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**THE ROLE OF AN INTEGRATIVE APPROACH IN THE FORMATION
OF RESEARCH COMPETENCIES OF GYMNASIUM TEACHERS**

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Abstract. The research article analyzes the concept of «integration» and «integrative approach» on the basis of the psychological and pedagogical literature under the conditions of professional interaction of teachers in a secondary school. Within the scope of the selected study, a logical-structural component of an integrated educational environment based on synergistic relationships – diagonal integration – was identified. In accordance with the requirements of the New Ukrainian School, it was established that the subject-methodical component involves inter-subject and intra-subject integration, which is implemented by teachers based on the use of various forms and methods of teaching students research activities. Based on the study of the peculiarities of the organization of research activities of the participants of the educational process, the personal component is defined as a component of the integrated educational environment, which reflects partner interaction or interpersonal integration of the participants of the educational process. Based on the concept of integration in education, the professional component of pedagogical workers is outlined through inter-branch, intra-branch and professional integration. According to the list of teaching aids of persons with special educational needs and current regulatory documents on the operation of STEM laboratories, it was found that the material and technical component of an integrated educational environment relies on the inclusive integration of schoolchildren into the modern educational space. Based on the study of the combination of traditional and electronic modern means of information transmission and learning technologies, the peculiarities of the information and digital component, which reflects the integration of traditional and electronic learning, are revealed. It has been demonstrated that the selected research problem is relevant, as it involves the practical implementation of an integrated educational environment to ensure online and offline interaction of primary and basic school teachers with the aim of sharing experience in the formation of students' research competences during the teaching of science and mathematics disciplines in a general secondary school education.

Key words: integrative approach; research competences; interaction of teachers.

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РОЛЬ ІНТЕГРАТИВНОГО ПІДХОДУ У ФОРМУВАННІ ДОСЛІДНИЦЬКИХ КОМПЕТЕНТНОСТЕЙ УЧИТЕЛІВ ГІМНАЗІЇ

Анотація. У дослідницькій статті проаналізовано поняття «інтеграція» та «інтегративний підхід» на основі психолого-педагогічної літератури в умовах професійної взаємодії вчителів у закладі загальної середньої освіти. Визначено логіко-структурний компонент інтегрованого освітнього середовища на основі синергетичних зв'язків – діагональну інтеграцію. Встановлено, що предметно-методичний компонент передбачає міжпредметну та внутрішньопредметну інтеграцію, яка реалізується вчителями на основі використання різних форм і методів навчання учнів дослідницької діяльності. На основі вивчення особливостей організації дослідницької діяльності учасників освітнього процесу, особистісний компонент визначено як складник інтегрованого освітнього середовища, що відображає партнерську взаємодію, міжособистісну інтеграцію учасників освітнього процесу. Базуючись на концепції інтеграції в освіті, професійний компонент педагогічних працівників окреслено через міжгалузеву, внутрішньогалузеву та професійну інтеграцію. Відповідно до чинних нормативних документів щодо функціонування STEM-лабораторій, встановлено, що матеріально-технічний компонент інтегрованого освітнього середовища ґрунтується на інклюзивній інтеграції школярів у сучасний освітній простір. На основі дослідження поєднання традиційних, електронних сучасних засобів передачі інформації та технологій навчання розкрито особливості інформаційно-цифрового компонента, який відображає інтеграцію традиційного та електронного навчання. Обрана проблема є актуальною, оскільки передбачає практичне впровадження інтегрованого освітнього середовища для забезпечення онлайн- та офлайн-взаємодії вчителів з метою обміну досвідом у формуванні дослідницьких компетентностей учнів під час викладання природничо-математичних дисциплін у закладі загальної середньої освіти.

Ключові слова: інтегративний підхід; дослідницькі компетентності; взаємодія вчителів.

Problem statement and its rationale. In the context of the development of Ukrainian and European education, the study of integration in science education is a pressing issue of today. Ukraine's orientation towards European values requires a modern understanding of the concept of «integration» for the effective organisation of educational activities in general secondary education institutions.

However, despite the growing theoretical interest in educational synthesis, the practical mechanisms for establishing a continuous integrated learning environment remain insufficiently developed. This fragmentation is further aggravated by the lack of specialized methodological frameworks that would effectively guide teachers through cross-disciplinary cooperation in general secondary education. Furthermore, modern challenges such as martial law and the shift toward distance learning demand new, flexible strategies for teacher-to-teacher professional interaction. Consequently, there is an urgent need to investigate how contemporary tools, including STEM laboratories and digital educational platforms, can be synergistically combined to cultivate research competencies. Addressing this problem is essential for transforming the educational space into a cohesive, inclusive, and adaptive environment capable of fostering advanced investigative skills in both educators and students.

Analysis of the recent publications. The concept of integration is widely used in contemporary psychological and pedagogical research and is interpreted in various ways:

– defines integration as a process of system development that leads to the emergence of a higher integral quality – integrity or integral wholeness; thus, integration expresses the dynamics of the system, while integrity represents the result of this movement (Babenko, 2015, p. 9–12);

– interprets integration as a process of interaction between elements with predefined properties, accompanied by the establishment, complication and strengthening of essential connections between elements based on sufficient grounds, resulting in the formation of an integrated object (Larionova, Streltsova, 2018, p. 8);

– defines it as a unifying process realised through integrative tools; a process in which both internal and external content-related and procedural aspects of integration, a continuous, holistic object or phenomenon are implemented (Zasiekina, 2020, p. 61);

– describes it as an approach that involves constructing educational content (a subject or educational field) as a didactic model based on a substantiated combination of knowledge elements from different subjects and implemented using integrated forms and methods of teaching (Opachko, 2016, p. 43);

– understands the integrative approach as one aimed at ensuring the integrity of knowledge about reality, nature, an educational field, subject, course, section or topic (Romaniuk, 2021, p. 69–75).

Furthermore, current research emphasizes that the modernization of education is inseparable from the introduction of innovative technologies that catalyze the development of teachers' professional competence.

In this context, authors (Tovkanets, Popova, Ivanytska, Kmit, & Paska, 2024, p. 49–67) highlight that the integration of digital tools and innovative pedagogical strategies not only enhances the quality of instruction but also fosters a collaborative environment essential for continuous professional growth and the effective formation of students' research skills.

So, definitions of the integrative approach differ in scope, covering integration at the level of educational content, educational processes, interdisciplinary and inter-sectoral integration, as well as methodological means of implementing integration in learning.

Modern educational paradigms necessitate the development of specialized frameworks for online teacher collaboration to support students with diverse learning requirements. Structured digital interaction among educators plays a pivotal role in creating an inclusive research-oriented environment, ensuring that students with special educational needs can effectively acquire essential cognitive and investigative skills through tailored technological support (Ivanytska, 2024, p. 1–16).

The implementation of an integrative approach requires consistent monitoring of pedagogical outcomes to ensure the effectiveness of professional cooperation. Evaluating the results of teachers' professional interaction in general secondary education institutions allows for the identification of successful collaborative patterns and the adjustment of strategies for developing students' research competencies (Ivanytska, 2024, p. 64–77).

Pedagogical synergetics plays a particularly important role in the modernisation of education. It is a new educational field that studies the effects of interaction among multiple subsystems, leading to the formation of stable structures and self-organisation in complex systems. The synergetic systems are characterised by cooperative interaction of components, collective coordinated behaviour, responsibility for results based on collective interaction, nonlinearity of development, and the constructive nature of contradictions arising during interaction.

Purpose (objectives) of the study. The purpose of the article is to identify the components of a modern educational environment in general secondary education institutions. Achieving this goal involves the following objectives: to determine which types of integration are directly related to a modern educational environment based on the analysis of psychological and pedagogical literature; to identify interconnected directions of integration that ensure professional interaction between primary and basic school teachers.

Methods and Materials. The study employed empirical methods (analysis and systematisation of research activities of students and teachers in primary and basic school) and theoretical methods (analysis of current regulatory documents in the general secondary education system).

To construct a comprehensive framework for the integrated educational environment, a structural-functional analysis was applied to isolate its subject-methodological, personal, professional, material-technical, and information-digital components. The theoretical inquiry involved a comparative review of contemporary psychological and pedagogical literature regarding horizontal, vertical, and diagonal types of educational integration. Additionally, content analysis was performed on current national regulatory acts, specifically focusing on state standards for STEM education equipment and inclusive learning tool frameworks. This multi-method approach enabled a synergistic synthesis of traditional teaching strategies and blended interaction models to systematically support the development of teachers' research competencies.

Results and Discussion. Among the didactic foundations of the integrative approach, the following areas of teacher activity are identified: designing integrated learning outcomes; forming students' holistic knowledge of nature, technology and engineering; developing students' scientific inquiry skills (Zasiekina, 2020, p. 61–68). There are distinguished the following types of integration: horizontal (combining subjects of similar content), vertical (integrating material across different levels of complexity), and diagonal (based on an evolutionary-synergetic paradigm and the integral nature of the individual) (Romaniuk, 2021, p. 69). While horizontal and vertical integration are most common in practice, diagonal integration is considered as the most effective for creating an integrative educational environment. Since synergetics is rooted in natural sciences, its principles are directly linked to research activities in general secondary education. Internal relationships are reflected in interaction among participants in the educational process.

Accordingly, the logical and structural component of the integrated educational environment aligns the content of students' and teachers' research activities across educational stages and is based on diagonal (synergetic) integration. In line with the New Ukrainian School requirements, interdisciplinary integration is implemented through integrated courses, innovative lesson formats, educational projects, and thematic days or weeks. This enhances systematic understanding, promotes practical application of knowledge, and develops systems thinking. Accordingly, among the advantages of integrated learning we can highlight: a clearer understanding of the purpose of each academic discipline and a specific topic through its study based on different views; the use of a complex perception of the world picture; improving the skills of system thinking and forming in students the ability to establish relationships.

So, the above-mentioned facts allow us to state that within the framework of the chosen study, one of the components of the educational environment designed to form teachers' research competences and the research competences of primary and basic school students are the academic disciplines of the natural-mathematical cycle that students study in secondary schools in accordance with the current educational programs – namely, the subject-methodical component of the educational environment. Accordingly, the interdependence between these components lies, in our opinion, in interdisciplinary and intra-disciplinary integration implemented by teachers through the use of various forms and methods of learning.

Social integration, that is understood as interaction based on shared values and goals, is particularly important for organising research activities, especially under conditions of pandemic and martial law. For primary and secondary school students, research activities are the best organised in micro-groups, while teachers may collaborate in micro, small or medium

groups, including in distance formats. These considerations allow us to define the personal component of the integrated educational environment, characterised by partnership interaction or interpersonal (social) integration.

Researchers argue that an interactive educational environment serves as a fundamental determinant of personality development, particularly within the context of higher and secondary education. Such environments foster synergistic relationships and partnership interactions, which are crucial for the holistic formation of a teacher's professional identity and the effective implementation of research-oriented pedagogical strategies (Prima, Ivanytska, Kyslychenko, Levytska, & Kudra, 2024, p. 43–59).

The role of teachers becomes particularly significant in the practical implementation of remote interaction through the use of modern communication technologies. Integrated student learning places a number of requirements on the organisation of teachers' research activities, including the selection of identical or similar research objects and methods based on materials from different academic disciplines, as well as the identification of common patterns for understanding complex systems that encompass the selected objects of study. The practical implementation of these activities requires, in our opinion, the development of appropriate research competencies.

The formation of holistic (integrated) knowledge in secondary school students is complicated by the lack of specialists in general teaching methodologies (Zasiekina, 2020, p. 66). Since the system of pedagogical and professional interaction among teachers consists of a number of interconnected elements, it is appropriate, in our view, to consider integration not in isolation but as a foundational principle within the framework of the integrated educational environment of the «primary – basic school». The integrated educational environment is of particular importance in the formation of teachers' scientific and research competencies and students' research competencies, as defined by current regulatory documents. Thus, the above considerations allow us to conclude that another component of the integrated educational environment is the personal component, represented by the participants in the educational process. Accordingly, partnership interaction or interpersonal (social) integration among these participants constitutes the interdependence between the components.

For effective organisation of an integrated educational environment, it is also necessary to consider integration in education and pedagogical integration. Pedagogical integration emphasises the interrelation and mutual influence of knowledge, requiring teachers to perceive education as a holistic process. In addition, professional integration plays a crucial role. Intra-sectoral integration, that is understood as the unification of mono-professional occupations within one sector, provides: the integration of professions having significant common functional characteristics; the integration of professions that require workers to possess shared knowledge, have minor common functional characteristics, and may be performed with a certain time gap; and the integration of professions that do not have common functional characteristics but belong to the same sector and are most often observed among employees with a wide range of duties. However, in our opinion, the general principles of professional integration can be projected onto the pedagogical field, namely onto the professional interaction (integration) of primary and lower secondary school teachers in general secondary education institutions under conditions of forming teachers' research competence and students' digital competence.

We believe that, within the scope of our study, an example of such intra-sectoral professional integration is the pedagogical activity of a primary school teacher who simultaneously teaches several subjects in their class and also teaches computer science in their class and at the corresponding grade level.

Global economic integration and rapid technological progress impose new requirements on specialists in all fields of knowledge: the maximum training of workers with broad qualifications who are able to quickly adapt to constant changes and meet employers' demands. Narrow specialization and limited professional competencies do not satisfy the needs of the economy, society, or the individual. Therefore, the vast majority of countries around the world address this problem through the introduction of integrated professions. Thus, the above facts allow us to assert that, within the scope of our study, the next component of the integrated educational environment can be identified as the professional component of pedagogical staff. Accordingly, the interrelations in their activity include inter-sectoral, intra-sectoral, and professional integration. In our opinion, psychological and pedagogical studies (Romaniuk, 2021, p. 70; Zasiakina, 2020, p. 61–68) are devoted to the issue of integration separately within the systems of primary and lower secondary school; however, the problem of cooperation between pedagogical staff of primary and lower secondary school aimed at forming students' digital competence and teachers' research competence remains insufficiently studied. To choose directions for solving this problem, we consider the role of material and technical support in the integrated educational environment. Within the scope of our study, the use of mobile furniture for organizing group-based curricular and extracurricular student activities becomes particularly important for forming teachers' research competence and students' digital competence.

Thus, according to a grant program on learning the basics of robotics, the use of a seasonal thematic field with LEGO-based tasks requires the presence of a movable table in the classroom for robot competitions, around which students are positioned to control their creations using tablets. The use of modern digital educational tools, electronic educational platforms, online services, and instruments by participants in the educational process expands opportunities for their research activities.

The creation of an integrated educational environment, in our view, requires consideration of the requirements for organizing inclusive education in general secondary education institutions: creating conditions to ensure learner-centered education for different categories of students, including those with special educational needs (SEN). When students with SEN perform research tasks, pedagogical staff and teacher assistants must take into account the resources available in the resource room, as specified by the Order of the Ministry of Education and Science of Ukraine «On Approval of the Standard List of Assistive Learning Tools (Special Means for Correcting Psychophysical Development) for Persons with Special Educational Needs Studying in Educational Institutions» (2018). It should be noted that inclusive education in a broad sense includes not only work with children with SEN, but also the involvement of all students in the educational process, taking into account their individual characteristics.

Therefore, in our opinion, the introduction of modern STEM laboratories into the educational process within the scope of the selected study becomes particularly important for the integrated educational environment and its material and technical support. According to the Order of the Ministry of Education and Science of Ukraine «Standard List of Teaching Aids and Equipment for Classrooms and STEM Laboratories» (2020), equipment should not only comply with educational standards but also take into account the real needs of participants in the educational process. Since, in addition to typical teaching aids (collections, models, micropreparations, etc.), a STEM laboratory involves students' use of multimedia equipment and electronic educational resources, this, in our opinion, makes it possible to maximally adapt learning to the individual characteristics of each student and create conditions for inclusive integration of school students into the modern educational environment. Thus, within the scope

of our study, the next component of the integrated educational environment can be identified as the material and technical component, which becomes the basis for face-to-face and distance research activities of students and relies on the inclusive integration of learners into the modern educational space.

In our opinion, the integrative educational environment is directly connected with the information and educational environment (IEE). The IEE is based on the integration of information on traditional and electronic media, computer and telecommunication interaction technologies, virtual libraries, and the like. The IEE is predominantly a virtual learning environment, that is, an open system that provides a set of interrelated and constantly updated learning tools, ensures synergy, and enables interactive interaction among participants in the educational process (Topuzov, 2018, p. 20). For the IEE we consider the integration of the following components: a comprehensive IEE (within the structure of a general secondary education institution); a specialized IEE (within the profile structure of an educational institution); the individual's information and educational space within an organizational and economic environment with the implementation of specific learning strategies and the introduction of modern pedagogical learning technologies (including distance learning technologies); and the IEE within the organizational and economic mechanism of integrated courses or a separate academic subject.

Current academic discourse highlights the transformative potential of immersive tools in professional education. In particular, virtual reality technologies significantly enhance the quality of specialist training by providing high-fidelity simulations that bridge the gap between theoretical knowledge and practical application. Integrating such technologies within a research-oriented educational environment allows for the development of complex professional skills through interactive and safe experimental scenarios (Miroshnichenko, Mahas, Kochubei & Ovdii, 2024, p. 10–22).

Taking into account the above facts, it can be argued that integration within the IEE involves the combination of traditional (offline) and electronic (online) modern means of information transmission and learning technologies. As a result, in our opinion, new opportunities open up for organizing research activities of students and scientific research activities of teachers in general secondary education institutions. Accordingly, under modern conditions of the pandemic and martial law, the IEE requires maximum use of digital learning tools in the educational process, which is confirmed by the main directions for implementing the Resolution of the Cabinet of Ministers of Ukraine «On Approval of the Concept for the Development of Digital Competencies and Approval of the Action Plan for Its Implementation» (2021), namely: a dynamic combination of knowledge, skills, abilities, ways of thinking, and views in the field of ICT and digital technologies; improvement of professional standards taking into account frameworks of professional digital competencies. The integration of the IEE and the electronic educational environment occurs during the organization of blended learning, which involves a combination of traditional and electronic (distance and mobile) learning (Miziuk, 2019, p. 174).

We agree that regarding a broad understanding of the content of this concept, taking into account the advantages it offers for the formation of students' digital competence and teachers' research competence, namely: expansion of students' educational opportunities through increased accessibility and flexibility of education, taking into account the individual educational needs of participants in the educational process; an increase in the level of independence, motivation, reflection, self-analysis, and, as a result, the effectiveness of the educational process; transformation of the teacher's style of activity: a transition from knowledge transmission to interactive interaction; personalization of the educational process.

In blended learning, integration is considered not only as a combination of traditional and

electronic learning, but may also reflect other types of integration (combinations), such as: integration of structured, well-organized learning, where a participant in the educational process is provided with a set of pre-developed learning materials and a specific learning trajectory, and unstructured learning, which occurs through conversations, meetings, and email correspondence; integration of user-generated content and external materials; integration of individual and collaborative learning through the use of electronic learning tools aimed at sharing acquired knowledge and experience (Movchan, Komisarenko, 2022, p. 191).

We agree that the above-mentioned types of integration in blended learning for both students and pedagogical staff indicate that the concept of the physical classroom partially loses its significance. Accordingly, within the scope of our study, the concept of a «virtual classroom» acquires substantial importance for further practical application aimed at forming teachers' research competence and students' digital competence.

Blended learning gains particular advantages, especially under conditions of martial law, including: asynchronous work becomes controlled and coordinated among participants in the educational process; the educational process may include adaptive technologies and interactive phenomena that will be positively perceived by participants in learning interaction; and the role of psychological support among members of the student and pedagogical community is strengthened. In our opinion, these advantages of blended learning can also be applied to the research activities of students in general secondary education institutions and to the scientific research activities of teachers. Thus, within the scope of our study, the next component of the integrated educational environment can be identified as the information and digital component, which reflects the integration of traditional and electronic learning, that is, the implementation of both offline and online learning.

Based on the outcomes of the offline and online interaction of pedagogical staff, their diagnostics was conducted. For this purpose, control and experimental groups of teachers from Lyceum № 85 of the Odesa City Council were selected to identify the levels of formation of their research competence components, which reflects the effectiveness of their interaction within the integrated educational environment (Fig. 1, Fig. 2).

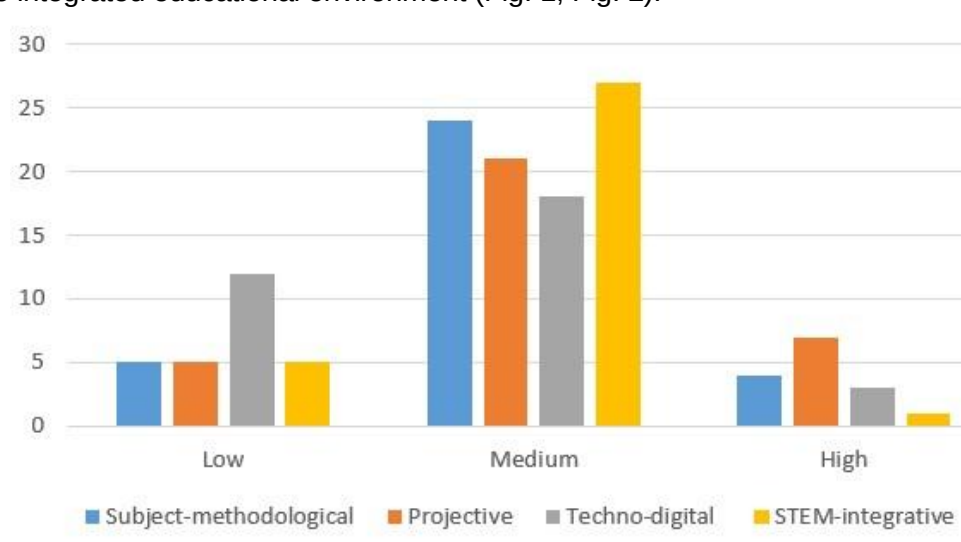


Fig. 1. Indicators of research competence components of the experimental group members (33 individuals)

Source: developed by the author.

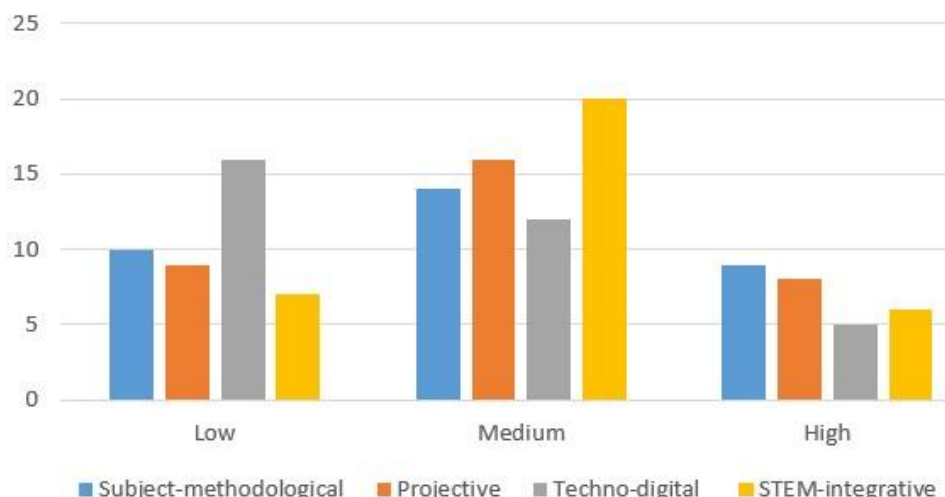


Fig. 2. Indicators of research competence components of the control group members (33 individuals)

Source: developed by the author.

To evaluate the effectiveness of professional interaction within the integrated educational environment, a comparative analysis was conducted between the experimental and control groups of teachers, focusing on four core components of research competence: subject-methodological, projective, techno-digital, and STEM-integrative. The data illustrated in Fig. 1 demonstrates that a significant majority of the experimental group members reached the «Medium» level across all indicators, with the STEM-integrative component showing the highest concentration of educators at this level. Furthermore, the experimental group achieved noticeable progression into the «High» level, particularly within the projective and subject-methodological categories, while keeping the «Low» level indicators relatively minimal. In contrast, the control group exhibited a more fragmented distribution, as shown in Fig. 2, with a substantially higher number of teachers remaining at the «Low» level, particularly in the techno-digital and subject-methodological dimensions. Overall, this comparative analysis confirms that structured online and offline teacher interaction within the integrated environment significantly enhances the development of research competencies compared to traditional settings.

Conclusions and prospects for further research. The study confirms that the research objectives have been achieved. The formation of students' research competencies and teachers' scientific research competencies within an integrated education requires optimisation of the number of integration elements, identification of interconnected components of the integrated educational environment: subject-methodological (interdisciplinary and intra-disciplinary integration); personal (interpersonal or social integration); professional (inter-sectoral, intra-sectoral and professional integration); logical-structural (diagonal integration); material-technical (inclusive integration); information-digital (integration of traditional and electronic learning); selection of key characteristics of pedagogical synergetics for effective functioning of the environment; organisation of interaction among participants of the educational process considering pedagogical and professional integration.

Specifically, the systemic review of psychological and pedagogical literature allowed us to substantiate diagonal integration, rooted in the evolutionary-synergetic paradigm, as the most effective structural axis for modern school settings. By bridging the theoretical gap between isolated disciplines, this approach ensures that natural sciences and mathematics

are taught through cohesive, interconnected knowledge structures. Furthermore, the investigation successfully outlined the professional and personal trajectories of cooperation between primary and lower secondary school educators. It was established that structured professional integration effectively mitigates the fragmentation traditionally observed during students' transition between these educational tiers. Moreover, the integration of material, digital, and STEM resources was proven crucial for sustaining both face-to-face and remote collaborative investigative practices. Ultimately, these findings provide a valuable methodological foundation for school administrators aiming to foster a collaborative, research-oriented institutional climate under modern digital and social constraints.

The research problem is relevant, as it provides a practical framework for implementing an integrated educational environment that supports online and offline interaction between primary and basic school teachers and facilitates the exchange of experience in forming students' research competencies in science and mathematics education.

Prospects for further research include developing specific methodological guidelines for implementing diagonal integration in STEM lessons, establishing evaluation criteria for teacher collaboration efficiency, and studying the psychological and pedagogical aspects of transitioning research activities from virtual spaces to physical modern school laboratories.

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