2022 to 2025. This trajectory underscores a growing institutional recognition of esports as a complex object of scientific analysis, requiring sophisticated AI tools for performance optimization, strategic forecasting, and spectator engagement.

Based on the reviewed literature, scientific articles can be classified according to the following thematic areas, which reflect various aspects of the application of artificial intelligence (AI) in esports:

1. Predicting match results (Win Prediction).

2. Analysis of player performance and behavior.

3. AI agents and game process automation.

4. Physiology, health, and emotional state.

5. Viewing experience, broadcasts, and media.

6. Social aspects, communication, and NLP (Natural Language Processing).

7. Business, marketing, and economics.

8. Creating datasets.

This review acknowledges several limitations: 1) While WoS CC provides comprehensive coverage, relevant publications in other databases may have been missed; 2) English-only inclusion may exclude relevant research in other languages; 3) Emphasis on peer-reviewed publications may exclude gray literature, technical reports, or industry white papers; 4) The rapidly evolving nature of both AI technology and esports means recent developments may not yet appear in indexed literature; 5) The heterogeneity of study designs necessitated a flexible rather than standardized quality appraisal approach.

1. Predicting match results (win prediction). Win prediction constitutes the most extensively developed thematic cluster in the reviewed literature, encompassing studies across multiplayer online battle arena (MOBA), first-person shooter (FPS), and mobile game genres. Three cross-cutting findings characterize this body of work. First, ensemble learning methods – notably XGBoost and Random Forest – consistently outperform logistic regression and simpler classifiers across game genres (Chowdhury et al., 2025; Xia et al., 2025; Birant & Birant, 2023; Birant, 2022). Second, models integrating pre-match draft data with real-time in-game statistics demonstrate superior predictive validity relative to those drawing on either data source in isolation (Chowdhury et al., 2025; Costa et al., 2021; Chen et al., 2020). Third, the subfield is undergoing a methodological reorientation – from black-box accuracy optimization toward interpretable modeling frameworks: the application of Shapley Additive exPlanations (SHAP) and explainable artificial intelligence (XAI) methods enables identification of the specific game-state features –

including gold income, damage output, and champion synergy – that drive predicted outcomes (Galán-Sales et al., 2024; Jing et al., 2025; Yang et al., 2022).

Within the draft-phase subgroup, the available evidence confirms that hero or champion selection constitutes a substantive predictive signal independent of in-game performance. Historical performance records have been identified as the most reliable pre-match feature (Costa et al., 2021), whereas models that incorporate player-specific skill ratings and inter-champion synergy indices yield further improvements in predictive accuracy (Hitar-García et al., 2023). Graph-based approaches that model league-wide team relationships over a full competitive season have achieved state-of-the-art performance (Bisberg & Ferrara, 2022), and role-weighted metrics have improved upon aggregate team statistics by accounting for positional responsibilities (Bahrololloomi et al., 2022; Yoon & Jeong, 2025).

Real-time and in-game prediction represents a substantively distinct and practically significant research direction. Models trained on the initial five to ten minutes of match data achieve predictive accuracy of 74–85%, facilitating early strategic assessment for players and analysts (Hodge et al., 2021; Wilathgamuwa, 2024). Spatio-temporal architectures developed for the mobile MOBA title Honor of Kings extend this capability by generating interpretable, timestep-level predictions that decompose the contribution of individual game events to the evolving match outcome (Yang et al., 2022; Tian et al., 2022). A methodologically notable extension involves predicting comeback victories rather than outright match winners, employing bounty-based mechanics to model the conditions under which a losing team can reverse a late-game deficit (Lee & Kim, 2025; Kamal et al., 2026).

Despite the breadth of this subfield, a fundamental limitation persists: the predominant research design involves training and evaluating models on fixed historical datasets, leaving the reliability of deployed systems across game patches and evolving competitive meta-games largely unexamined. Cross-title generalization likewise remains rare – the concentration of studies on League of Legends and Dota 2 raises questions regarding the

transferability of findings to games with structurally distinct mechanics.

2. Analysis of player performance and behavior. Research in this domain extends beyond match-level outcomes to examine how individual players act, make decisions, and perform within competitive game environments. Three methodological directions structure the literature: the development of novel performance metrics and rating systems, the automated classification of player roles and behavioral profiles, and the use of peripheral input data – including keyboard activity, mouse dynamics, and physiological sensors – for player profiling.

The most substantive methodological contribution of the metrics subgroup is the transition from outcome-contingent statistics (kills, deaths, assists) toward context-sensitive evaluation frameworks. Rather than quantifying the frequency of player actions, these approaches assess whether each discrete action – conditioned on the instantaneous game state – increased the team's probability of winning. This evaluative logic underpins both the PandaSkill framework for League of Legends, which updates player ratings on the basis of performance scores rather than match outcomes (De Bois et al., 2025), and Maymin's (2021) contextual reframing of kills and deaths as events that either advance or retard the team's win probability at a given moment. The xKills model extends this principle to FPS environments by estimating the probability of a successful elimination for each engagement opportunity, conditioned on spatial context (Gordon et al., 2024). Across these contributions, SHAP-based explainability methods are employed to identify the most diagnostically informative indicators – including kills per round, round-opening success rate, and pistol round rating – thereby supporting data-driven coaching interventions (Jing et al., 2025).

The role classification subgroup addresses a distinct analytical challenge: whether AI systems can reliably infer a player's positional role or strategic archetype from observable in-game behavior. Evidence across multiple genres indicates that this is feasible. Logistic regression applied to replay file data classifies player roles in Dota 2 with stable accuracy (Eggert et al., 2015), while clustering methods applied to PlayerUnknown's Battlegrounds (PUBG) data distinguish four behavioral archetypes

– Hunter, Sniper, Traveler, and Camper – based on aggression and mobility scores (Sagong et al., 2025). In League of Legends, video-based gameplay analysis enables automated classification of cooperative versus aggressive play styles, providing a foundation for personalized coaching systems that do not require manual annotation (Kim et al., 2021).

The input-data subgroup demonstrates that the manner in which a player interacts with hardware constitutes a reliable and discriminative signal of competitive skill. Telemetry data from sim racing – encompassing vehicle speed, steering angle, and lateral acceleration – separates elite from novice drivers with 97% classification accuracy (Hojaji et al., 2024a, 2024b). Keystroke and mouse movement sequences reliably distinguish professional players from amateurs and casual participants, with control mechanics emerging as a stronger predictor of elite-level membership than general gaming experience (Lange et al., 2022). Multimodal fusion of physiological and interaction data – including heart rate, hand activity, cursor movements, and gaze position – classifies League of Legends skill level at 90% accuracy via symbolic transfer entropy, suggesting that the integration of multiple sensory channels captures dimensions of cognitive engagement inaccessible to game log analysis alone (Noroozi et al., 2025).

A limitation common to all three subgroups is dataset specificity: models are trained and validated within a single title, and the extent to which behavioral and input-based markers generalize across games with differing mechanical demands remains unclear. Cross-title validation studies capable of distinguishing genre-specific from domain-general indicators of player skill and decision quality would substantially advance the field.

3. AI agents and game automation. Research on AI agents in esports is organized around two distinct and, in certain respects, opposed research objectives: the development of systems capable of defeating human players at the highest competitive level, and the development of systems designed to collaborate with human players to enhance team performance and training outcomes. These objectives entail divergent design requirements, and the

bodies of literature addressing them have evolved largely independently.

The superhuman agent subgroup encompasses some of the most technically ambitious work in the reviewed literature. Across multiple game genres, reinforcement learning systems have attained or exceeded elite human performance benchmarks: AlphaStar achieved Grandmaster rank in StarCraft II across all three playable races through multi-agent training within a self-play league (Vinyals et al., 2019); Gran Turismo Sophy defeated world-class sim racing competitors via model-free deep reinforcement learning incorporating a reward function that penalised violations of racing etiquette (Wurman et al., 2022); agents trained through curriculum self-play and Monte Carlo Tree Search defeated top professional teams under an unrestricted hero pool in Honor of Kings (Ye et al., 2020); and a memristive hardware implementation enabled millisecond-level strategic adaptation in Street Fighter (Go et al., 2023). The unifying characteristic across these systems is not a shared algorithm but a common training paradigm: performance improvement through progressive self-play against increasingly capable opponents, rather than behavioral cloning from human demonstrations. A parallel line of work extends this paradigm to multiplayer FPS environments, where agents trained via Proximal Policy Optimization acquire survival, coordination, and combat improvement capabilities without human expert supervision (Piergigli et al., 2019).

Game preparation and strategy automation constitute a more applied research direction. An automated deck construction system for Hearthstone employs a utility-based optimization framework that accounts for mana curve composition, card synergy, and community meta-game data to generate competitive decks from a player's available card pool (Stiegler et al., 2016). Sequential pattern mining applied to real-time strategy games identifies recurring action sequences and quantifies their relative contribution to match outcomes, yielding a methodology applicable to both agent design and professional replay analysis (Bosc et al., 2014). Although fewer in number and narrower in scope than the superhuman agent literature, these studies address a practically significant problem: reducing cognitive

overhead associated with strategic preparation in competitive play.

The human-AI collaboration subgroup addresses a fundamentally different question – not whether AI systems can win, but whether humans and AI agents can operate effectively as integrated teammates. Experimental evidence indicates that the presence of anonymous AI teammates in MOBA environments reduces toxic social dynamics and supports problem-focused coping strategies, whereas social robots are more effective in facilitating emotional regulation (Wang et al., 2023). Interview-based studies with professional esports players identify cross-training – defined as mutual comprehension of each partner's roles and capabilities – as a prerequisite for effective human-AI team functioning, with expert players characterizing AI as a coach or adaptive collaborator rather than a surrogate team member (Lancaster et al., 2025a). Player skill level moderates these requirements: higher-skilled players require AI systems oriented toward socio-emotional attunement and role-based awareness, whereas novices benefit primarily from procedural guidance (Lancaster et al., 2025b). Analysis of professional players in EA FC similarly identifies joint learning and shared team identity as necessary conditions for stable human-autonomy collaboration (Nols et al., 2026). Across these studies, a consistent finding emerges: the technical capability of an AI agent is insufficient to guarantee effective collaboration – successful human-AI teaming additionally requires trust, operational transparency, and adaptive task allocation that contemporary systems only partially provide.

Auxiliary infrastructure for agent development includes a standardized bot competition framework for Dota 2 that enables external AI controllers to participate in 1-on-1 matches under controlled conditions (Font & Mahlmann, 2019), and a design framework that identifies four key challenges – team coordination, in-game decision-making, game state tracking, and performance monitoring – where AI assistants can most productively support player development (Kleinman et al., 2022). The application of esports-derived reinforcement learning methods to naval combat simulation, yielding a win rate of approximately 90% with heterogeneous agent configurations, further demonstrates the

cross-domain transferability of these methodologies (Chen & Nie, 2022).

A structural gap persists throughout this domain: research on superhuman agent performance and human-AI collaboration proceeds largely in isolation, with limited attention to the question of whether agents optimized for competitive superiority can be adapted to fulfill collaborative roles – or whether the training objectives of competitive AI are fundamentally at odds with the transparency and predictability that effective human-AI teaming requires.

4. Physiology, health, and emotional state. Research in this domain treats the esports player's body and cognitive system as objects of empirical measurement, employing AI and machine learning methods to detect, classify, and predict physiological and psychological states during competitive activity. The literature is organized into three analytical levels: neurological and cognitive state monitoring, psychological state identification, and physical health assessment.

The neurological monitoring subgroup establishes that brain activity measured prior to and during gameplay carries a reliable predictive and classificatory signal. Electroencephalography (EEG) data collected immediately before match commencement enables outcome prediction at 80% accuracy via the LightGBM algorithm, with beta-band activity in the parietal cortex identified as the primary biomarker – an approach that retains predictive validity in conditions where statistical performance models fail, including matches with unexpected outcomes (Minami et al., 2024). EEG recordings acquired during active gameplay discriminate between professional and amateur players at an F1-score of 95% and classify fatigue state at 90% accuracy, confirming that neuroimaging interfaces are capable of monitoring player condition in real time rather than solely in retrospective analysis (Melentev et al., 2020). Collectively, these findings establish pre-game cognitive state as a meaningful performance variable – one that coaching and athlete management practices have yet to systematically integrate.

The psychological state subgroup examines mental conditions that directly impair or enhance competitive

performance but are not observable from game log data. The identification of tilt – an affective dysregulation state that degrades decision quality – and flow – a state of complete attentional absorption – from multimodal physiological, cognitive, and behavioral data establishes a methodological pathway toward early warning systems capable of intervening before performance deterioration becomes apparent (Manikandan et al., 2025). Eye-tracking analysis reveals that expert players process visual scenes qualitatively differently from novices, exhibiting broader horizontal gaze distribution and shorter fixation durations, indicative of faster perceptual integration rather than accumulated experience alone (Jeong et al., 2024). Mental workload, operationalized as a composite of subjective self-report and objective measures of heart rate variability and electrodermal activity, can be classified with 82% accuracy using a support vector machine across a sample of 96 participants, linking objective physiological measurement to the subjective cognitive demands that players report experiencing (Al Fawwaz et al., 2024). Voice communication analysis introduces a team-level dimension: emotion classifiers applied to tournament audio achieve 92.7% accuracy and reveal a significant positive correlation between the affective intensity of intra-team communication and competitive outcomes, suggesting that affective coordination constitutes a measurable component of collective performance (Abramov et al., 2022).

Physical health research reorients the domain's focus from performance optimization toward player welfare. A large-scale cross-sectional study conducted among 1,025 Brazilian players identified a pain prevalence of 60%, with the spine and wrists most frequently affected; gender differences in pain reporting were also observed, as was a counterintuitive association between prior physical therapy and elevated pain during gameplay, most plausibly attributable to pre-existing injury rather than treatment failure (Viana et al., 2025). This study is distinguished from others in the domain by framing esports within an occupational health paradigm – a conceptual approach that remains underrepresented in the broader literature.

A methodologically innovative subgroup applies esports as an instrument for supporting healthy aging. Infrared

thermography of facial skin temperature during gameplay classifies emotional arousal states in older adults with over 90% accuracy, providing a non-invasive assessment tool applicable to populations at risk of dementia (Kikuchi et al., 2025). A subsequent study employs CNN-LSTM analysis of changes in facial color saturation in the cheek region to classify emotional valence (positive vs. negative) during gameplay, extending continuous affective monitoring to settings without specialized equipment (Kikuchi et al., 2024). These studies are notable not only for their methodological originality but also for conceptually repositioning esports as a potential public health intervention for older adult populations, rather than exclusively as a competitive youth medium.

Two limitations apply across the domain. Sample sizes are consistently small – the majority of studies involve fewer than 100 participants – and study populations are predominantly young and male, constraining the generalisability of findings to broader demographic groups. Additionally, laboratory data collection conditions, however rigorously controlled, may not adequately replicate the physiological demands of high-stakes competitive play, in which performance pressure, audience effects, and prize incentives introduce confounding variables that experimental designs cannot fully accommodate.

5. Viewing experience, broadcasts, and media. Research in this domain investigates how artificial intelligence transforms the relationship between esports competition and its audiences – encompassing both the visualization and narration of game data for viewers and the progressive automation of broadcast production processes. The literature is organized around three interconnected directions: data-driven storytelling and visualization, the cognitive and communicative design of AI-generated information for live audiences, and the automation of broadcast production tasks.

The data storytelling subgroup addresses a challenge specific to esports spectatorship: the gap between how match events unfold on screen and the comprehension available to viewers without specialized game knowledge. The DAX system, implemented within the Weavr companion application for ESL One tournaments, demonstrates that providing real-time, personalized

statistics increases viewer engagement and deepens understanding of the strategic complexity that conventional broadcasts leave unexplained (Kokkinakis et al., 2020). A methodologically significant extension of this principle involves reframing prediction output from the question of who will win to that of how a team can win: the Win Condition model generates caster-oriented narratives structured around the game states a team must achieve to secure victory, thereby rendering AI-based analytics directly functional for broadcast storytelling rather than merely for predictive display (Chitayat et al., 2024a). The visualization of the underlying machine learning models – as demonstrated through the live broadcast integration of the WARDS ward-placement prediction model for Dota 2 – indicates that complex AI outputs can be rendered accessible to general audiences without material loss of analytical depth, provided that visual design principles foreground communicative clarity (Chitayat et al., 2024b). These studies collectively establish that the primary challenge in this domain is not predictive precision but communicative translation: the transformation of model outputs into audience-interpretable narratives.

The cognitive design subgroup empirically investigates how live audiences receive and process AI-generated information during broadcasts, with findings that complicate the assumption that increased informational richness improves viewer experience. Although viewers demonstrate superior learning from causal explanations of why events occur relative to descriptive accounts of what is occurring, live commentators predominantly employ the latter format – because detailed real-time causal explanations demonstrably increase cognitive load to a degree that impairs comprehension (Robertson et al., 2021). This finding imposes a practical constraint: the analytical depth that renders AI-generated insights valuable in post-match contexts constitutes a liability in live broadcast environments where viewer attention is divided. Complementary evidence from audience research on win prediction displays during League of Legends streams indicates that viewers evaluate predictive AI outputs not solely on accuracy but also on their contribution to narrative tension – preferences that favor predictions that maintain match uncertainty over those that are merely statistically correct (Wang, 2023). Together, these findings indicate that broadcast AI tools require a design logic

distinct from that of analytical AI systems: one calibrated to narrative pacing and cognitive load management rather than to model performance metrics.

The production automation subgroup examines the application of AI to broadcast labor, where automated systems are progressively employed to replicate or supplement the functions of skilled human operators. The Observer framework for StarCraft II learns from recorded human observer behavior to automate in-game camera selection, achieving 56.9% behavioural similarity to human decision-making and outperforming rule-based alternatives (Bae et al., 2025). Highlight detection in League of Legends matches is addressed by the DENAN network, which learns spatiotemporal dependencies from match footage to generate tournament highlight reels without manual editorial intervention (Wan et al., 2022). At the level of commentary generation, the LoL-MDC tool compresses large-scale game log data into formats compatible with large language model (LLM) processing, enabling automated generation of match summaries and strategic commentary while circumventing input token-length constraints (Kim et al., 2025). A parallel line of research employs convolutional neural networks to extract game event sequences and classify ability readiness states from broadcast video footage – enabling statistical analysis for tournament organizers who lack programmatic access to internal game data (Luo et al., 2019; Eichelbaum et al., 2018).

The audience behavior subgroup examines the viewer dimension of streaming platforms through NLP analysis of chat data as a proxy for audience engagement and community dynamics. A BERT-based model trained on 18 million Finnish Twitch messages classifies chat content into original viewer commentary, emoji spam, copypasta, and bot commands, enabling researchers and platform stakeholders to isolate substantive audience feedback from high-volume data streams (Lindroos et al., 2025). Transfer learning from toxicity detection models trained on Twitter data demonstrates practical effectiveness for real-time Twitch chat moderation despite platform-specific lexical variation, indicating that cross-platform NLP transfer is viable for community management at scale (Gao et al., 2021).

A tension persists across the domain that individual studies have not fully resolved: the most analytically sophisticated broadcast tools – including interpretable predictive models, win condition narratives, and real-time SHAP visualizations – are simultaneously the most cognitively demanding for live audiences. The production automation strand moves in the opposite direction, prioritizing seamlessly integrated and cognitively unobtrusive outputs. Productive integration of these orientations – delivering analytical depth through production designs that actively manage rather than disregard cognitive load – represents an important agenda for future research.

6. Social aspects, communication, and natural language processing. Research in this domain examines esports as a social and cultural phenomenon, employing computational and qualitative methods to investigate how communities form, communicate, and contest meaning around competitive gaming. The literature is organized around two principal directions: the application of natural language processing (NLP) tools to map public discourse and sentiment across social media platforms, and qualitative and conceptual examination of the ethical, identity-related, and socio-economic dimensions of esports communities.

The public discourse subgroup applies a consistent methodological toolkit – encompassing topic modeling, sentiment analysis, and large-language model-augmented classification – to datasets from Reddit, YouTube, and Twitter. A cross-study finding is that public discourse around esports systematically extends beyond the boundaries of gaming itself, encompassing questions of cognitive development, social identity, cultural legitimacy, and economic participation. Analysis of StarCraft-related Reddit discussions reveals that community discourse encompasses emotional resilience and the transfer of competencies to non-gaming contexts alongside strategic content (Altindag & Balcioglu, 2025); comment analysis of YouTube videos addressing esports in the metaverse identifies immersive experience and technical constraints as the dominant public concerns, with health risks and accessibility barriers constituting a secondary thematic cluster (Mahmoud, 2025); BERTopic modelling augmented by GPT-4, applied to discourse surrounding the 2023 Asian Games, demonstrates that institutional inclusion in major multi-sport

events accelerates esports legitimisation without resolving residual mainstream scepticism (Qian et al., 2025); and sentiment analysis of Reddit discourse concerning blockchain-based reward platforms indicates that positive community framing exerts a significant influence on user adoption intentions (Yadav et al., 2022). These studies are most productively read not as discrete findings but as a cumulative portrait of an industry actively negotiating its cultural status – simultaneously asserting institutional legitimacy, managing persistent stigma, and integrating into mainstream sport and entertainment structures.

The ethics, identity, and socio-economics subgroup addresses dimensions of esports community life that resist quantification and are correspondingly underrepresented in a domain dominated by predictive and classificatory modeling. Discourse analysis of the SaltyBet platform – in which viewers place wagers on matches between AI-controlled characters – reveals how communities construct shared interpretive frameworks around the unpredictability of AI behavior, generating an entertainment context organized around irony and collective spectatorship rather than competitive identification (Summerley & McDonald, 2025). Conceptual scholarship on the metaverse as a site for advancing diversity, equity, and inclusion in sport identifies virtual environments as potential structural equalizers that can reduce the physical, geographic, and economic barriers that constrain access to traditional athletics (Cunningham & Ko, 2025). A philosophical analysis of esports in the context of advancing AI argues for a reconceptualization of competitive values as the boundary between virtual and physical sport becomes increasingly permeable, raising questions of digital ethics that technical research programs have yet to systematically address (Xu, 2023). Economic analysis of the Overwatch League reveals a behavioral labor market dynamic – physical attractiveness predicts contract acquisition probability, but functions as a negative hiring signal in high-performing teams when unaccompanied by competitive results – demonstrating that esports labor markets reproduce and in some instances amplify biases documented in traditional sports industries (Babin et al., 2024). Collectively, these contributions perform an analytical function that the computational subgroup cannot: they interrogate the normative assumptions and

structural values embedded in the institutional arrangements that NLP-based studies take as empirical givens.

A productive tension exists between the two subgroups that the literature has yet to address systematically. Public discourse studies treat community sentiment as a datum to be measured; ethics and identity studies treat community norms as social constructions to be critically examined. These orientations are complementary rather than mutually exclusive, and future research would benefit from methodological integration – employing computational tools to identify discourse patterns at scale while applying qualitative and theoretical frameworks to account for why those patterns assume the forms they do. A further limitation applies to the subfield as a whole: the predominance of English-language datasets systematically underrepresents the world's largest esports markets in East and Southeast Asia, where community discourse patterns, platform infrastructure, and cultural orientations toward competitive gaming differ substantially from the Western contexts that dominate the reviewed corpus.

7. Business, marketing, and economics. Research in this domain applies quantitative and analytical methods to esports as a commercial ecosystem, examining how AI and machine learning tools can optimize revenue generation, inform marketing strategy, and illuminate the economic structures – including labor markets, investment platforms, and fan engagement mechanisms – through which the industry operates. The literature is organized around three directions: commercial performance optimization, marketing effectiveness, audience engagement, and the economic organization of the esports industry.

The commercial optimization subgroup demonstrates that machine learning-based forecasting is both technically feasible and practically applicable across several esports revenue contexts. Regression models applied to a dataset comprising over 450 games – incorporating active player counts, prize pool volumes, and tournament frequency – indicate that the Huber Regressor, following hyperparameter optimization, achieves a near-perfect fit for merchandise sales forecasting while avoiding overfitting, thereby providing industry stakeholders with a data-driven foundation for revenue planning (Abu Sufian et al., 2024). In the

digital trading card game segment, text-based features derived from card ability descriptions improve price prediction accuracy beyond that achievable from numeric attributes alone, confirming that a card's competitive utility – encoded in its rules text – constitutes a meaningful economic signal that conventional regression inputs fail to capture (Sakaji et al., 2020). Together, these studies establish proof of concept: esports revenue streams are sufficiently structured and data-dense to support predictive modelling, although both studies acknowledge that model performance remains sensitive to market volatility and meta-game shifts that training data cannot prospectively capture.

The marketing and engagement subgroup examines how esports organizations attract, retain, and monetize audiences, with particular attention to the roles of social media influencers and platform-specific content strategies. Nano-influencers emerge as effective communication intermediaries whose perceived authenticity amplifies positive user behavioral intentions while attenuating the negative effects of unverified trending information – a finding with direct implications for influencer selection and relationship management by esports brands (Yadav et al., 2022). The relationship between traditional sports fandom and esports engagement is characterized by genre specificity rather than uniform crossover: enthusiasm for sport simulation titles such as FIFA correlates positively with traditional football attendance and merchandise purchasing, whereas interest in structurally distinct esports genres – including MOBA and shooter titles – correlates negatively, suggesting that cross-promotional strategies must account for genre alignment rather than treating esports audiences as homogeneous (Lettieri & Orsenigo, 2020). At the content production level, generative AI demonstrates competence in interactive engagement formats such as audience polls but underperforms human-generated content in attracting non-follower audiences, indicating that AI-assisted content generation functions as a viable efficiency instrument for community maintenance rather than as a substitute for human creative capacity in audience acquisition (Ruiz-Pozo et al., 2025). Across these studies, the consistent implication is that marketing effectiveness in esports is determined less by channel selection than by the alignment between content authenticity, audience identity, and genre-specific community norms.

The economic organization subgroup examines the structural conditions governing esports as an industry, including tournament financing, player mobility, and the value-generation mechanisms of live events. Crowdfunding analysis of over 14,000 projects on the Matcherino platform identifies equitable prize distribution, major brand sponsorship, and game genre as the primary determinants of successful community fundraising, providing independent organizers with an empirical basis for campaign design (Xue et al., 2023). Social network analysis of the professional Dota 2 player transfer market reveals that player mobility is shaped by regional homophily, role-specific demand, and vertical mobility patterns analogous to those documented in traditional sports labor markets (Marchenko & Suschevskiy, 2018). The application of experience economy theory to esports tournament events highlights the role of immersive technologies – including virtual and augmented reality and large-format display systems – in transforming offline attendance into a sensory and affective spectacle that generates audience value exceeding that of the competitive content itself (Brock & Crawford, 2025). Generational analysis of 747 respondents confirms that attitudes toward esports as a sporting category and as an economic driver vary significantly by age cohort, with implications for industry positioning across demographic segments (Zdrilic et al., 2025). Bibliometric analysis situates esports within a decade-long structural transformation of the sports industry, in which AI and data analytics have generated novel business models and fan engagement mechanisms that traditional sports organizations are only beginning to integrate (Prabowo et al., 2026).

A limitation common to all three subgroups is the near-total absence of player welfare from the economic literature. Studies in this domain optimize revenue forecasting, marketing efficiency, and event experience design for organizers, sponsors, and audiences, while the working conditions, income distribution, career trajectories, and labor rights of professional players – the human infrastructure upon which the commercial ecosystem depends – receive no systematic analytical attention. This constitutes a structural gap that future scholarship in sports economics and labor studies is well positioned to address.

8. Dataset creation. Research in this domain addresses the infrastructural precondition for empirical progress across all other thematic areas reviewed in this chapter: without openly accessible, methodologically rigorous, and comprehensively documented datasets, advances in win prediction, player profiling, agent training, and audience analysis remain constrained by data availability rather than driven by analytical capacity. The literature is divided into three directions: datasets derived from professional match replays and telemetry, datasets designed specifically for MOBA game analysis, and datasets supporting NLP and behavioral research.

The replay and telemetry subgroup develops large-scale resources to extend access to esports research to scholars without direct access to game APIs or proprietary data infrastructure. SC2EGSet compiles 17,930 StarCraft II replay files from major tournaments since 2016, accompanied by open-source PyTorch tools for data retrieval and modeling, and explicitly targets research communities in AI, machine learning, psychology, and human-computer interaction simultaneously (Bialecki et al., 2023). The CDOPS dataset aggregates over one million rounds from professional Counter-Strike: Global Offensive tournaments into a resource designed for the study of coordinated human team dynamics under competitive pressure – a level of ecological validity that laboratory-based experimental designs cannot replicate (Duffy et al., 2025). The Professional Go Dataset extends esports data infrastructure to a title with an unusually long competitive history, compiling 98,043 games from 2,148 professional players spanning 1950 to 2021, with each move annotated using AlphaZero-based evaluation – enabling investigation of the longitudinal evolution of strategic thinking rather than solely outcome prediction or classification (Gao, 2022). Across all three contributions, the primary value lies not in the empirical findings but in the resource itself: each dataset materially reduces the barriers to entry for researchers who would otherwise be precluded from esports analysis due to data access constraints.

The MOBA dataset subgroup addresses two specific gaps in the broader data landscape: the underrepresentation of mobile esports and the scarcity of feature-rich datasets that support

interpretable modeling frameworks rather than purely predictive ones. Two successive datasets from Honor of Kings provide the feature density required, respectively, to train the TSSTN model for simultaneous prediction and feature attribution (Yang et al., 2022) and to extend in-game event coverage sufficient for gradient attribution methods that explain model predictions rather than merely generating them (Yang et al., 2023). A methodologically distinct contribution generates a new category of League of Legends data – including champion positional data sampled at sub-second intervals, ability activations, and health and mana values – through computer vision and dynamic client instrumentation rather than API access, with the data generation pipeline made openly available (Maymin, 2021). Collectively, these datasets represent a deliberate effort to shift the analytical baseline of MOBA research from outcome prediction toward process understanding: from establishing who won to identifying why, and at which point in the match outcome became structurally determined.

The NLP and behavioral subgroup produces datasets designed to capture dimensions of the esports experience that are inaccessible to game log analysis: player engagement, audience dynamics, and community toxicity. A multimodal engagement dataset combining facial video recordings, gameplay footage, and minute-by-minute self-reported engagement data from 40 participants provides the annotated ground truth required to train automated engagement detection models – a resource with direct applications in game design, broadcast production, and player welfare monitoring (Guglielmi et al., 2025). The FinTwitchBERT dataset, comprising 18 million Finnish Twitch chat messages with a manually labeled subset of 7,529 messages annotated across four content categories, addresses both the linguistic specificity of gaming community discourse and the underrepresentation of non-English streaming platforms in existing NLP corpora (Lindroos et al., 2025). A toxicity detection dataset drawn from four Twitch communities spanning competitive, violent, and non-violent game genres provides the cross-genre variation necessary to evaluate whether classifiers trained in one community context transfer to others – a test that platform-specific datasets cannot support (Gao et al., 2021). The shared methodological commitment across these contributions is annotation rigor: each invests substantially

in labeling reliability, reflecting the recognition that behavioral and linguistic ground truth is more difficult to establish than game outcome data and correspondingly more valuable when established with care.

Two structural limitations apply across the domain. Dataset coverage remains concentrated on a small number of titles – StarCraft II, Counter-Strike, League of Legends, and Honor of Kings – leaving fighting games, battle royale titles, and the rapidly expanding mobile esports sector substantially underrepresented. More fundamentally, the datasets reviewed are almost exclusively static snapshots of competitive activity at a given point in time. Longitudinal datasets tracking the same players, teams, or communities across multiple competitive seasons – capturing skill trajectories, strategic adaptation, roster transitions, and the effects of game patches – remain rare despite being essential for addressing the developmental and evolutionary research questions that the field is increasingly posing. The construction of such datasets requires sustained institutional commitment beyond the capacity of individual research projects, indicating a role for governing bodies, platform operators, and esports organizations in supporting data infrastructure as a collective resource for the research community.

AI in Esports as a Case of Digital Transformation in Physical Culture Education

The results of the literature review allow interpreting artificial intelligence in esports not only as a rapidly developing technological field but also as a concentrated case of broader changes that are becoming increasingly relevant to physical culture education. The reviewed studies show that AI in esports is applied to match prediction, player-performance analysis, behavioral profiling, physiological monitoring, automated agents, media support, social interaction analysis, business analytics, and dataset development. Taken together, these directions reveal a professional environment in which performance is no longer assessed solely through direct observation, practical experience, or conventional coaching judgment. Instead, it is increasingly mediated by data streams, predictive systems, and algorithmic

models that influence both decision-making and performance evaluation.

From an educational perspective, this shift is significant because it signals a change in the structure of professional competence. In traditional models of physical culture and sport education, emphasis has usually been placed on methodology of training, motor development, physical performance, tactical preparation, and pedagogical interaction. The esports case demonstrates that these components remain important, yet they are no longer sufficient on their own in technology-intensive environments. Future professionals must also be able to interpret performance data, understand the logic and limitations of AI-based recommendations, critically assess automated outputs, and combine digital evidence with contextual professional judgment. In this sense, digital transformation should not be reduced to the simple introduction of new tools. It involves a deeper reconfiguration of how knowledge is produced, how performance is interpreted, and how professional action is justified in educational and training settings.

The esports environment is especially useful for analyzing these processes because it makes visible the growing instability of technologically mediated professional practice. In esports, strategies quickly lose relevance due to game updates, shifts in competitive balance, platform changes, and the emergence of new analytical models. This creates a field in which expertise is constantly challenged by volatility. Such conditions make resilience particularly important. In this chapter, resilience is understood not as a narrow psychological trait, but as a professional capacity to maintain meaningful and responsible action under conditions of rapid change, incomplete certainty, informational overload, and technological dependence. Read in this way, the case of AI in esports highlights that professional resilience in physical culture education increasingly depends on adaptability, readiness for continual learning, critical interpretation of digital evidence, and the ability to act when algorithmic systems provide support without offering complete certainty.

This interpretation also has implications for educational leadership. If the professional field is being reshaped by data-

driven analysis, biometric monitoring, predictive systems, and automated support tools, educational leadership can no longer be limited to preserving established curricular models or reproducing conventional approaches to preparation. It must guide the redesign of programs in ways that reflect the changing relationship between human expertise and intelligent systems. This includes integrating interdisciplinary components into physical culture education, strengthening data and AI literacy, creating pedagogically sound approaches to digital monitoring, and preparing future professionals to work responsibly with ethically sensitive information. It also requires the creation of educational environments in which technological innovation is accompanied by critical reflection, interpretive caution, and an awareness of the risks associated with bias, opacity, and overreliance on automated decision support. In this respect, AI in esports can be read as a case within a broader case: it is a specific field of technological development that helps clarify the deeper logic of digital transformation in physical culture education under conditions of social uncertainty.

Conclusions

The conducted review of scientific publications enabled us to systematize the major directions of artificial intelligence application in esports and to demonstrate that this field extends far beyond isolated technical solutions. The analyzed studies demonstrate that AI in esports encompasses match-outcome prediction, player-performance analysis, behavioral modeling, autonomous and semi-autonomous agents, physiological and emotional monitoring, media support, social communication analysis, business analytics, and the creation of specialized datasets. Such findings confirm that esports has developed into a complex digital environment in which professional action is increasingly mediated by algorithmic systems, predictive models, and data-based evaluation procedures.

At the same time, the significance of this case extends beyond esports as a distinct industry. The review shows that AI integration in esports may be interpreted more broadly as a concentrated manifestation of changes that are becoming relevant

to physical culture education as well. The analyzed body of research reflects a shift toward data-driven performance evaluation, technologically supported decision-making, continuous monitoring, and greater reliance on digital infrastructure. As a result, the case of esports provides an analytically productive basis for understanding how professional preparation in sport-related educational fields is being transformed by artificial intelligence and digital technologies.

This transformation has direct implications for the content of education. The case of AI in esports indicates that the preparation of future professionals in physical culture and sport can no longer rely exclusively on conventional training models centered on methodological knowledge and practical instruction. It increasingly requires data literacy, AI literacy, the ability to interpret performance analytics, and a critical awareness of the limitations and risks of automated systems. Equally important is the development of ethical sensitivity regarding biometric monitoring, behavioral profiling, and predictive modeling, since these tools influence not only performance enhancement but also privacy, fairness, and accountability in educational and professional practice.

The findings also clarify the meaning of resilience in digitally transformed environments. Under conditions of social uncertainty, resilience should be understood as a professional capacity to preserve reasoned action and adaptive judgment in situations shaped by rapid technological change, unstable digital platforms, shifting metrics, and incomplete algorithmic transparency. In this sense, resilience is linked to flexibility, critical thinking, continual relearning, and the ability to combine technological support with human responsibility rather than merely to endure external pressure.

Accordingly, educational leadership in physical culture education acquires a renewed role. It is increasingly associated with the ability to redesign curricula, strengthen interdisciplinary preparation, create ethically responsible models of technology use, and support learners' readiness to act in uncertain and rapidly changing professional conditions. From this perspective, the case of AI in esports helps illuminate a broader educational challenge:

how to prepare future professionals for environments in which innovation, uncertainty, and algorithmic mediation are the norm.

Recommendations

In light of the analyzed case, several practical directions may be proposed for the development of physical culture education. First, it is advisable to update the content of educational programs by incorporating topics related to digital analytics, interpretation of performance data, AI-assisted decision support, and the pedagogically appropriate use of intelligent systems in sport-related practice. Such renewal would allow future professionals to engage more competently with environments in which data and algorithms increasingly influence assessment and training.

Second, the training of specialists in physical culture and sport should be strengthened through interdisciplinary integration. The reviewed material suggests that contemporary professional preparation benefits from linking sport studies with pedagogy, psychology, digital technologies, and data analysis. This would make it possible to move from a narrowly instrumental understanding of technology toward a more comprehensive model in which digital tools are interpreted within broader educational, ethical, and professional frameworks.

Third, educational practice should include case-based and problem-based tasks that model situations of technological volatility, uncertain data, limited explainability of algorithmic outputs, and the need for responsible decision-making. Such tasks may contribute to the development of professional resilience by helping learners act thoughtfully in the face of change rather than merely reproduce stable routines.

Fourth, particular attention should be paid to preparing educators and academic leaders for the responsible governance of digital transformation. This includes awareness of privacy risks, algorithmic bias, data ethics, transparency, and the limitations of monitoring systems. The introduction of AI into educational and sport-related environments should therefore be accompanied by explicit ethical guidance and reflective pedagogical strategies.

Finally, further research appears promising regarding the transferability of the practices identified in esports to broader fields of physical culture education. It is worth examining which AI-based approaches can be meaningfully adapted to the preparation of coaches, physical education teachers, sport analysts, and other professionals whose work is increasingly influenced by digital monitoring, predictive systems, and data-supported forms of professional judgment.

References

Abu Sufian, M., Varadarajan, J., Hanumanthu, M., Katneni, L., Jamil, A., Lal, V., & Boomer, J. (2024). Optimizing e-sports revenue: A novel data driven approach to predicting merchandise sales through data analytics and machine learning. *In Intelligent Computing* (Lecture Notes in Networks and Systems, Vol. 1018, pp. 522–567). Springer. https://doi.org/10.1007/978-3-031-62269-4_35

Al Fawwaz, A., Rahma, O. N., Ain, K., Ittaqillah, S. I., & Chai, R. (2024). Measurement of mental workload using heart rate variability and electrodermal activity. *IEEE Access, 12*, 197589–197601. https://doi.org/10.1109/ACCESS.2024.3521649

Altindag, E., & Balcioglu, Y. S. (2025). Beyond the fog of war: Mining social dynamics and genre shaping in the StarCraft universe. *Telematics and Informatics Reports, 20*, 100252. https://doi.org/10.1016/j.teler.2025.100252

Babin, J. J., Chauhan, H. S., & Kistler, S. L. (2024). When pretty hurts: Beauty premia and penalties in eSports. *Journal of Economic Behavior & Organization, 217*, 726–741. https://doi.org/10.1016/j.jebo.2023.12.002

Bae, C. M., Joo, H. T., Lee, S., & Kim, K. J. (2025). Observer: An open-source framework for automating spectator for Real-time Strategy game of StarCraft. *SoftwareX, 32*, 102421. https://doi.org/10.1016/j.softx.2025.102421

Bahrololloomi, F., Sauer, S., Klonowski, F., Horst, R., & Dörner, R. (2022). A machine learning based analysis of e-sports player performances in League of Legends for winning prediction based on player roles and performances. *In Proceedings of the 17th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP)* (Vol. 2, pp. 68–76). SCITEPRESS. https://doi.org/10.5220/0010895900003124

Bialecki, A., Jakubowska, N., Dobrowolski, P., Bialecki, P., Krupinski, L., Szczap, A., Bialecki, R., & Gajewski, J. (2023). SC2EGSet: StarCraft II esport replay and game-state dataset. *Scientific Data, 10(1)*, 600. https://doi.org/10.1038/s41597-023-02510-7

Birant, K. U. (2022). Multi-view rank-based random forest: A new algorithm for prediction in eSports. *Expert Systems, 39(2)*, e12857. https://doi.org/10.1111/exsy.12857

Birant, K. U., & Birant, D. (2023). Multi-objective multi-instance learning: A new approach to machine learning for eSports. *Entropy, 25(1)*, 28. https://doi.org/10.3390/e25010028

Bisberg, A. J., & Ferrara, E. (2022). GCN-WP - Semi-supervised graph convolutional networks for win prediction in esports. *In 2022 IEEE Conference on Games (CoG)*, 449–456. IEEE. https://doi.org/10.1109/CoG51982.2022.9893671

Bosc, G., Kaytoue, M., Raïssi, C., Boulicaut, J. F., & Tan, P. (2014). Mining balanced sequential patterns in RTS games. *In ECAI 2014 - 21st European Conference on Artificial Intelligence,* 975–976. IOS Press. https://doi.org/10.3233/978-1-61499-419-0-975

Brock, T., & Crawford, G. (2025). The esports experience economy: A multiple-case study of esports events, peripherals and fashion. *Internet Research, 35(5)*, 1821–1842. https://doi.org/10.1108/INTR-02-2024-0138

Chen, W., & Nie, J. (2022). A MADDPG-based multi-agent antagonistic algorithm for sea battlefield confrontation. *Multimedia Systems*. https://doi.org/10.1007/s00530-022-00922-w

Chen, Y., Mei, J., & Huang, S. (2020). Machine learning and data mining on the innovation of E-sports industry. *International Journal of Education and Information Technologies, 14*, 121–132. https://doi.org/10.46300/9109.2020.14.15

Chitayat, A. P., Block, F., Walker, J., & Drachen, A. (2024a). Applying and visualising complex models in esport broadcast coverage. *In Proceedings of the 2024 ACM International Conference on Interactive Media Experiences (IMX 2024)*, 108–116. ACM. https://doi.org/10.1145/3639701.3656319

Chitayat, A. P., Block, F., Walker, U. J. A., & Drachen, A. (2024b). How could they win? An exploration of win condition for esports narratives in Dota 2. *Proceedings of the ACM on Human-Computer Interaction, 8(CHI PLAY)*, Article 314. https://doi.org/10.1145/3677079

Chowdhury, S., Ahsan, M., & Barraclough, P. (2025). Applications of linear and ensemble-based machine learning for predicting winning teams in League of Legends. *Applied Sciences, 15(10)*, 5241. https://doi.org/10.3390/app15105241

Costa, L. M., Mantovani, R. G., Souza, F. C. M., & Xexéo, G. (2021). Feature analysis to League of Legends victory prediction on the picks and bans phase. *In 2021 IEEE Conference on Games (CoG)*, 1015–1019. IEEE. https://doi.org/10.1109/COG52621.2021.9619019

Cunningham, G. B., & Ko, Y. J. (2025). Diversity, equity and inclusion in the sport metaverse. *International Journal of Sports Marketing and Sponsorship, 26(2)*, 279–291. https://doi.org/10.1108/IJSMS-04-2023-0080

De Bois, M., Parmentier, F., Puget, R., Tanti, M., & Peltier, J. (2025). PandaSkill-Player performance and skill rating in esports: Application to League of Legends. *IEEE Transactions on Games, 17(4)*, 989–1002. https://doi.org/10.1109/TG.2025.3581070

Duffy, B., Gallagher, J., Rego, J., Fatnassi, W., & Warren, M. (2025). CDOPS: Complex dynamics of online professional squads. *In 2025 IEEE Conference on Games (CoG)*. IEEE. https://doi.org/10.1109/COG64752.2025.11114134

Eggert, C., Herrlich, M., Smeddinck, J., & Malaka, R. (2015). Classification of player roles in the team-based multi-player game Dota 2. *In Entertainment Computing (ICEC 2015)* (Lecture Notes in Computer Science, pp. 112–125). Springer. https://doi.org/10.1007/978-3-319-24589-8_9

Eichelbaum, J., Hänsch, R., & Hellwich, O. (2018). Classification of icon type and cooldown state in video game replays. *In Image Analysis and Recognition (ICIAR 2018)* (Lecture Notes in Computer Science, Vol. 10882, pp. 227–234). Springer. https://doi.org/10.1007/978-3-319-93000-8_26

Font, J. M., & Mahlmann, T. (2019). Dota 2 bot competition. *IEEE Transactions on Games, 11(3)*, 285–289. https://doi.org/10.1109/TG.2018.2834566

Galán-Sales, F. J., Linares-Barrera, M. L., Reina-Jiménez, P., Rodríguez-López, A., & Jiménez-Navarro, M. J. (2024). Toward explaining competitive success in League of Legends: A machine learning analysis. *In Advances in Artificial Intelligence (CAEPIA 2024),* 184–193. Springer. https://doi.org/10.1007/978-3-031-62799-6_19

Gao, Y. (2025). *The role of artificial intelligence in enhancing sports education and training for public health goals in universities*. *Frontiers in Public Health, 13*, Article 1554911. https://doi.org/10.1016/j.jshs.2025.101047

Gao, Y. F. (2022). PGD: A large-scale professional Go dataset for data-driven analytics. In 2022 *IEEE Conference on Games (CoG)*, 284–291. IEEE. https://doi.org/10.1109/CoG51982.2022.9893704

Gao, Z. W., Yada, S., Wakamiya, S., & Aramaki, E. (2021). A preliminary analysis of offensive language detection transferability from social media to video live streaming platforms. *In Advances in Artificial Intelligence* (Lecture Notes in Artificial Intelligence, Vol. 1357, pp. 121–132). Springer. https://doi.org/10.1007/978-3-030-73113-7_11

Go, S. X., Jiang, Y., & Loke, D. K. (2023). A phase-change memristive reinforcement learning for rapidly outperforming champion Street-Fighter

players. *Advanced Intelligent Systems, 5(11)*, 2300335. https://doi.org/10.1002/aisy.202300335

Gordon, P., Kavanagh, W., Howson, T., & Lavallee, D. (2024). Assessing player performance in tactical FPS games: A proposal for an xGoals-inspired model. *In 2024 IEEE Conference on Games (CoG)*. IEEE. https://doi.org/10.1109/CoG60054.2024.10645546

Guglielmi, E., Bavota, G., Novielli, N., Oliveto, R., & Scalabrino, S. (2025). Is it really fun? Detecting low engagement events in video games. *In 2025 IEEE/ACM 22nd International Conference on Mining Software Repositories (MSR)*, 564–575. IEEE Computer Society. https://doi.org/10.1109/MSR66628.2025.00089

Hitar-García, J. A., Morán-Fernández, L., & Bolón-Canedo, V. (2023). Machine learning methods for predicting League of Legends game outcome. *IEEE Transactions on Games, 15(2)*, 171–181. https://doi.org/10.1109/TG.2022.3153086

Hodge, V. J., Devlin, S., Sephton, N., Block, F., Cowling, P., & Drachen, A. (2021). Win prediction in multiplayer esports: Live professional match prediction. *IEEE Transactions on Games, 13(4)*, 368–379. https://doi.org/10.1109/TG.2019.2948469

Hojaji, F., Toth, A. J., Joyce, J. M., & Campbell, M. J. (2024a). AI-enabled prediction of sim racing performance using telemetry data. *Computers in Human Behavior Reports, 14*, 100414. https://doi.org/10.1016/j.chbr.2024.100414

Hojaji, F., Toth, A. J., Joyce, J. M., & Campbell, M. J. (2024b). An AI approach for analyzing driving behaviour in simulated racing using telemetry data. *In Games and Learning Alliance (GALA 2023)* (Lecture Notes in Computer Science, pp. 194–203). Springer. https://doi.org/10.1007/978-3-031-49065-1_19

Jeong, I., Kudo, K., Kaneko, N., & Nakazawa, K. (2024). Esports experts have a wide gaze distribution and short gaze fixation duration: A focus on League of Legends players. *PLoS ONE, 19(1)*, e0288770. https://doi.org/10.1371/journal.pone.0288770

Jing, S. Y., Awang, M. M., Wan Pa, W. A. M., Pan, P., Memmert, D., & Zhang, Z. (2025). Interpretable machine learning with SHAP for esports performance analysis of professional Counter-Strike players from 2012 to 2025. *International Journal of Sports Science & Coaching*. https://doi.org/10.1177/17479541251388864

Kamal, A. A., Mansor, M. A., & Kasihmuddin, M. S. M. (2026). Interpretable predictive framework for Mobile Legends match outcome using analytic hierarchy process weighted logistic regression variants. *Applied Soft Computing, 187*, 114301. https://doi.org/10.1016/j.asoc.2025.114301

Kikuchi, R., Kageyama, Y., Shirai, H., Ishizawa, C., Suehiro, K., Takahashi, N., ... & Sato, N. (2024). Method for classifying emotions in older adults playing eSports. *In 2024 Joint 13th International Conference on Soft Computing and Intelligent Systems and 25th International Symposium on Advanced Intelligent Systems (SCIS&ISIS)*. IEEE. https://doi.org/10.1109/SCISISIS61014.2024.10760157

Kikuchi, R., Suwa, Y., Suehiro, K., Takahashi, N., Saito, H., Kobayashi, T., ... & Kageyama, Y. (2025). Estimation of emotional arousal in older adults during esports: A machine learning approach focused on facial skin temperature and body movement changes. *International Journal of Innovative Computing, Information and Control, 21(5)*, 1167–1185. https://doi.org/10.24507/ijicic.21.05.1167

Kim, J. H. (2025). Ethical implications of artificial intelligence in sport: A systematic scoping review. *Journal of Exercise Science & Fitness*. https://www.sciencedirect.com/science/article/pii/S2095254625000250

Kim, J., Lee, W., & Park, J. (2025). Structured summarization of League of Legends match data optimized for large language model input. *Applied Sciences, 15(13)*, 7190. https://doi.org/10.3390/app15137190

Kim, S., Kim, D., Ahn, H., & Ahn, B. (2021). Implementation of user playstyle coaching using video processing and statistical methods in League of Legends. *Multimedia Tools and Applications, 80(26-27)*, 34189–34201. https://doi.org/10.1007/s11042-020-09413-4

Kokkinakis, A. V., Demediuk, S., Nölle, I., Olarewaju, O., Patra, S., Robertson, J., ... & Drachen, A. (2020). DAX: Data-driven audience experiences in esports. *In Proceedings of the 2020 ACM International Conference on Interactive Media Experiences (IMX 2020)*, 94–105. ACM. https://doi.org/10.1145/3391614.3393659

Lee, J., & Kim, N. (2025). Development of machine learning-based indicators for predicting comeback victories using the bounty mechanism in MOBA games. *Electronics, 14(7)*, 1445. https://doi.org/10.3390/electronics14071445

Lettieri, E., & Orsenigo, C. (2020). Predicting soccer consumption: Do eSports matter? Empirical insights from a machine learning approach. *Sport, Business and Management: An International Journal, 10(5)*, 523–544. https://doi.org/10.1108/SBM-10-2019-0093

Lindroos, J., Peltonen, J., Välisalo, T., Koskimaa, R., & Toivanen, I. (2025). From PogChamps to insights: Detecting original content in Twitch chat. *In Proceedings of the 58th Hawaii International Conference on System Sciences*, 2542–2551. HICSS.

Luo, Z. J., Guzdial, M., & Riedl, M. (2019). Making CNNs for video parsing accessible: Event extraction from DOTA2 gameplay video using transfer, zero-shot, and network pruning. *In Proceedings of the 14th International Conference on the Foundations of Digital Games (FDG '19)*. ACM. https://doi.org/10.1145/3337722.3337755

Mahmoud, A. B. (2025). Eliciting public beliefs about metaverse esports. *Internet Research, 35(5)*, 1867–1888. https://doi.org/10.1108/INTR-02-2024-0275

Manikandan, K., Madduri, K. S., Irby, J., & Coza, A. (2025). Predicting the onset of acute performance decline in esports. *Computers in Human Behavior, 168*, 108648. https://doi.org/10.1016/j.chb.2025.108648

Marchenko, E., & Suschevskiy, V. (2018). Analysis of players transfers in esports: The case of Dota 2. *In Mindtrek '18: Proceedings of the 22nd International Academic Mindtrek Conference*, 255–257. ACM. https://doi.org/10.1145/3275116.3275151

Maymin, P. Z. (2021). Smart kills and worthless deaths: eSports analytics for League of Legends. *Journal of Quantitative Analysis in Sports, 17(1)*, 11–27. https://doi.org/10.1515/jqas-2019-0096

Minami, S., Koyama, H., Watanabe, K., Saijo, N., & Kashino, M. (2024). Prediction of esports competition outcomes using EEG data from expert players. *Computers in Human Behavior, 160*, 108351. https://doi.org/10.1016/j.chb.2024.108351

Nols, T., Ulfert, A. S., & Gevers, J. (2026). Human-autonomy-teaming in e-sports: An exploratory study. *Computers in Human Behavior Reports, 21*, 100919. https://doi.org/10.1016/j.chbr.2025.100919

Noroozi, A., Hasan, M. S., Ravan, M., Norouzi, E., & Law, Y. Y. (2025). An efficient machine learning approach for extracting eSports players' distinguishing features and classifying their skill levels using symbolic transfer entropy and consensus nested cross-validation. *International Journal of Data Science and Analytics, 20(2)*, 1349–1362. https://doi.org/10.1007/s41060-024-00529-6

OECD. (2024). *The potential impact of artificial intelligence on equity and inclusion in education* (OECD Artificial Intelligence Papers, No. 23). OECD Publishing. https://www.oecd.org/en/publications/the-potential-impact-of-artificial-intelligence-on-equity-and-inclusion-in-education_15df715b-en.html

Piergigli, D., Ripamonti, L. A., Maggiorini, D., & Gadia, D. (2019). Deep reinforcement learning to train agents in a multiplayer first person shooter: Some preliminary results. *In 2019 IEEE Conference on Games (CoG)*. IEEE. https://doi.org/10.1109/COG.2019.8847959

Prabowo, S. A., Marsudi, I., Siantoro, G., Yuhantini, E. F., Ristiawan, B., Khuddus, L. A., ... & Ayubi, N. (2026). Digitalization accelerates sport industry in last decade: Systematic literature review and bibliometric analysis. *Sportis, 12(1)*, 12302. https://doi.org/10.17979/sportis.2026.12.1.12302

Qian, T. Y., Yu, B., Li, W. Z., & Xu, C. L. (2025). Esports' debut as a medal event at 2023 Asian Games: Exploring public perceptions with BERTopic and GPT-4 topic fine-tuning. *In Proceedings of the 58th Hawaii International Conference on System Sciences.* 4303–4312. HICSS.

Robertson, J., Kokkinakis, A. V., Hook, J., Kirman, B., Block, F., Ursu, M. F., ... & Drachen, A. (2021). Wait, but why?: Assessing behavior explanation strategies for real-time strategy games. *In IUI '21 - 26th International Conference on Intelligent User Interfaces*. 32–42. ACM. https://doi.org/10.1145/3397481.3450699

Ruiz-Pozo, I., Morales-Garcia, J., Aguirre-Mejia, C. X., & Serrano, A. (2025). Using generative artificial intelligence to improve user engagement in content marketing. *Journal of Universal Computer Science, 31(12)*, 1274–1296. https://doi.org/10.3897/jucs.151691

Sagong, C., Woo, J. Y., & Kim, H. K. (2025). Are you a Hunter or Camper? A phase-based framework for real-time survival prediction in battle royale using FightScore and ActiveScore. *Entertainment Computing, 55*, 101040. https://doi.org/10.1016/j.entcom.2025.101040

Sakaji, H., Kobayashi, A., Kohana, M., Takano, Y., & Izumi, K. (2020). Card price prediction of trading cards using machine learning methods. *In Advances in Networked-Based Information Systems (NBIS-2019) (Lecture Notes in Intelligent Systems and Computing, Vol. 1036*, 705–714. Springer. https://doi.org/10.1007/978-3-030-29029-0_70

Stiegler, A., Messerschmidt, C., Maucher, J., & Dahal, K. (2016). Hearthstone deck-construction with a utility system. *In 2016 10th International Conference on Software, Knowledge, Information Management & Applications (SKIMA).* 21–28. IEEE. https://doi.org/10.1109/SKIMA.2016.7916193

Summerley, R., & McDonald, B. (2025). Perceived foolishness: How does the Saltybet community construct AI vs AI spectatorship? *Games and Culture, 20(8)*, 984–1029. https://doi.org/10.1177/15554120241238262

Tian, P., Lan, W., & Zhang, X. (2022). Hero featured learning algorithm for winning rate prediction of Honor of Kings. *In 2022 IEEE Conference on Games (CoG).* 322–329. IEEE. https://doi.org/10.1109/CoG51982.2022.9893634

UNESCO. (2023). *Guidance for generative AI in education and research*. UNESCO. https://www.unesco.org/en/articles/guidance-generative-ai-education-and-research

Viana, A. F. M., Rosa, C. G., Ferreira, G. E., Caputo, E. L., & Araujo, F. X. (2025). E-sports players have a high prevalence of musculoskeletal pain. *Science & Sports, 40(8)*, 646–652. https://doi.org/10.1016/j.scispo.2025.08.002

Vinyals, O., Babuschkin, I., Czarnecki, W. M., Mathieu, M., Dudzik, A., Chung, J., ... & Silver, D. (2019). Grandmaster level in StarCraft II using multi-agent reinforcement learning. *Nature, 575(7782)*, 350–354. https://doi.org/10.1038/s41586-019-1724-z

Wan, Q., Wang, A., Zhang, G. S., Liu, L., & Wu, J. J. (2022). Discriminative and efficient non-local attention network for league of legends highlight detection. *Complex & Intelligent Systems, 8(6)*, 5377–5386. https://doi.org/10.1007/s40747-022-00762-1

Wang, M. (2023). The communication effectiveness of AI win prediction applied in esports live streaming: A pilot study. *In Computer-Human Interaction Research and Applications (CHIRA 2023)*. 315–325. Springer. https://doi.org/10.1007/978-3-031-49368-3_19

Wang, N., Li, L., Xiao, L., Yang, G., & Zhou, Y. (2018). Outcome prediction of DOTA2 using machine learning methods. *In Proceedings of 2018 International Conference on Mathematics and Artificial Intelligence (ICMAI 2018)*. 61–67. ACM. https://doi.org/10.1145/3208788.3208800

Wang, Y. M., Dai, Y. L., Chen, S. K., Wang, L. X., & Hoorn, J. F. (2023). Multiplayer online battle arena (MOBA) games: Improving negative atmosphere with social robots and AI teammates. *Systems, 11(8)*, 425. https://doi.org/10.3390/systems11080425

Wilathgamuwa, M. (2024). Kills or turrets: An exploratory data analysis and win prediction of League of Legends based on early-game data. *In 2024 9th International Conference on Information Technology Research (ICITR)*. 1–6. IEEE. https://doi.org/10.1109/ICITR64794.2024.10857792

Wurman, P. R., Barrett, S., Kawamoto, K., MacGlashan, J., Subramanian, K., Walsh, T. J., ... & Kitano, H. (2022). Outracing champion Gran Turismo drivers with deep reinforcement learning. *Nature, 602(7896)*, 223–228. https://doi.org/10.1038/s41586-021-04357-7

Xia, X., Salinas, A., & Morstatter, F. (2025). Precision under fire: Analysis and predictive modeling in Counter-Strike: Global Offensive. *In 2025 IEEE Conference on Games (CoG). IEEE*. https://doi.org/10.1109/COG64752.2025.11114164

Xu, Y. J. (2023). The evolving eSports landscape: Technology empowerment, intelligent embodiment, and digital ethics. *Sport, Ethics and Philosophy, 17(3)*, 356–368. https://doi.org/10.1080/17511321.2023.2168039

Xue, H. H., Du, J., Pizzo, A. D., Baker, B. J., Henry, T. E., Yan, G., & Watanabe, N. M. (2023). The dynamics of esports crowdfunding campaign success: A social exchange perspective. *International Entrepreneurship and Management Journal*. https://doi.org/10.1007/s11365-023-00850-9

Yadav, J., Misra, M., Rana, N. P., Singh, K., & Goundar, S. (2022). Netizens' behavior towards a blockchain-based esports framework: A TPB and machine learning integrated approach. *International Journal of Sports Marketing and Sponsorship, 23(4)*, 665–683. https://doi.org/10.1108/IJSMS-06-2021-0130

Yang, Z., Pan, Z., Wang, Y., Cai, D., Shi, S., Huang, S.-L., Bi, W., & Liu, X. (2022). Interpretable real-time win prediction for Honor of Kings – A popular mobile MOBA esport. *IEEE Transactions on Games, 14(4)*, 589–597. https://doi.org/10.1109/TG.2022.3149044

Yang, Z., Wang, Y., Li, P., Lin, S., Shi, S., Huang, S.-L., & Bi, W. (2023). Predicting events in MOBA games: Prediction, attribution, and evaluation. *IEEE Transactions on Games, 15(2)*, 193–201. https://doi.org/10.1109/TG.2022.3159704

Ye, D. H., Chen, G. B., Zhang, W., Chen, S., Yuan, B., Liu, B., ... & Liu, W. (2020). Towards playing full MOBA games with deep reinforcement learning. *In Advances in Neural Information Processing Systems (NeurIPS 2020) (Vol. 33)*. NIPS.

Yoon, W., & Jeong, S. (2025). Role-sensitive analysis of positional contributions and win prediction in multiplayer online battle arena esports. *IEEE Access, 13*, 158440–158449. https://doi.org/10.1109/ACCESS.2025.3607328

Zdrilic, I., Rajko, M., & Tadic, D. P. (2025). The contribution of the video game industry to the development of esports-an analysis of generations X, Y and Z. *Zbornik Veleučilišta u Rijeci, 13(1)*, 125–148. https://doi.org/10.31784/zvr.13.1.4

Zhou, D., Keogh, J. W. L., Ma, Y., Tong, R. K. Y., Khan, A. R., & Jennings, N. R. (2025). Artificial intelligence in sport: A narrative review of applications, challenges and future trends. *Journal of Sports Sciences*, 1–16. https://doi.org/10.1080/02640414.2025.2518694

AFTERWORD

Olena Semenikhina

The studies brought together in this monograph show that contemporary education operates in conditions where instability is no longer an episodic disturbance but a persistent characteristic of the environment in which educational decisions are made. Under such conditions, education should be examined not only as an institutional system or a pedagogical process, but also as a field of ethical judgment, organizational adaptation, collective resilience, and digitally mediated transformation. This monograph has sought to address that complexity by considering leadership, resilience, and digital development within a shared analytical frame.

A central conclusion of the volume is that educational uncertainty is not merely a managerial or technical problem. It is also normative in character. It brings to the foreground questions that are less visible in more stable circumstances: how fairness is interpreted in practice, how inclusion is implemented with limited resources, how continuity is maintained without reducing education to procedural survival, and how institutions preserve legitimacy under pressure. For this reason, the educational challenges discussed in the monograph cannot be reduced to separate domains. Ethical dilemmas, crisis management, well-being, psychological safety, partnership, teamwork, and digital transformation are interconnected expressions of one broader process of educational reconfiguration.

The volume also supports a broader understanding of educational leadership. Leadership appears here not simply as

formal administration, but as the capacity to organize meaningful collective action, justify decisions, sustain trust, and preserve the educational purpose of institutions under unstable conditions. In this sense, leadership is distributed across levels of educational practice. It is visible in institutional planning and crisis response, as well as in the work of teachers who support psychologically safe interactions, build partnerships with parents, organize teamwork in digital environments, and act as facilitators of professional cooperation. The monograph's materials therefore suggest that leadership in education should be understood less as positional authority and more as responsible coordination grounded in ethical and pedagogical judgment.

A similar clarification concerns resilience. Across the chapters, resilience is treated not as individual endurance alone, but as a multi-level capacity shaped by institutional conditions, support structures, team relations, and professional culture. The findings indicate that resilience cannot be sustained where organizational environments are fragmented, support is inconsistent, or communication is marked by distrust and role ambiguity. Conversely, resilience is more likely when institutions provide continuity planning, professional support, psychological safety, and transparent coordination. This allows resilience to be understood as a property of educational communities and systems, not only of individuals working within them.

The monograph also demonstrates that digital development in education should not be interpreted in narrowly technological terms. Digitalization changes not only tools, but also the structure of communication, visibility of professional work, distribution of expertise, and forms of decision-making. In some cases, digital tools strengthen continuity, access, and collaboration. In others, they intensify overload, complicate responsibility, or generate new ethical tensions. The discussion of teamwork in digital environments and the analysis of artificial intelligence in esports indicate that future educational development will increasingly require forms of literacy that combine technical competence with interpretive caution, ethical awareness, and collaborative capacity. Digital transformation, therefore, is not exhausted by innovation itself; it must also be evaluated in relation to educational purpose, equity, and accountability.

Another important result of the volume is the demonstrated connection between educational quality and the internal conditions of educational communities. The chapters devoted to well-being, psychological safety, and partnership show that sustainable quality depends not only on standards, curricula, or formal procedures, but also on whether institutions create environments in which participants experience support, legitimacy, and meaningful involvement. This applies to teachers and learners, as well as to families, communities, and external stakeholders. The monograph thus argues against separating academic effectiveness from human support. Under conditions of uncertainty, these dimensions are structurally linked.

Analyses of ethics, risk management, and stakeholder partnerships extend this argument to the institutional level. They show that educational systems are tested most clearly when values conflict, resources are constrained, and established routines lose effectiveness. In such situations, procedural justice, preparedness, and partnership become especially important. Institutions strengthen their credibility not by declarative commitment alone, but by the quality of their decision-making processes, the transparency of their priorities, the adequacy of their response mechanisms, and the seriousness with which they engage those affected by educational decisions.

The monograph does not suggest that uncertainty can be removed from education. Nor does it advance a single universal model applicable across all settings. Its contribution is of a different kind. It seeks to clarify the conditions under which educational actors and institutions can act more responsibly, more coherently, and more sustainably when certainty is unavailable. This includes the capacity to distinguish between adaptation and erosion of standards, innovation and dependency, and urgency and disorganized reaction. Such distinctions are increasingly significant for both theory and practice.

The Ukrainian educational experience, which informs much of the material presented here, gives particular force to these conclusions. War, displacement, infrastructural disruption, emotional strain, and institutional vulnerability have intensified longstanding educational challenges and revealed new ones. At the same time, these conditions have shown the importance of

ethically grounded leadership, meaningful cooperation, psychologically sustainable professional environments, and critically integrated digital practices. Although the monograph is shaped by this specific experience, the questions it raises are not limited to one national setting. They belong to a broader international discussion about the future of education in the context of crisis, technological acceleration, and social fragmentation.

Several directions for further research follow from the present volume. These include longitudinal studies of moral judgment and professional resilience under prolonged instability, comparative analyses of leadership and support cultures across educational sectors, deeper examinations of the relationship between digital systems and educational accountability, and further integration of pedagogical ethics, organizational psychology, and educational governance. The materials of this monograph do not close these lines of inquiry. They provide grounds for continuing them on a more systematic basis.

In sum, the monograph supports one general proposition: education under conditions of social uncertainty requires more than continuity of operation. It requires ethically justified leadership, resilient institutional cultures, support-oriented professional communities, and reflective approaches to digital development. Only within such a framework can education preserve both its stability and its human meaning under changing and often adverse conditions.

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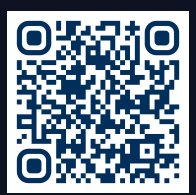

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