International Journal of Basic and Applied Sciences, 15 (1) (2026) 11-19

International Journal of Basic and Applied Sciences

Website: www.sciencepubco.com/index.php/IJBAS
https://doi.org/10.14419/a4k9r454
Research paper

Future Teacher Training for Integrated Learning in Contemporary Information Educational Environments

Iryna Mozul [1] *, Dmytro Nyshchak [2], Nadiya Vasylkivska [3], Oksana Abramova [4], Natalia Myronenko [4], Olena Anisimova [5], Natalia Nazarenko [6], Inna Radiuk [7], Olena Bukhniieva [8], Nadiia Gramatyk [8]

[1] Oleksandr Dovzhenko Hlukhiv National Pedagogical University, Ukraine
[2] Drohobych Ivan Franko State Pedagogical University, Ukraine
[3] Ternopil Volodymyr Hnatiuk National Pedagogical University, Ukraine
[4] Volodymyr Vynnychenko Central Ukrainian State University, Ukraine
[5] Kherson State University, Ukraine
[6] Bohdan Khmelnytsky National University of Cherkasy, Ukraine
[7] Lesya Ukrainka Volyn National University, Ukraine
[8] Izmail State University of Humanities, Ukraine
**Corresponding author E-mail: puhach_s@ukr.net*

Received: December 14, 2025, Accepted: January 5, 2026, Published: January 8, 2026

Abstract

The article clarifies the meaning of "integration" in education and outlines its types. The role of the integrated information educational envi-ronment in higher education is substantiated; in particular, key provisions for organizing it are presented. Ways to prepare students for ap-plying integrated forms of educational organization in higher education through various types of disciplinary integration are presented. Dur-ing the ascertaining experiment, the diagnostic methods used revealed that respondents in the EG and CG lacked skills and analytical abili-ties, as well as self-control, reflection, self-regulation, and professional self-improvement. During diagnostics, we found that more than 70% of future specialists in socionomic specialties are not ready for integrated training in the information educational environment, indicating the need to study the problem outlined above. Summarizing the results of the ascertaining stage of the study, we emphasize the need to develop, substantiate, and implement new content, pedagogical conditions, practical means, forms, and methods. The data obtained during the forma-tive experiment allow us to conclude about the effectiveness and efficiency of implementing pedagogical conditions, because in the EG, where pedagogical conditions were introduced, the respondents increased their initial level of readiness for the specified problem.

Keywords: *Higher Education Institutions; Information and Computer Technologies, Information Educational Environment; Integrated Learning, Training of Future Teachers.*

1. Introduction

The continuous informatization of society, rapid change in technologies, knowledge, ideas, socio-political, globalization, cultural, economic processes of modernity motivate the formation of an innovative, intelligent, self-sufficient, democratic person, for whom the essential feature of the way of life will be the acquisition of knowledge and who, based on the knowledge obtained, can act [1]. All these places place new demands on the higher education system, a modern school in transition to competency-based learning.

The use of knowledge integration in the educational process is one of the directions of reforming the educational sector. The urgent need is to form an integrative type of thinking in a modern individual, which emphasizes the need for an innovative phenomenon – integrated learning for further successful adaptation of a person in today's competitive real conditions. Preparing future teachers to implement integrated learning in an information-rich educational environment is integral to the professional training of a modern specialist [2].

Due to information overload in the modern educational process, the importance of integration processes is increasing, a key aspect of applied and scientific knowledge.

Improving the quality and modernization of education largely depends on teachers' training, which must combine initiative, versatility, and competence.

The availability of systemic knowledge across various fields of education requires modern teachers to fulfill their professional duties. Therefore, the quality of education depends directly on improving the organization of the higher education system.

Implementing an integrated approach in educational practice stimulates participants' creativity and fosters a holistic view of the world. Integrated learning provides flexibility in selecting lesson content, topics, and instructional methods, enabling more effective assimilation of the material. The selection of educational components depends on the promising and relevant educational, developmental, and learning tasks of the educational process [3].

Radical changes are a sign of our time, occurring in educational institutions and in how the educational process is structured at all levels. By using pedagogical technologies, the content of the educational process is effectively enhanced and expanded, enabling changes such as interaction among the participants in the educational activity. A high level of professional training for future specialists ensures the use of Internet services to provide regular assistance to higher education applicants, to conduct innovative classroom activities by introducing various types of intermediate and current controls, and to conduct consultations. The essence of the educational process, which can last throughout life, lies in the teacher's preparation of future specialists for self-educational activity. In the educational market, the most competitive technologies are those based on telecommunications and computer technologies, as electronic resources within the educational environment facilitate information exchange and provide free access to the latest scientific research results at higher education institutions. Within the integration of processes lies the solution to this issue: an education grounded on the principles of blended learning is a strategic function, focused on students' self-development as future professionals and their formation as individuals [4].

2. Literature Review

The integration of the educational process is widely recognized as a necessary methodological and organizational condition for improving the quality of future teacher training. In response to the growing complexity of knowledge and the digitalization of education, researchers from different countries have focused on preparing future teachers to implement integrated learning within information educational environments. A synthesis of the cited studies allows the identification of several clearly defined thematic clusters.

Cluster 1. Methodological Models of Integrated Learning

The first cluster includes studies that develop methodological foundations and organizational models of integrated learning. Lenoir and Hasni [5] propose a comprehensive methodology for implementing integrated learning, conceptualizing integration as a response to disciplinary fragmentation. Michelsen and Sriraman [6] further develop this idea by offering a structured scheme for organizing integrative learning, which supports teachers in designing and conducting integrated lessons during both pre-service training and professional practice. These approaches align with international theoretical orientations that emphasize interdisciplinarity as a core principle of modern education, particularly within UNESCO’s vision of holistic and sustainable learning.

Cluster 2. Integrated Learning and Competence Formation

The second cluster focuses on competence-oriented outcomes of integrated learning. Ríordáin et al. [7] demonstrate that studying professionally oriented interdisciplinary topics supported by electronic educational resources enhances students’ ability to apply knowledge across domains. Hawkey et al. [8] present an algorithm for developing key and professional competencies through cross-curricular integration, highlighting integrated learning as a mechanism for competence transfer rather than content accumulation.

These findings correspond with the OECD Education 2030 framework, which prioritizes transversal competencies, systems thinking, and the ability to solve complex real-world problems. The current study reinforces this orientation by empirically confirming that competence development is mediated by motivational, cognitive, and activity-reflective readiness components.

Cluster 3. Digital and Information Educational Environments as Enablers of Integration

The third cluster addresses the role of information educational environments and digital technologies in supporting integrated learning. Maistruk [11] substantiates the effectiveness of innovative teaching technologies in creating a new virtual dimension of education, while Chovriy et al. [12] emphasize the potential of integrated learning within digital environments for developing students’ creative capacities. These studies are consistent with international digital competence models such as TPACK and DigCompEdu, which stress the interdependence of pedagogical, technological, and content knowledge. The present study extends these models by demonstrating that an information educational environment is not merely a technological context but a pedagogical space that enables the systematic formation of readiness for integrated learning.

Cluster 4. Professional Training of Future Teachers for Integrated Learning

The fourth cluster comprises research devoted to preparing future teachers for integrative educational practice. Juraev and Aroyev [9] examine ways of training teachers to apply integrative approaches and develop communicative competencies within information-rich environments. Samson [10] analyzes interdisciplinary project-based learning, emphasizing the teacher’s role as a facilitator and consultant in digitally supported integrated projects. Pidhorna and Tverdokhlib [13] identify stages of integration development in education and define professional requirements for teachers capable of implementing integrated learning using digital technologies.

While these studies provide valuable conceptual insights, most remain predominantly theoretical or descriptive. In contrast, the current research contributes empirical validation of pedagogical conditions through a quasi-experimental design and statistical analysis, thereby addressing a key methodological limitation in this cluster.

Synthesis and Alignment with International Orientations

Overall, the reviewed studies establish a strong theoretical and contextual foundation for integrated learning and its digital support. They collectively emphasize interdisciplinarity, competence development, and the transformative role of information educational environments. These orientations are broadly aligned with international frameworks such as UNESCO’s Teacher Competency Framework, OECD competence models, and DigCompEdu.

However, the literature reveals a shortage of empirically validated pedagogical conditions for systematically preparing future teachers to implement integrated learning. By aligning its findings with these international orientations and addressing the identified research gaps, the present study advances evidence-based models for training future teachers in information-rich, competence-oriented educational systems.

PURPOSE OF THE RESEARCH. Professional training of future specialists for the implementation of integrated learning in the educational information environment.

3. Methodology

3.1. Research design

The study employed a quasi-experimental research design with control and experimental groups to examine the effectiveness of pedagogical conditions for preparing future teachers to implement integrated learning within an information educational environment. The design included ascertaining (pre-test) and formative (post-test) stages, enabling the assessment of changes in participants' readiness levels over time.

3.2. Participants

The empirical study was conducted during 2023–2025 at several Ukrainian higher education institutions. The total sample consisted of 90 undergraduate students enrolled in socionomic specialties. Participants were divided into two groups:
Experimental Group (EG): 44 students who were trained using the author's methodology under specially designed pedagogical conditions;
Control Group (CG): 46 students who followed the traditional curriculum without targeted methodological intervention.
The sample size meets the requirements for statistical representativeness at a 95% confidence level, ensuring the reliability and generalizability of the findings.

3.4. Research instruments

To assess the readiness of future teachers for implementing integrated learning in an information educational environment, a complex of diagnostic tools was used, including: structured questionnaires; pedagogical testing; observation protocols; diagnostic tasks and self-assessment tools.
Readiness was operationalized through four interrelated components: motivational, cognitive, activity-based, and reflective. Based on these components, three assessment criteria were defined: motivational, cognitive, and activity-reflective.
Participants' readiness levels were classified as low, average, sufficient, or high, using a 100-point scale.

3.5. Procedure

At the ascertaining stage, baseline diagnostics were conducted to determine the initial level of readiness in both groups. Following this, the formative stage was implemented in the experimental group, which involved: enhancing students' motivation for integrated learning; updating curriculum content to reflect interdisciplinary integration; gradual mastery of methodological principles of integrated learning; practical training through workshops, seminars, and teaching practice within an information educational environment.
The control group continued learning under standard instructional conditions.

3.6. Data analysis

Quantitative data were processed using methods of mathematical statistics. To verify the significance of differences between the experimental and control groups after the formative stage, the Kolmogorov–Smirnov λ-test was applied.
The hypotheses tested were:
H_0: No statistically significant differences exist between the distributions of readiness levels in EG and CG;
H_1: Statistically significant differences exist between the distributions.
The empirical value of the test statistic exceeded the critical value at $p \leq 0.05$ and $p \leq 0.01$, confirming the acceptance of the alternative hypothesis (H_1) and indicating the effectiveness of the implemented pedagogical conditions.

3.7. Ethical considerations

Participation in the study was voluntary. All respondents were informed about the purpose of the research and provided consent for data collection and analysis. The study adhered to ethical standards of educational research, ensuring anonymity and confidentiality of participants' data.

4. Results and Discussion

4.1. The concept of "integration" in education includes types of integration. the role of the integrated information educational environment of higher education in education

Integration is a necessary didactic tool – the requirement of combining the components of the objects of the educational process into a whole, with the help of which interdisciplinary competence is formed in students, and it is possible to create a holistic idea of the object that is currently being studied. It is advisable to orient higher education towards an integrative, developmental, and productive approach [14]. The concept of "integration" in education is ambiguous and complex:

- Integration is a means of learning that involves establishing connections and identifying common content of subject areas.
- Integration is the goal of learning that leads to the formation of a holistic image of the world in which all objects are interconnected by students of the educational process [15].

There are the following types of integration in the educational process of higher education:

- Inter-subject integration − manifests itself in the use of techniques, methods, principles of one discipline when studying another, consists of inter-subject connections, blocks, integrated courses, programs, etc.
- Intra-subject integration − includes the integration of concepts within individual subjects. With such an organization of learning, cognition can proceed from general to partial, or from partial to general [16]. Integration in education is extremely effective, important,

and relevant as a contemporary challenge in developing students' competencies. In higher education institutions, this aspect must be considered when training future teachers [17].

Modern education should be grounded in effective models and innovative information technologies that foster lifelong self-learning skills. Integrated learning is an innovative approach that, given the need to develop integrative thinking, is especially relevant and contributes to individuals' competitiveness and adaptation in modern society. In the context of social transformations, such thinking serves as a tool for self-improvement, self-actualization, and self-realization, enabling students to master significant volumes of vital and educational information, navigate the educational landscape effectively, and recognize their place in the world. The need to optimize the integration of educational components underscores the importance of integration, which helps avoid subject-level content duplication, reduces student overload, and ensures a modern, harmonious educational process in the information environment [3].

4.2. Key provisions of the organization of the integrated information educational environment of higher education

Let us formulate the key provisions of the organization of the integrated information educational environment of higher education.

Learning combines blended, information, and computer-based approaches; it uses virtual and multimedia resources, cloud and network technologies, and supports interactive forms (forums, chats, video). Teachers guide students as consultants, applying pedagogical and IT methods to foster cognitive independence. SMART, scribing, and portfolio tools enhance goal-setting and skill development.

Teaching integrated material requires a teacher to have broad erudition, professional skills, and deep methodological knowledge. Integrated subjects can be studied separately in time or within close time frames, which form the following types of intersubject connections: vertical – the material of one subject is based on knowledge from another subject, and horizontal – during parallel study, intersubject connections are established [16].

Integration allows: by establishing new logical connections, to ensure the systematic nature of knowledge, to form qualitatively new knowledge that is distinguished by dynamism and a higher level of comprehension, to meet the age characteristics of a person, to eliminate one-sided development of the personality, since human thinking is characterized by a figurative and holistic perception of the world [18].

An important direction in modernizing the integrated information environment is to overcome the isolated teaching of individual subjects. This requires the creation of fundamentally new educational programs oriented on a developmental and productive approach. Achieving this goal is possible through the active implementation of integrated courses, the development of new integrated textbooks, and the conduct of integrated classes [3].

4.3. Preparing students for the application of integrated forms of education organization in higher education through various types of integration of disciplines

There are different types of integration of disciplines:

- Transdisciplinarity – from the point of view of the dynamics of entire systems – comparison for the subordination of integral schemes (hierarchy, subordination) of disciplines.
- Interdisciplinary –to establish a new level of integration of knowledge – synthesis of two or more disciplines.
- Multidisciplinary – the process of comparing disciplines not as integrated, but as components [19].

We consider preparing students for the application of integrated forms of organizing the educational process in higher education to be an integrated learning process that ensures teachers' professional competence for integrated activities.

The readiness of future specialists is defined as a characteristic that is integrated for the qualitative result of the training of future teachers and provides for the formation of innovative structural components for work in an information-integrated educational environment:

- Value readiness – reflects interests, needs, value orientations, goals, motives, beliefs to realize the importance of creating an integrated information educational environment, ensuring and positive attitude of the teacher to the formation of holistic ideas about the world around each individual, interest and activity of the student in mastering the practice and theory of applying integrated forms of organizing the educational process.
- Scientific readiness – involves students mastering subject-methodological knowledge, a system of psychological and pedagogical knowledge, ideas about modern processes and integration trends in higher education, about the general scientific aspect of the concepts of “pedagogical integration”, “integration” about algorithms for integrating the content of higher education; about basic concepts and subject, interdisciplinary, key competencies; about types of integrated forms of organizing the educational process, methods of their implementation on an integrated basis, results and functions of learning.
- Practical readiness – is inherent in the skills to select and analyze educational material to clarify cross-cutting generalized competencies and concepts that are formed during learning; to establish and identify a hierarchy of inter-subject, intra-subject, extra-subject relationships; is based on content-constructive skills (to improve and create interaction between disciplines and educational topics, to choose integrated appropriate forms of organizing the educational process, to develop tasks of an integrated nature, to implement and design algorithms for using tasks); in evaluative and predictive skills (to correctly predict and evaluate the results of applying integrated forms of organizing learning) [20].

4.4. Organization and course of the pedagogical experiment

The experimental work was carried out during 2023–2025.

Two groups were selected during the experiment: the experimental group (EG), where future specialists were trained in the information educational environment to implement integrated learning using the author's methodology; the control group (CG), where future specialists were trained using the usual methodology, no special changes were envisaged in the methods, forms, content, and teaching aids of the respondents, they were aimed at training students in their specialty.

The EG included 44 students. The CG included 46 students.

To calculate the volume of a random sample using statistical methods, we identified the formulas.

Let's calculate the sample size using the formulas:

$$n = \frac{t^2\, w(1-w)\, N}{\Delta_w^2\, N + t^2\, w(1-w)}$$

$$n = \frac{1.96^2 \cdot 0.1(1-0.1) \cdot 224}{0.05_w^2 \cdot 224 + 1.96^2 \cdot 0.1(1-0.1)}$$

Where n is the sample size; t is the standard deviation, which is determined based on the selected confidence level; N is the size of the general population; S is the variation found for the sample; S2 is the variance of the random variable; w is the proportion indicator; Δ is the permissible margin of error that is consistent with the given confidence level P. The value of t is determined using the normal distribution table – the standard deviation. Therefore, t = 1.96, if P = 0.95. We recommend using the maximum S value to obtain more accurate and reliable results. S = 0.5 is used in the absence of statistical information, as it gives the maximum variance: 0.5*0.5 = 0.25. Thus, the sample size indicator will be overestimated, providing additional reliability to the results.

Based on the formulas above, we conclude that, for reliable results, the sample size n should be at least 86. The conclusions drawn from the experimental results could then be extended to the general population with 95% confidence.

To verify the effectiveness of the pedagogical conditions we developed for training future teachers in the information educational environment, and to implement integrated learning before the experiment, particularly during the formative stage, respondents were divided into control and experimental groups. In distributed groups used to select students, it is necessary to determine the minimum number of students per group.

To form experimental and control groups of respondents who will directly participate in the study, calculations were conducted to determine the required sample sizes for each group, ensuring a sufficient sample size and full representativeness of the experiment. For this, we used the following formula:

$$n = \frac{t^2\, p(1-p)}{a_0^2}$$

Where n is the sample size, P (0.95) is the size of the general population, t is the significance coefficient (1.96), and 0 is the margin of error of the sample. Such calculations prove the accuracy of this sample (5%).

It has been established that the minimum number of respondents per group is 18.

In our pedagogical research, we accept t = 4. Because the general share is approximately 5%, the probability of a particular deviation of the studied feature, its selective share, is equal at t = 4. In the study, to prepare future teachers for implementing integrated learning in the information educational environment, we are limited to the average accuracy of the marginal error, because the management and functioning of this process are influenced by factors that cannot always be quantified.

Before the start of the experiment (the ascertaining stage), we developed criteria (motivational, cognitive, and activity) and indicators of the readiness of future teachers to implement integrated learning in the information educational environment, aligned with the identified components: motivational, cognitive, activity, and reflexive. A selection of diagnostic methods was used to determine the levels (low, medium, sufficient, high) of future specialists' readiness to the specified problem and their initial readiness.

To assess the readiness of future specialists for the specified problem and to determine the components to be formed, we developed criteria and corresponding indicators.

To determine the level of readiness of future specialists to the specified problem, we use the following indicators according to the motivational criterion:

1) Value attitude to future professional activity and training.
2) Motivation to master the practice and theory of implementing integrated learning in the educational information environment.
3) Awareness of the importance and relevance of integration in education.

To determine the level of readiness of future specialists for the specified problem, we use the following indicators according to the cognitive criterion:

1) Understanding of the features of integrated learning, and the didactic principles of conducting innovative educational activities.
2) Understanding of the individual's psychological characteristics.
3) Understanding of the principles of building integrated classes and the structure of innovative educational activities in the information educational environment.

To determine the level of readiness of future specialists for the specified problem, we use the following indicators according to the activity-reflective criterion:

1) Awareness of conducting integrated classes in the information educational environment and with the methodology of preparing for them.
2) Ability to construct integrated classes in the information educational environment independently.
3) Orientation towards self-development and self-knowledge of the individual.

We distinguish four levels of readiness appropriate for pedagogical integration: high, sufficient, average, and low.

The maximum possible points were 100, which students could earn during the diagnostics. The following level distribution of points was proposed:

- 75–100 points – a high level of readiness of respondents.
- 50–74 points – a sufficient level of readiness of respondents.
- 25–49 points – an average level of readiness of respondents.
- 0–24 points – a low level of respondent readiness.

The formative stage of the experiment involved implementing selected pedagogical conditions within the experimental groups to prepare future teachers to implement integrated learning in the information educational environment.

The purpose of the formative experiment is to increase the readiness of future specialists to implement integrated learning in the information educational space by introducing developed and implemented pedagogical conditions into the educational process of respondents in the EG.

With students of the experimental group, the educational process at this stage was organized in accordance with the developed and substantiated pedagogical conditions for training future specialists to implement integrated learning in the information educational space.

In the control group, students were taught using traditional methods.

At the stage of pedagogical research of the formative experiment, the following pedagogical conditions developed and proposed by us were implemented in the EG:

- formation of motivation of future teachers to implement integrated learning for each individual.

- updating the program results of learning in the information educational environment and the content of training future teachers to implement integrated learning in it.
- ensuring the gradual mastery of methodological and theoretical features of integrated learning by future teachers.
- to gain experience in improving and using skills in implementing integrated learning in an information educational environment − using the potential of production practice.

For respondents who participated in the experiment, we provided methodological assistance, organized workshops and seminars, and developed recommendations for experimental work.

The experimental work was structured in accordance with the stages and defined tasks:

- At the first stage, a theoretical analysis of the problem was conducted, and a methodology for experimental work was developed.
- At the second stage, pedagogical conditions for training future specialists in the information educational space for implementing integrated learning were developed, and the statement stage of the experiment was conducted.
- At the third stage of the study, a formative stage of the experiment was organized.
- At the fourth stage, generalization, analysis, and verification of the results were conducted, and the study's findings were formalized and systematized.

Let us present a generalization of the experimental results.

Statement stage.

According to the study, based on generalized data, almost a quarter of students in both groups (EG and CG) have a low level of motivational component formation. They do not pursue development and lack clear motivation for their professional activities.

The results of the diagnostic assessment of future teachers' readiness to implement integrated learning in the information educational environment, based on the motivational criterion, are presented in Table 1.

Table 1: Distribution of Respondents of the Experimental Group and the Control Group According to the Motivational Criterion

Level	Respondents (in %)
High	8
Sufficient	21
Average	47
Low	24

It should be noted that a large percentage of respondents (44%) are familiar with the didactic principles of learning; they are least familiar with the information educational environment and with the principles of building integrated classes (11%).

The results of the diagnostic assessment of future teachers' readiness to implement integrated learning in the information educational environment, based on the cognitive criterion, are presented in Table 2.

Table 2: Distribution of Respondents of the Experimental Group and the Control Group According to the Cognitive Criterion

Level	Respondents (in %)
High	5
Sufficient	18
Average	52
Low	25

The results of statistical processing indicate that the cognitive component of teachers' readiness for integrated learning is insufficiently developed; knowledge of the features of integrated classes is not systematized, poorly understood, and incomplete. The reason is the lack of formation of students' ideas about the specificity and essence of the chosen activity, a responsible attitude to the future profession, interest in learning in general, to the results and process of professional activity, and understanding of the importance of obtaining higher education for the chosen field of professional activity.

The results of the diagnostic assessment of future teachers' readiness to implement integrated learning in the information educational environment, according to the activity-reflective criterion, are presented in Table 3.

Table 3: Distribution of Respondents of the Experimental Group and the Control Group According to the Activity-Reflective Criterion

Level	Respondents (in %)
High	6
Sufficient	16
Average	42
Low	36

In the course of the experiment, through the diagnostic methods conducted, we found that EG and CG respondents have not developed skills and analytical abilities, nor the ability to self-control, reflect, self-regulate, or improve their professional qualities.

During diagnostics, we found that more than 70% of future specialists in socionomic specialties are not ready for integrated learning in the information educational environment, indicating the need to study the problem outlined.

Summarizing the results of the ascertaining stage of the study, we emphasize the need to develop, substantiate, and introduce into practice new content, pedagogical conditions, and effective means, forms, and methods.

The formative stage of the experiment.

The implementation of the formative experiment involved establishing pedagogical conditions for training future specialists to implement integrated learning in the information educational space, and developing and justifying new content, as well as effective means, forms, and methods of training.

The goal of the formative stage of the experiment was to train a modern specialist who is competent and ready for integrated learning in the information educational space.

As the questionnaire administered at the formative stage of the experiment showed, EG respondents (a larger number) reported more professionally oriented motives for learning than CG respondents. We have established that, according to diagnostic results, a significant percentage of EG students have mastered the practice and theory of integrated learning and demonstrate a high and sufficient level of motivation. This is explained by the increased interest in integrated learning among EG respondents and their conscious specialty choice.

We present a summary of the experimental results following the formative experiment.

The results of the diagnostic assessment of future teachers' readiness to implement integrated learning in the information educational environment, based on the motivational criterion (after the formative stage), are presented in Table 4.

Table 4: Distribution of Respondents of the Experimental Group and the Control Group According to the Motivational Criterion After the Formative Experiment

Level	Respondents (in %)	
	CG	EG
High	10	21
Sufficient	25	42
Average	45	37
Low	20	0

The results of the diagnostics of the level of readiness of future teachers for the implementation of integrated learning in the information educational environment according to the motivational criterion (after the formative stage) showed that in the experimental group, after the completion of the experiment, the number of students with a motivated attitude to future professional activity and to learning increased by 18% (significantly).

According to the motivational criterion for the creative level of readiness for integrated learning, 10% more students in the EG than in the CG met this criterion. No students with a low level were identified in the experimental group. This indicates the effectiveness and feasibility of implementing pedagogical conditions, developing and substantiating new content, and employing effective training methods, means, and forms to implement integrated learning.

The results of the diagnostic assessment of future teachers' readiness to implement integrated learning in the information educational environment, based on the cognitive criterion (after the formative stage), are presented in Table 5.

Table 5: Distribution of Respondents of the Experimental Group and the Control Group According to the Cognitive Criterion after the Formative Experiment

Level	Respondents (in %)	
	CG	EG
High	8	18
Sufficient	23	44
Average	47	31
Low	22	7

Comparison in the CG and EG by the cognitive criterion of the dynamics of the levels of readiness of respondents for integrated learning showed that updating the program learning outcomes, the content of training future specialists and providing them with the basis of the presentation by teachers of various academic disciplines, the consistency of tasks, the gradual mastering by respondents of the methodological and theoretical features of integrated learning allowed to increase the level of features of integrated learning and understanding of didactic principles, psychological characteristics of the personality, principles and structure of building integrated classes.

The results of the diagnostic assessment of future teachers' readiness to implement integrated learning in the information educational environment, using the activity-reflective criterion (after the formative stage), are presented in Table 6.

Table 6: Distribution of Respondents of the Experimental Group and the Control Group According to the Activity-Reflective Criterion after the Formative Experiment

Level	Respondents (in %)	
	CG	EG
High	9	27
Sufficient	23	40
Average	37	31
Low	31	2

Having summarized the obtained results of the study of the level of readiness of future teachers to implement integrated learning in the information educational environment according to the specified criteria, we determined the generalized level of readiness of respondents after the formative stage of the study, which showed a significant increase in the positive state of readiness of respondents according to all specified criteria. We will show this in Table 7.

complex of diagnostic tools To mathematically verify the effectiveness of the developed and implemented pedagogical conditions for training future specialists for the implementation of integrated learning in the information educational space, the objectivity and reliability of the results obtained, the statistical criterion λ Kolmogorov-Smirnov was applied.

After the CG and EG experiments, the empirical distributions of levels were analyzed. The content of two hypotheses was substantiated:

H_0 – differences are unreliable between the distributions;

H_1 – differences are reliable between the distributions.

The empirical value of the criterion was calculated using the formula:

$$\lambda_e = d_{max}\sqrt{\frac{n_1 n_2}{n_1+n_2}}$$

Where, in the first and second samples, respectively, n1 and n2 are the numbers of respondents, and dmax is the largest absolute value of the differences in accumulated empirical frequencies.

Thus, we obtained the criterion value λ. According to the criterion table, $\lambda_{emp} = 2.811$; $c = 1.36$ at $p \leq 0.05$; and $\lambda_{crit} = 1.63$ at $p \leq 0.01$.

So, $\lambda_{emp} > \lambda_{crit}$, which means that the differences between the distributions are reliable, that is, the hypothesis H_1 is confirmed.

As a result of the experiment, the reliability of the differences in the indicators of all levels of readiness of future specialists for the implementation of integrated learning in the information educational space upon completion of the formative stage of the experiment in the experimental group was proven, which proves the conclusions of the study and the reliability of the empirical results.

The data obtained allow us to conclude about the effectiveness and efficiency of implementing pedagogical conditions, because in the EG, where pedagogical conditions were introduced during the formative experiment, respondents increased their initial level of readiness for the specified problem.

Table 7: Integrated Distribution of Readiness Levels of Future Teachers for Implementing Integrated Learning in the Information Educational Environment (Before and After the Formative Experiment)

Level	Control Group – Before (%)	Experimental Group – Before (%)	Control Group – After (%)	Experimental Group – After (%)
High	7	6	7	15
Sufficient	22	18	23	38
Average	47	46	45	42
Low	24	30	25	5

The table presents a generalized synthesis of students' readiness levels based on motivational, cognitive, and activity-reflective criteria. While the control group demonstrates marginal and statistically insignificant changes, the experimental group shows a pronounced shift from low and average levels toward sufficient and high readiness. The reduction of the low readiness category from 30% to 5% and the increase of sufficient and high levels confirm the effectiveness of the implemented pedagogical conditions, which was further validated by the Kolmogorov–Smirnov λ-test ($p \leq 0.05$; $p \leq 0.01$).

Interpretative Synthesis of the Results

The obtained results indicate that readiness for implementing integrated learning in an information educational environment is not a spontaneously formed characteristic but a multidimensional construct that requires purposeful pedagogical support. The predominance of low and average readiness levels at the ascertaining stage suggests a systemic mismatch between traditional teacher education models and the contemporary demands of integrated and digitally enriched learning environments. In particular, fragmented disciplinary training and limited opportunities for reflective and practice-oriented integration appear to constrain the development of holistic professional competence.

The significant positive dynamics observed in the experimental group after the formative intervention demonstrate that readiness for integrated learning develops through the synergistic interaction of motivational, cognitive, and activity-reflective components. The increase in motivation can be interpreted as a result of students' awareness of the professional relevance of integration, which transforms external learning requirements into internally meaningful goals. At the same time, the growth of the cognitive component reflects not merely an accumulation of knowledge but the restructuring of students' conceptual frameworks toward interdisciplinary thinking.

The improvement of activity-reflective indicators highlights the decisive role of practice-based and reflective learning in consolidating integrated competencies. Engagement in designing and implementing integrated learning tasks within an information educational environment enabled students to move from reproductive actions to conscious pedagogical decision-making. This finding confirms that practical immersion and reflection function as mediating mechanisms that translate theoretical understanding into sustainable professional skills.

From a theoretical perspective, the results support the view that pedagogical integration is most effective when embedded in an information educational environment that facilitates flexibility, interaction, and continuous feedback. The statistically significant differences between the experimental and control groups indicate that the proposed pedagogical conditions operate not as isolated factors but as an integrated system that amplifies their individual effects.

Overall, the study contributes to a deeper understanding of how integrated learning readiness is formed and strengthened in future teachers. It demonstrates that systematic pedagogical interventions can transform initial unpreparedness into a stable readiness for interdisciplinary and digitally supported teaching, thereby addressing a critical challenge of contemporary higher education.

5. Conclusion

The study addressed the problem of preparing future teachers for the implementation of integrated learning within a contemporary information educational environment, which was defined as the purpose of the research. In line with this aim, the conceptual foundations of educational integration were clarified, its main types were systematized, and the role of the integrated information educational environment in higher education was substantiated.

The results of the ascertaining stage demonstrated a predominantly insufficient level of readiness among future teachers to apply integrated learning in information-rich educational contexts. More than 70% of respondents showed low or average levels of readiness, characterized by limited motivation, fragmented theoretical understanding, insufficient practical skills, and underdeveloped self-regulation and reflective abilities. These findings confirm the problem identified in the Abstract and justify the necessity of targeted pedagogical intervention.

The formative experiment empirically verified the effectiveness of the proposed pedagogical conditions for preparing future teachers for integrated learning. The implementation of motivational support, curriculum content updating based on interdisciplinary integration, gradual mastery of methodological principles, and practice-oriented training within an information educational environment led to a significant increase in students' readiness levels across motivational, cognitive, and activity-reflective criteria in the experimental group.

Statistical verification using the Kolmogorov–Smirnov λ-test confirmed the reliability of the obtained results, demonstrating statistically significant differences between the experimental and control groups ($p \leq 0.05$; $p \leq 0.01$). The increase in the proportion of respondents with sufficient and high levels of readiness in the experimental group provides empirical evidence of the efficiency of the developed pedagogical model.

Thus, the study contributes to educational research by substantiating and experimentally validating a structured approach to training future teachers for integrated learning in an information educational environment. The results expand the theoretical understanding of pedagogical integration and offer practical guidelines for improving teacher education programs in higher education institutions.

The research does not exhaust all aspects of the outlined problem. Further studies may focus on longitudinal analysis of readiness development, the integration of digital and AI-based tools into integrated learning models, and the adaptation of the proposed pedagogical conditions to different educational contexts and specialties.

Future Research Directions

Future studies should extend the present findings through cross-national comparative research to examine how institutional, cultural, and policy-related factors influence teachers' readiness for integrated learning in different educational systems. Additionally, longitudinal research designs are needed to assess the sustainability and long-term impact of readiness for integrated learning during graduates' professional practice. Finally, further investigation into the scalability of the proposed pedagogical conditions across diverse institutional contexts

will enhance their adaptability and practical relevance for higher education systems with varying levels of digital and organizational capacity.

References

[1] Shyika, S. V. (2017). Information and communication technologies as a means of improving traditional methodologies in Ukrainian language teaching (for professional purposes). Information Technologies and Learning Tools, 59(3), 114–125. http://nbuv.gov.ua/UJRN/ITZN_2017_59_3_13. https://doi.org/10.32839/2304-5809/2020-3-79-85.

[2] Sakaliuk, O., & Stefunko, L. (2020). Component components of preparation of future teachers for implementation of integrated learning in primary school. Young Scientist, (3)(79), 412–415. https://molodyivchenyi.ua/index.php/journal/article/view/1748/1716. https://doi.org/10.32839/2304-5809/2020-3-79-85.

[3] Potapchuk, T., & Makaruk, O. (2025). Professional training of future primary school teachers for the implementation of integrated learning young students. Society and National Interests, 4(12), 309–320. https://doi.org/10.52058/3041-1572-2025-4(12)-309-320

[4] Naumenko, N. (2024). The creation of integrated educational environment as a pedagogical condition of future teachers' preparation for the organization of blended learning. Scientific Notes of the Mykhailo Kotsiubynskyi Vinnytsia State Pedagogical University. Series: Pedagogy and Psychology, 77, 43–53. https://doi.org/10.31652/2415-7872-2024-77-43-53.

[5] Lenoir, Y., & Hasni, A. (2016). Interdisciplinarity in primary and secondary school: Issues and perspectives. Creative Education, 7(16), 2433–2458. https://doi.org/10.4236/ce.2016.716233.

[6] Michelsen, C., & Sriraman, B. (2009). Does interdisciplinary instruction raise students' interest in mathematics and the subjects of the natural sciences? ZDM, 41(1–2), 231–244. https://doi.org/10.1007/s11858-008-0161-5.

[7] Ríordáin, M. N., Johnston, J., & Walshe, G. (2016). Making mathematics and science integration happen: Key aspects of practice. International Journal of Mathematical Education in Science and Technology, 47(2), 233–255. https://doi.org/10.1007/s11858-008-0161-5.

[8] Hawkey, K., James, J., & Tidmarsh, C. (2019). Using Wicked problems to foster interdisciplinary practice among UK trainee teachers. Journal of Education for Teaching, 45(4), 446–460. https://doi.org/10.1080/02607476.2019.1639263.

[9] Juraev, M. M. & Aroyev D. D. (2023). Interdisciplinary integration is an important part of developing the professional training of students. Open Access Repository, 9(1), 93–101. https://repo.journalnx.com/index.php/nx/article/view/4525.

[10] Samson, G. (2014). From Writing to Doing: The Challenges of Implementing Integration (and Interdisciplinarity) in the Teaching of Mathematics, Sciences, and Technology. Canadian Journal of Science, Mathematics and Technology Education, 14(4), 346–358. https://doi.org/10.1080/02607476.2019.1639263.

[11] Maistruk, T. (2022). Innovative learning technology as a condition for achieving optimization of education results of children primary school. New Teaching Technologies, (96), 125–132. https://doi.org/10.52256/2710-3560.2022.96.17.

[12] Chovriy, S., Ralo, G., Zakharevych, M., Sinitska, N., Gavrylenko, O., Chernychko, S., Taran, S., Shynkaruk, V., & Kuchai, O. (2025). STEM-Based Training in Future Specialists in Higher Education. International Journal of Basic and Applied Sciences, 14(6), 586-595. https://doi.org/10.14419/zqcznm16.

[13] Pidhorna, T., & Tverdokhlib, I. (2023). Peculiarities of training future teachers for the implementation of an integrative approach in the educational process. Ukrainian Pedagogical Journal, (3), 132–143. https://doi.org/10.32405/2411-1317-2023-3-132-143.

[14] Bibik, N. M. (Ed.). (2019). New Ukrainian School: A teacher's guide: Teaching and methodological manual (pp. 102–104). Kyiv: Litera LTD. https://elibrary.kubg.edu.ua/id/eprint/34093/1/Y_Naida_NYSH_KSIO.pdf.

[15] Larionova, N. B., & Streltsova, N. M. (2018). Integrative approach: Relevance, essence, features of implementation in primary school conditions: Teaching and methodological manual. Kharkiv: Madrid Printing House. https://znayshov.com/FR/6748/235.pdf.

[16] Nikolenko, L. T. (2019). Integration in the New Ukrainian School: An integration approach in primary general education. Educational Management, (12), 36–40. http://lib.iitta.gov.ua/id/eprint/709952/1/Ніколенко_Стаття%20Нова%20укр.%20шк.%20інтегр..pdf.

[17] Petryk, K. Yu., & Taranenko, Yu. P. (2023). Training of future teachers for integration in education as a challenge of the time. Innovative Pedagogy: Scientific Journal, 58(2), 106–110. https://dspace.bdpu.org.ua/handle/123456789/575. https://doi.org/10.32782/2663-6085/2023/58.2.22.

[18] Antonova, O. Ye., & Vashchuk, O. V. (2017). Integrative approach to building a model of forming teachers' readiness for the development of students' academic talent. In S. S. Vitvytska & N. Ye. Kolesnyk (Eds.), Professional education in the context of integration processes: Theory and practice: Collection of scientific works (Part 1, pp. 174–182). Zhytomyr: FOP "N. M. Levkovets". https://eprints.zu.edu.ua/id/document/167095

[19] Tonnetti, B. & Lentillon- Kaestner, V. (2023). Teaching interdisciplinarity in secondary school: A systematic review, Cogent Education. https://doi.org/10.1080/2331186X.2023.2216038.

[20] Ionova, O. M., & Sinopalnikova, N. M. (2013). Theoretical issues of training future teachers to use integrated forms of organization of the educational process in primary schools. Visnyk of Alfred Nobel University. Series "Pedagogy and Psychology". Pedagogical Sciences, 2(6), 35–39. https://pedpsy.duan.edu.ua/images/PDF/2013/2/8.pdf.