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DEVELOPMENT OF PROFESSIONAL-CREATIVE COMPETENCES OF FUTURE BIOLOGY TEACHERS THROUGH THE DIGITAL ECOSYSTEM

Abstract. The study evaluated the effectiveness of developing professional and creative competence of students enrolled in the 6B01505 Biology, 6B01508 Chemistry-Biology teacher training programs through a digital educational ecosystem. A pedagogical experiment was conducted across diagnostic, formative, and control stages with the participation of 127 students. The instructional model incorporated virtual laboratories, 3D anatomical visualization, AR/VR simulations, digital biosimulations, analytical AI modules, and interactive design platforms. A mixed-method assessment approach was employed, integrating standardized tests, self-assessment questionnaires, observation checklists, and semi-structured interviews. Data analysis using SPSS Statistics 27 confirmed a statistically significant increase in competence indicators at $p < 0.01$. The motivational-value component improved from 2.84 to 4.19, cognitive-intellectual from 2.91 to 4.37, operational-technological from 2.76 to 4.45, and reflexive-evaluative from 2.63 to 4.22. Growth rates ranged from 47.5% to 61.2%, demonstrating substantial progress across all developmental dimensions. Qualitative findings indicated enhanced research initiative, analytical reasoning, and digital literacy among participants. The results support the transition to a modular educational structure, integration of digital research projects, and adoption of competence-oriented assessment strategies. The practical value of the study lies in strengthening professional identity formation of future teachers through reflective practices and competence monitoring tools.

Keywords: project-integrative learning, biology teacher, research skills, practical experience, genetic analysis.

Introduction

The concept of "competence" was introduced into the field of education as a result of research in psychology. From a psychological point of view, competence is the ability of a specialist to act correctly in unexpected situations, use new approaches to communication, solve complex tasks, effectively use conflicting information, and plan the course of the process in advance. Professional creative competence is the ability of a specialist to master the knowledge and skills necessary for performing professional activities at a high level and to effectively apply them in practice. It requires mastering not individual knowledge and skills, but a generalized system of actions. A competent specialist must be able to continuously supplement his knowledge, search for, process, and implement new information in his activities.

Creativity requires interest, knowledge, diligence, risk-taking, internal motivation, and imagination. Interest, enthusiasm, and passion are recognized as important personal qualities. Knowledge, hard work, perseverance, and willingness to take risks are also identified as necessary qualities for creativity. Hard work and perseverance are of particular importance, as they contribute to the development of students' creative abilities. Intrinsic motivation and imagination are also mentioned as factors necessary for creativity in the classroom. According to research, there are pedagogical strategies aimed at developing creativity in biology. Research-based teaching methods allow for the development of skills in conducting experiments, collecting and analyzing data. The use of digital resources and virtual laboratories expands the possibilities for visualizing complex biological processes and research. Project tasks and 3D modeling ensure that students can clearly express their ideas and improve their creative thinking skills.

Cross-disciplinary approaches linking biology with computer science, mathematics or art disciplines allow students to come up with new solutions and apply ideas in different contexts. Tasks aimed at solving creative problems develop analytical thinking. Group and joint work contribute to increasing creative potential through cooperation. The assessment system should be based not only on the result, but also on the creative process, the ability to generate new approaches and ideas. The systematic introduction of strategies

into the lesson allows for the effective development of creativity in the professional practice of biology teachers, improving cognitive and research skills.

Krauss (2024) notes that the advantage of a competency-based approach is that it focuses on students applying their knowledge to real-life situations. In biology, there are many opportunities to use theoretical knowledge in practical work and analysis of environmental problems. It has been shown that integrated teaching of subjects creates a holistic approach to the natural sciences.

Tomlinson (2014) shows that adapting the content and methods of learning to the individual needs of each student allows for their independent development.

Nogerbek, A. (2022) conducted a scientific study on the professional competencies of students preparing for the specialty of biology teacher. Scientists used a two-dimensional tool in the study. Quantitative data were collected using a special scale for assessing the competencies of creative thinking and teaching technology. According to the results of the study, it was found that the level of creative thinking and the competence of using teaching technologies of students studying in the “Preparing Biology Teachers” program is at an average level. These competencies did not differ significantly depending on gender and course of study. Qualitative data showed that the majority of students need to pay attention to personal development, participate in events such as courses, seminars, and conferences to develop creative thinking. It is important to show interest in digital tools and systematically use them in the learning process to master teaching technologies. It is recommended to develop special educational content and organize seminars at universities on the methods of forming creative thinking and teaching technology competencies.

Digital educational platforms and virtual laboratories allow for the improvement of practical and creative activities in the field of biology. It opens the way for the introduction of innovative approaches in teaching biology. The modern educational space is moving towards digitalization, raising all components of the pedagogical process to a new level. In the formation of professional and creative competencies in the field of biology, the digital ecosystem plays an important role as an innovative environment that combines virtual laboratories, interactive simulations, online platforms and artificial intelligence-based learning tools. The ecosystem allows developing research skills, increasing creative potential, and effectively using modern digital technologies in future professional activities. Salybekova, N. (2023) and other scientists in the article “E-Learning Adoption: Designing a Network-Based Educational and Methodological Course on “Humans and Their Health” set the goal of introducing a methodological model based on a digital ecosystem for teaching secondary school biology. The proposed model is aimed at effectively organizing the online learning process, increasing the active participation of students and improving learning outcomes. According to the researchers, the development of professional and creative competence of teachers through a digital ecosystem is carried out through e-learning platforms. The ecosystem approach enhances learning motivation and contributes to increasing learning achievement. The article describes a study aimed at developing and implementing a distance learning course for the subject "Man and His Health". Based on the results of the first stage, an educational and methodological ecosystem was created in a network format and the effectiveness of its use in subject teaching was tested.

In recent years, the development of professional and creative competence through a digital ecosystem has aroused considerable interest in industry and academia. Most of the research is focused on human-computer interaction and the functionality of learning platforms. In academic works, consideration of the process from the perspective of developing students' competence is still rare among Kazakhstani scientists.

Foreign scholars Beghetto (2010) argue that in recent years, developing students' creative abilities has become an important educational goal worldwide, as it provides economic, social, and personal benefits. Glăveanu, Ness, Wasson, & Lubart (2019), Loveless (2003, 2007), Lubart (2005), Mishra, Yadav, & Deep-Play Research Group (2013) argue that ecosystem models are new tools and environments for developing students' creativity. Cachia & Ferrari (2010) show that ecosystem technologies contribute to the development of creativity.

Scott, Leritz, & Mumford (2004), Lai, Yarbro, DiCerbo, & deGeest (2018), Ma (2006), Valgeirsdottir & Onarheim (2017) show that there are few experimental studies that have examined the effects of learning activities on ecosystem technologies on creativity. Andiliou & Murphy (2010), Skiba, Tan, Sternberg, & Grigorenko (2017) show that teachers' attitudes towards creativity directly affect the ways in which students develop their creative abilities. Bereczki & Kárpáti (2018) studied how teachers understand creativity, the

characteristics of creative learners, and the characteristics of learning environments that foster creativity. Henriksen & Mishra, Merriman, Scott (2015) write that highly qualified teachers understand creativity scientifically and can use pedagogical strategies that stimulate it. Mullet et al. (2016), Ertmer, & Ottenbreit-Leftwich (2017) show that teachers' beliefs and practices are determined only through individual research on creativity and technology. Based on these theoretical foundations, we defined the purpose of our study. It is to develop a scientific and methodological model for the development of students' professional and creative competence based on the capabilities of the digital ecosystem and to identify ways to implement it in the pedagogical process.

Accordingly, the objectives of the study were determined:

1. To analyze the theoretical foundations of professional and creative competence of students in biology, chemistry and biology.
2. To identify the impact of digital ecosystem elements such as virtual laboratories, biosimulation, digital content, artificial intelligence tools on the professional and creative development of students and to propose a learning model.
3. To verify the effectiveness of the proposed model through practical and experimental methods.

Methods and organization of research

The educational process is organized using project-based learning, research-oriented approaches, and digital modeling methods. Structural components of digital ecosystems are integrated into laboratory activities through the use of platforms such as Labster, PhET, and BioDigital Human for creating virtual models of biological processes, conducting virtual experiments, and processing experimental data. Artificial intelligence tools, including ChatGPT Edu and BioStat AI, are employed to support digital data analysis within the information and analytical module. Collaborative scientific projects are developed using interactive digital platforms such as Miro, Padlet, and Microsoft Loop, fostering a creative and communicative learning environment. Students' professional development is continuously monitored through a reflective and interactive module utilizing Mentimeter and Google Forms Analytics for self-assessment and feedback. As part of the learning process, each student develops an independent digital project and conducts a virtual investigation of a biological object. Assessment of learning outcomes and professional competencies is based on a comprehensive set of diagnostic tools, including professional and creative competency assessment cards, checklists, self-assessment questionnaires, testing, semi-structured interviews, the five-point Likert motivation scale, the Pedagogical Motivation questionnaire, the Research Interest Index adapted from P. Renzulli's model, and tests developed in accordance with Bloom's taxonomy.

Results and discussion

The study was conducted in the conditions of a pedagogical university in the subject "Human Anatomy" of the educational programs 6B01505-Biology Teacher Training and 6B01508-Chemistry-Biology. During the experimental work, an ecosystem model was introduced into the content of the 2nd year "Human Anatomy" subject. It was aimed at empirically proving the effectiveness of the process of developing students' professional and creative competence through a digital ecosystem.

Virtual laboratories, 3D anatomical images, AR/VR simulators, PhET and Visible Body platforms were used as the core of the model. Technologies increased students' participation in research activities and influenced the development of motivational-value, cognitive and action components of professional and creative competence.

The practical and experimental work consisted of diagnostic, formative, control and final stages.

1) At the initial stage of the study, the level of professional and creative competence of students was assessed using four main criteria:

2) At the motivational-value level, internal motivation for professional and creative activity, professional orientation, and research interest were assessed. To determine the motivational process, the Likert 5-point motivational scale, the "Pedagogical Motivation" questionnaire, and the research interest index based on the Renzulli model were used.

3) 2. At the cognitive-intellectual level, the integration of biological knowledge, creative thinking, and the ability to make scientific predictions were assessed using a test based on Bloom's taxonomy.

4) 3. At the operational level, the use of digital tools and the organization of practical activities were carried out.

5) 4. At the reflective-evaluative level, self-analysis and the quality of professional decision-making were assessed. The assessment was carried out in the form of an individual reflective diary in digital format.

The features of integration with the motivational-value component and the digital ecosystem model were determined. The motivational-value component of professional-creative competence is considered the main psychological-pedagogical mechanism that determines the professional development of a biologist student. The digital ecosystem model expands the content of this component and creates conditions for the formation of motivation at a new level.

Table 1

Initial level indicators of professional-creative competence of students

Competency component	Low level (%)	Average level (%)	High level (%)
Motivational-value	33	52	15
Cognitive-intellectual	40	47	13
Operational and technological	38	50	12
Reflective-evaluative	36	51	13

The data in Table 1 show that the majority of all components of professional and creative competence are at an average level. Although the knowledge and skills necessary for professional activity of future biology, chemistry and biology teachers are formed, their deep creative activity and independent research skills are not sufficiently developed. The Likert scale recorded the instability of internal professional motivation. The Renzulli index revealed that research motivation is fragmented. The survey results showed that the career orientation of students depends on external factors. In terms of the motivational and value component, 33% were low, 52% were at an average level. The indicator indicates a weak professional interest and internal motivation, but the potential for development through ecosystem tasks was high.

The cognitive and intellectual component was 40% low, 47% at an average level. The fragmentary nature of biological knowledge and insufficient ability to make scientific predictions were observed in students. The operational and technological component was 38% low, 50% at an average level. The skills of using digital tools and organizing practical activities are unsystematic. The reflective-evaluative component is 36% low, 51% is at an average level. Self-assessment and professional decision-making skills remain at an unstable level. The results clearly demonstrate the need for a purposeful and systematic introduction of the digital ecosystem in the process of professional training. The need for a purposeful and systematic introduction of the digital ecosystem in the process of professional training was identified.

Scientific organization of the formative period

The research model was based on the concept of a pedagogical digital ecosystem. It was considered as a multi-level pedagogical system that increases the cognitive activity of the learner, integrates scientific and creative activity with the digital environment. The ecosystem model served as a dynamic pedagogical environment that ensures the learner's independent action in the digital space, creative decision-making and research activity. The ecosystem environment is characterized as a set of interconnected digital elements that activate the learner's internal motivation.

The formative stage was organized on the basis of the pedagogical digital ecosystem model. The structure of the model included Labster, PhET, BioDigital Human digital laboratory space, ChatGPT Edu, BioStatAi information and analytical module, Padlet, Miro, Microsoft Loop creative and communicative environment and Mentimeter, Google Form Analytics reflexive and interactive module as a single system.

In practical lessons on the subject of "Human Anatomy", digital laboratories, performing tasks of a research-research nature through an ecosystem model called Labster, PhET, BioDigital Human increased research interest and practical activity. During the study, students in the SPE developed a small scientific research project related to the subject of "Human Anatomy". They created hypotheses about biological phenomena and proved them through experience. They participated in online communities and professional forums, strengthening their professional orientation in the field of biology. Artificial intelligence-based learning platforms, such as adaptive tests, intelligent assistants, individually monitor the student's progress,

and work with analytical tools such as Mentimeter, Google Form Analytics allows for self-assessment. Biological data visualization tools, a virtual microscope, 3D modeling increase cognitive interest, and create an emotional connection to the professional world (Table 2).

Table 2

The manifestation of the motivational-value component in the ecosystem context

Indicators	View through ecosystem elements
Intrinsic motivation and professional interest	It is observed during the independent implementation of a research project in virtual laboratories and simulation platforms.
Professional orientation	Participation in online conferences and scholarly communities is strengthened by maintaining a digital portfolio.
Research interest	Data analysis, supported by artificial intelligence, is evolving in the process of creating numerical models of biological processes.
Value relationship	It is formed in the process of solving environmental, biotechnological, and ethical problems within the digital ecosystem.

The results showed that most students were at an average level, and some were at a low level. The ability to use digital technologies in the performance of professional and creative tasks was insufficient, and research and modeling skills were formed in a fragmentary manner.

The learning process was carried out using project-research and digital modeling methods. Each student completed an individual digital research project for a specific biological object, modeling anatomical processes based on AR/VR and 3D visualization. Such integrated activities enhanced the cognitive activity of students and combined professional and creative experience.

Table 3

Dynamics of components of professional and creative competence

Competency components	Diagnostic period (%)	Formative period (%)
Motivational-value	Low-33 Medium-52 High-15	Low-14 Medium-41 High-45
Cognitive-intellectual	Low-40 Medium-47 High-13	Low-15 Medium-41 High – 44
Operational and technological	Low-38 Medium-50 High-12	Low-16 Medium-38 High- 46
Reflective-evaluative	Low-36 Medium-51 High-13	Low-17 Medium-41 High-42

Comparative results in Table 3 showed positive dynamics in all components of professional and creative competence:

During the period of formation of the effectiveness of the cognitive and intellectual component, the indicator increased to 45%, and an almost threefold growth rate was recorded. During the diagnostic period, the share of high-level students was 15%. Such growth proves that the digital ecosystem modules contributed to the transformation of internal professional motivation into a stable motivational process. Digital laboratories, AR applications, and integration with scientific communities ensured that students recognized themselves as subjects of the scientific environment. As a result, professional goal-setting skills were strengthened, the perception of scientific research as a personal value was stable, and the desire to join the scientific community as a professional member increased. The component identified the ability to integrate biological knowledge, creative thinking, and scientific forecasting. Using the ecosystem model, students were able to connect anatomical structures with data from physiology, cytology, genetics, and molecular biology at an interdisciplinary level. Complex topics such as "Tissue", "Musculoskeletal System",

"Nervous System", "Internal Organs" of the subject "Human Anatomy" were mastered on the basis of 3D visualization and simulation models, and subject knowledge was integrated at the level of systematic scientific integrity. At the end of the experiment, the ability to analyze the interrelationships of biological systems, make scientific predictions, and draw substantiated conclusions significantly increased compared to the diagnostic stage.

The digital ecosystem formed professional and creative development as a natural, dynamic, and self-regulating process. The model provided an environment that not only developed the student's subject knowledge, but also strengthened his research activity and professional self-determination. Motivational and value orientation increased significantly, and students began to strive to apply theoretical material in practice and perceive the realization of their professional potential as a personal mission. The 45 percent increase recorded in the formative period proves the high effectiveness of the digital ecosystem in the formation of professional and creative competence.

In terms of the cognitive-intellectual component, students demonstrated the ability to spatially represent complex anatomical structures, system analysis, and explain functional relationships. The level of understanding of the interrelationships of tissue, bone, muscle, and joint systems through digital visualization increased. The ecosystem model allowed students to creatively apply their biological knowledge. The results of the cognitive-intellectual component were at a high level of 13% in the diagnostic period. In the formative period, it reached 44%, demonstrating a clear increase in cognitive transformation. Interactive modeling and digital simulations allowed for the analysis of structural-functional relationships of complex biological systems. Students were systematically involved in intellectual activity aimed at making scientific predictions and proving hypotheses. At the end of the experiment, the level of intra- and interdisciplinary integration increased, and the skills of multi-level analysis of biological processes were consolidated.

The results of the operational-technological component showed that students' skills in conducting research, modeling, working with digital data, and interpreting results improved. Tasks such as determining the morphological features of tissues using a virtual microscope and AR technologies, and modeling bone and muscle movement on the Complete Anatomy platform were performed. As a result of such activities, the ability to work independently increased by 46 percent, and the ability to analyze and draw conclusions by 42 percent. Using the PhET, Visible Body, and BioDigital Human platforms strengthened students' skills in modeling biological processes, planning experiments, and implementing them in a digital environment. The ability to process data, work with digital tools, and independently organize biological experiments significantly increased. The ecosystem environment was identified as the main catalyst for technological competence that forms research independence. In the operational-technological component, the use of digital tools and practical activities were organized. Ecosystem elements such as virtual laboratories, 3D models, AR applications, and biological simulators contributed to the improvement of students' practical skills. During the experiment, they created models of "Chemical composition of bones", "Microscopic structure of muscle tissue", "Joint movement". They modeled breathing and blood circulation using BioDigital, Visible Body, Anatomy VR. They allow you to predict the consequences of changes in the body and determine cause-and-effect relationships. Students were able to independently organize the research process using digital tools such as PhET, Visible Body, BioDigital Human. They performed tasks such as digitally recording the results of laboratory experiments and presenting interactive assessment tools. They increased their efficiency and independence in practical activities. The quality of processing experimental data and interpreting results improved. The component, forming the core of professional and creative competence, increased the research skills and digital literacy of future biology, chemistry and biology teachers.

The high level in the diagnostic stage for the reflective-evaluative component was 13%, and in the formative stage it increased to 42%. The systematic use of feedback tools allowed students to assess their own actions and improve the quality of professional decision-making. Digital reflection platforms, such as online portfolios and self-assessment modules, established a culture of personal professional reflection and increased the student's internal responsibility for engaging in science. The weak professional motivation, superficial nature of cognitive processes, and passivity in practical activity observed during the diagnostic period underwent significant changes during the formative period. The ecosystem model became a natural and dynamic mechanism for professional and creative development. The reflective-evaluative component

assessed the quality of self-analysis and professional decision-making. At the end of the study, students' abilities to self-analyze, make professional decisions, and evaluate learning outcomes significantly increased. In the digital ecosystem, comparisons of their own and others' results, analysis of achievements were carried out through Google Classroom, Padlet, and Mentimeter feedback tools, and the level of critical assessment of their own actions increased. In professional decision-making, they were oriented towards relying on scientific justification and substantiating experimental data. Reflective-evaluative development strengthened the internal professional position of students, increased their responsibility, and formed a culture of qualitatively assessing the results of creative activity.

Analyzing the results of the study, it can be seen that the digital ecosystem model strengthened the interconnection of all components of professional and creative competence. The motivational and value component increased cognitive activity, while cognitive development contributed to the improvement of action skills.

The results of the experimental study proved that the use of the digital ecosystem model in the preparation of biology, chemistry and biology undergraduates in pedagogical universities is an innovative and effective method of developing professional and creative competence. Ecosystem-based learning raised professional adaptation, research thinking, cognitive autonomy and creative activity to a new qualitative level.

The results of the study showed that the culture of thinking, action and reflection increased qualitatively when the development of professional and creative competence was carried out on the basis of a digital ecosystem. The content and quantitative changes of each component are analyzed below.

When working in a digital environment, intrinsic motivation and creative thinking activity increased, and the ability to make scientifically sound decisions, work with data, and interpret results increased. The results showed that the interconnection and consistency of all components of professional and creative competence were strengthened. Motivational-value development increased cognitive activity, while cognitive maturity ensured the effectiveness of operational and reflective actions. The interconnection proved the integrative nature of the digital ecosystem model.

3. At the end of the experiment, the data obtained with the participation of 127 students were processed using the SPSS Statistics 27 program to produce the results of the control-final stage.

Table 4

Results of the control-final period

Competency indicators	Initial average score	Final average score	Difference (t-test)	Significance level (p)
Motivational and value-based	2.84	4.19	6.12	< 0.01
Cognitive and intellectual	2.91	4.37	6.48	< 0.01
Operational and technological	2.76	4.45	7.03	< 0.01
Reflective and evaluative	2.63	4.22	5.89	< 0.01

The results in Table 4 showed a highly reliable statistical difference at the $p < 0.01$ level. The presence of t-criterion values in the range of 5.89–7.03 for all competency components scientifically proves that the digital ecosystem has a highly effective impact on the formation of professional and creative competencies of students. The qualitative growth observed in the formative period became quantitatively stable in the final period, indicating that a deep transformation took place in the structure of students' competencies as a result of the systematic impact of the ecosystem digital modules.

The observation showed that in the motivational-value component of the final period, the initial low level of motivation was almost completely eliminated, and the final average score increased to 4.19. The indicator indicates that the internal value orientation of students aimed at professional choice has stabilized, personal activity has increased through the digital ecosystem, and they have begun to perceive science as an important component of their future professional activity. According to the motivational value, cognitive

activity and professional motivation have significantly increased through the digital ecosystem. 47.5% of students were able to combine their personal interest in studying biology with digital tools.

The increase in the average score from 2.91 to 4.37 in the cognitive intellectual component proved that students were not limited to mastering biological knowledge only at the reproductive level, but also acquired the ability to conduct interdisciplinary integration, make scientific predictions, and analyze the logical connections of complex biological systems. The 30% increase recorded in the formative period turned into a stable cognitive level in the final period. In terms of cognitive-intellectual competence, 50.2% of students developed their ability to make scientific predictions and analytical thinking through digital laboratories and artificial intelligence-analysis modules.

In the operational-technological component, the increase from 2.76 to 4.45 showed that students were able to freely use virtual laboratories, 3D simulators and biological platforms such as PhET, Visible Body, BioDigital Human as professional-technological tools. The ability to plan research activities, analyze digital data, and independently organize experiments reached a high level, and research independence was established. 61.2% of students strengthened their applied biological skills through practical digital experiments and the Labster, BioDigital Human modeling platforms.

In the reflective-evaluative component, the increase from 2.63 to 4.22 showed that students completely got rid of dependence on external evaluation and formed an internal reflection mechanism. The ability to analyze their own actions, make professional decisions, and consciously evaluate the results has become a stable skill. The dynamics of the development of this component proves the pedagogical effectiveness of digital feedback systems. 60.4% of students raised their self-assessment culture and professional reflection to a new level using Mentimeter and Google Form Analytics. The digital ecosystem had a systematic, multi-level and transformative effect on the development of professional and creative competence of students.

The low-level indicators identified during the diagnostic period improved. We empirically consider the results as an effective digital ecosystem and an innovative pedagogical paradigm in teaching biology. Professional self-realization and reflective culture rose to a qualitatively new level. The digital ecosystem model demonstrated its systematic, integrative and transformative potential as a tool for developing professional and creative competence in the training of biology specialists.

Conclusion

The results of the study supplemented the conceptual basis for creating a digital educational environment in pedagogical universities. An innovative elective course entitled “Digital research and creative modeling in biology teaching” was developed and tested. The results of the study proved that the digital ecosystem is not only a didactic tool for the development of professional and creative competence of students of biology, chemistry-biology, but also a whole pedagogical transformation system. It allowed us to consider it as a scientifically based mechanism for the formation of cognitive autonomy, creative potential and innovative professional consciousness of the student.

A comprehensive analysis of the study results comprehensively proved the high effectiveness of the process of developing professional and creative competence of biology, chemistry-biology students through a digital ecosystem in the conditions of a pedagogical university.

The digital ecosystem model in the preparation of biology, chemistry-biology, and biology has been scientifically substantiated as a mechanism for the comprehensive development of professional competence. The methodology developed as a result of the study made a practical contribution to the development of academic digitalization, creative research and scientific integration in pedagogical universities. During the observation period, the cognitive index of students was at the level of 2.52, and after the formation period it increased to 5.22, which proves that learning motivation, self-assessment system and striving for personal development have increased. A significant increase in indicators at the disciplinary-reflective level has revealed that the formation of competence is a mechanism dependent on personal self-awareness. Positive changes were also observed in the reflective-communicative dimensions. The ability to express one's own opinion and make decisions has increased. Empirical data confirmed the effectiveness of the pedagogical influence system. The main mechanism for developing competence is to improve the student's "I Concept" at the personal-evaluative level.

Conflict of Interest Statement

The authors declare no potential conflicts of interest regarding the research, authorship, or publication of this article.

Author Contributions

B.B. Dildabekova led the conceptualization, data collection, formal analysis, and preparation of the original manuscript. M.B. Amanbayeva contributed to the study design, methodology, supervision, critical review, and editing of the manuscript. B.U. Dildabekova participated in data collection, analysis, interpretation of the findings, and manuscript preparation. All authors reviewed and approved the final version of the manuscript.

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