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PEDAGOGIKA

PEDAGOGY

THE ROLE OF IMMERSION TECHNOLOGY IN THE DEVELOPMENT OF STUDENTS' STEAM EDUCATION

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Abstract The article is devoted to the problem of forming the STEAM competence of future teachers of natural science subjects at the first stage of higher education. The questionnaire for fourth-year students on awareness of the forms of implementing STEAM education is analyzed in detail.

Keywords: STEAM education, STEAM competence, STEAM case, STEAM lesson, STEAM game, STEAM project, STEAM day, STEAM week, STEAM conference, STEAM camp.

INTRODUCTION

The intensive development of STEAM education, which has emerged as a global trend, indicates that modern educational systems have, in practice, responded to the needs of society under the conditions of Industry 4.0. STEAM education is a system of teaching and learning grounded in the integration of mathematics, natural sciences, technology, and engineering. It provides a foundation for developing learners' holistic worldview, creative thinking, and competencies necessary for solving real-life problems, while also fostering scientific and technical creativity and research skills. STEAM education is implemented primarily through project-based and problem-based learning approaches.

The key agent in the implementation of STEAM education is the teacher, who requires appropriate training, the essence of which lies in possessing a certain level of STEAM competence. STEAM competence constitutes a component of a teacher's professional competence. It is an integrative professional and personal quality expressed in the ability to synthesize the five STEAM domains into a unified educational system that involves designing and creating original educational products for the effective implementation of STEAM education.

The development of STEAM competence requires well-organized and content-rich methodological training of future teachers for the implementation of STEAM education in higher education institutions [2].

LITERATURE REVIEW AND METHODOLOGY

From 2020 to 2023, an experimental study aimed at developing STEAM competence in future teachers of natural science subjects was conducted at the Maksim Tank Belarusian State Pedagogical University. A total of 120 students from the Faculty of Natural Sciences took part in the pedagogical experiment. Based on the research design, the participants were divided into a control group (hereinafter CG) and an experimental group (hereinafter EG). Students in the CG received traditional training within the framework of subject-specific teaching methodologies. In contrast, the EG implemented and tested a system of methodological training designed to prepare future teachers of natural science subjects for the implementation of STEAM education.

The experimental implementation was supported by appropriate instructional and methodological resources, including a textbook, a practical guide, and an electronic educational and methodological complex. The core of the author’s methodology was the academic course *“The STEAM Approach in Natural Science Education”* [3].

Within the framework of this course, future teachers of natural science subjects studied various forms of STEAM education implementation, including the STEAM case, STEAM lesson, STEAM game, STEAM project, STEAM day, STEAM week, STEAM conference, and STEAM camp.

A STEAM case incorporates all the characteristic features of the case method: information is presented to learners in small portions, work is organized in small groups, and learners are immersed in real-life situations. A distinctive feature of the STEAM case is its focus on specific interdisciplinary economic, environmental, and social problems [1]. As a rule, a STEAM case consists of three components and is developed following the logic of PISA-type tasks:

1. textual blocks containing problem-based situational material;
2. interrelated tasks forming the basis for dialogue;
3. informational and reference materials presented in the form of tables, diagrams, graphs, etc. [4, 5].

A STEAM lesson is a single, self-contained class devoted to a specific topic, built on the principle of interdisciplinarity and aimed at developing particular competencies or solving a problem at a single level. There is no unified approach to the structure of a STEAM lesson in pedagogical literature, nor are there strict requirements for its organization. In general terms, the following basic recommendations may be identified:

– linking the lesson topic to a real-world problem;
– establishing interdisciplinary connections and identifying ways to implement them;
– using diverse methods to engage students in various types of activity;

– prioritizing research and engineering-technical activities;

– encouraging teamwork among students;

– creating conditions for a creative approach to problem-solving;

– defining the aesthetic components of the final product;

– determining the expected learning outcomes of the lesson [1].

A distinctive feature of a STEAM lesson is not only the unpredictability of its outcome but also the unpredictability of the lesson process itself. Teachers must be prepared for their own mistakes, students' mistakes, and unexpected questions.

A STEAM game is a means of organizing learners' cognitive activity on the basis of an interdisciplinary approach through the development of the emotional sphere. A STEAM game may function both as a traditional didactic game and as a form of educational gamification; in both cases, game rules serve as tools for achieving real educational goals. Through an engaging and unobtrusive format, learners not only acquire knowledge from different fields in a short period of time but also apply it in practice, which enhances learning retention [1].

STEAM games, like other didactic games, are characterized by several features:

– the acquisition of new knowledge occurs in a competitive format, typically involving other participants in the educational process;

– STEAM games contribute to the individualization of learning by allowing students to solve tasks at their own pace while preparing them for collaborative activities within a team;

– emotional engagement is enhanced, leading to increased motivation, improved concentration, and better comprehension of complex interdisciplinary material;

– STEAM games have significant potential for developing critical thinking skills through the analysis of diverse interdisciplinary content [6, 7].

A STEAM project is a system of interrelated components based on the principle of interdisciplinarity and aimed at solving a specific problem. While STEAM projects follow the general principles of project-based learning, they are distinguished by their interdisciplinary nature and technical component. A STEAM project represents the integration of students' research activities and technical creativity [1].

A STEAM day is a system of lessons, including integrated ones, united by a common theme or problem. It may function either as a form of extracurricular activity within STEAM education or be organically incorporated into the regular instructional schedule. A STEAM day constitutes part of the educational process based on the integration of various fields of knowledge. The object of integration may be a single concept (e.g., “symmetry,” “motion”), an event (World Post Day, Cosmonautics Day, Minerals Day), a historical figure (A. Lovelace, D. I. Mendeleev), or a professional field (Geologist's Day, Teacher's Day, Rescuer's Day) [1]. The essence of a STEAM day lies in offering learners a variety of individual and group activities throughout the day, enabling them to perceive the multifaceted nature of the object of integration.

A STEAM week is a series of integrated lessons based on a system of interdisciplinary connections and a shared thematic focus. Similar to a STEAM day, it may be structured around a concept, holiday, commemorative date, event, or prominent figure [1].

When organizing a STEAM week, special attention should be paid to the following aspects:

1. ensuring that all educational events correspond to a unified theme;
2. defining objectives and tasks, identifying focus areas, and planning key stages of the event; the goal of STEAM weeks is to develop inventiveness, logical and divergent thinking, information competence, communication skills, and the ability to integrate knowledge from different disciplines;
3. selecting optimal content based on pedagogical principles and learners' age characteristics;
4. ensuring diversity and creativity in student activities;
5. choosing appropriate methods and organizational forms, optimal pace and rhythm, and considering the relationship with previous and subsequent educational activities;
6. prioritizing content aligned with the curriculum to demonstrate the practical relevance of knowledge across subjects for everyday life and real-world problem-solving;
7. emphasizing content with patriotic significance (e.g., national inventions, discoveries, cities, nature, products, services);
8. incorporating proposals and ideas from subject teachers and fostering collaboration among the teaching staff;
9. conducting reflection as an essential stage for analyzing outcomes and improving future planning.

A STEAM conference is a form of organizing learners' cognitive activity aimed at presenting the results of independent research and discussing specific topics within the STEAM framework. The methodology of a STEAM conference is based on student presentations that consistently раскрывают its theme. A STEAM conference may be organized by one or several educators. Such conferences focused on interdisciplinary connections allow participants to identify real links among modern sciences, demonstrate how methods from one discipline contribute to the development of another, and address complex scientific problems. As a result, learners develop a worldview-oriented perspective and cognitive interests enabling them to interpret and evaluate phenomena of the surrounding world [1].

A STEAM camp is a form of organizing children's leisure activities during school holidays with the aim of increasing motivation to study STEAM disciplines. STEAM camps may be conducted during autumn, winter, spring, or summer breaks and function as educational spaces for conducting interdisciplinary experiments and research in chemistry, physics, engineering, mechanics, physiology, psychology, and other fields. The activities of a STEAM camp are structured around a common theme or object and combine elements of programming, scientific inquiry, engineering, and creative practices [1].

RESULTS

During the experimental study, students—future teachers of natural science subjects—were administered a questionnaire designed to assess their level of awareness of various forms of STEAM education implementation, reflecting the activity-based component of teachers' STEAM competence [2].

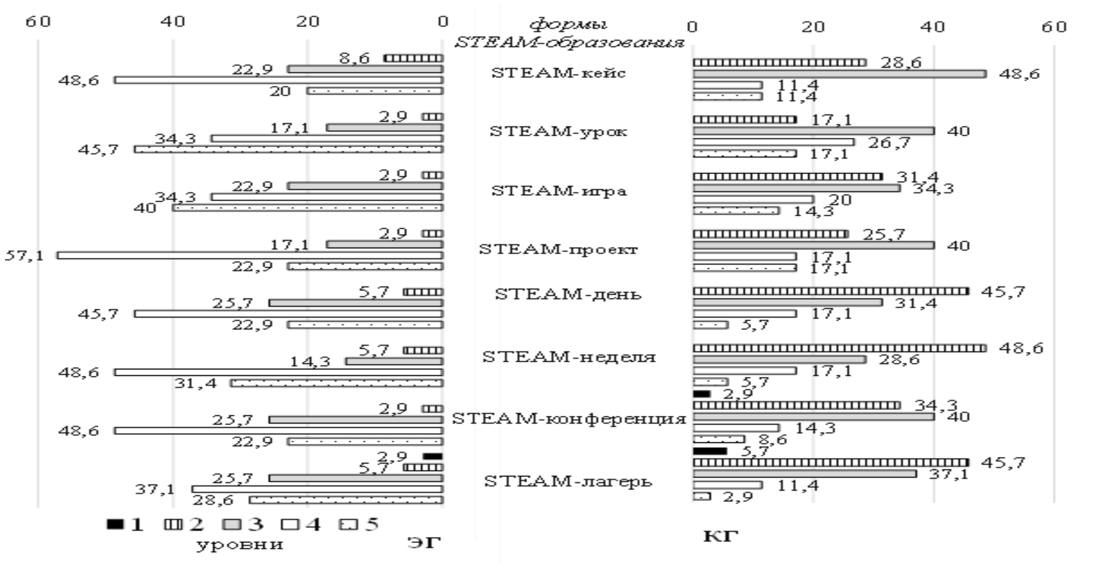

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Figure 1 – Histograms of the distribution of respondents' answers to the question "How clearly do you understand what … is?" (1 – no understanding at all; 2 – very limited understanding; 3 – some understanding; 4 – clear understanding; 5 – very clear understanding): (a) experimental group; (b) control group (%)

According to the data obtained after completion of the academic course *"The STEAM Approach in Natural Science Education"*, the level of awareness of various forms of STEAM education implementation in the experimental group (EG) increased by 18.5%, while the ability to organize and conduct such activities increased by 21% (Fig. 1).

Most respondents in the EG reported having a clear understanding of the STEAM case as a form of STEAM education implementation (48.5%). In the control group (CG), nearly 50% of respondents indicated that they had some understanding of STEAM cases. Only 9% of respondents in the EG reported having no understanding of what a STEAM case is, whereas in the CG this figure reached 28.5%.

A higher level of awareness was demonstrated by respondents when answering questions about the STEAM lesson. Specifically, 45.7% of respondents in the EG stated that they had a very clear understanding of this form, while 40% of respondents in the CG indicated that they had some understanding.

A more pronounced contrast between the EG and CG was observed in responses to the question *"How clearly do you understand what a STEAM game is?"*. In the CG, 31.4% of respondents reported having a very limited understanding, whereas in the EG, 45.7% indicated that they had a very clear understanding of this form of STEAM education.

Regarding the STEAM project, 57.1% of respondents in the EG stated that they had a clear understanding of this form, while 34.3% of respondents in the CG reported having some understanding.

When considering less widespread forms of STEAM education implementation, such as the STEAM day and the STEAM conference, a substantial disparity between the groups was again observed. For example, 45.7% of respondents in the CG indicated that they had a very limited understanding of what a STEAM day is, whereas the same proportion of respondents in the EG reported having a clear understanding. A similar pattern was observed in responses to the question *"How clearly do you understand what a STEAM week is?"*: 48.6% of respondents in the CG reported having a very limited understanding, while 48.6% of respondents in the EG indicated having a clear understanding.

In response to the question concerning awareness of the STEAM conference as a form of STEAM education, one respondent in the CG reported having no understanding at all, while 34.3% indicated a very limited understanding. In contrast, awareness of STEAM conferences in the EG was higher, with 48.6% of respondents reporting a clear understanding. This discrepancy can be explained by the fact that independent study was organized in the EG to examine the classification and structure of STEAM conferences, during which students developed the event themes and plans.

Respondents in both groups demonstrated the lowest level of awareness regarding the STEAM camp. This form of activity is the most complex and requires not only theoretical preparation but also practical experience.

Thus, a gap is observed between the experimental group (EG) and the control group (CG) in terms of awareness of the various forms of STEAM education implementation.

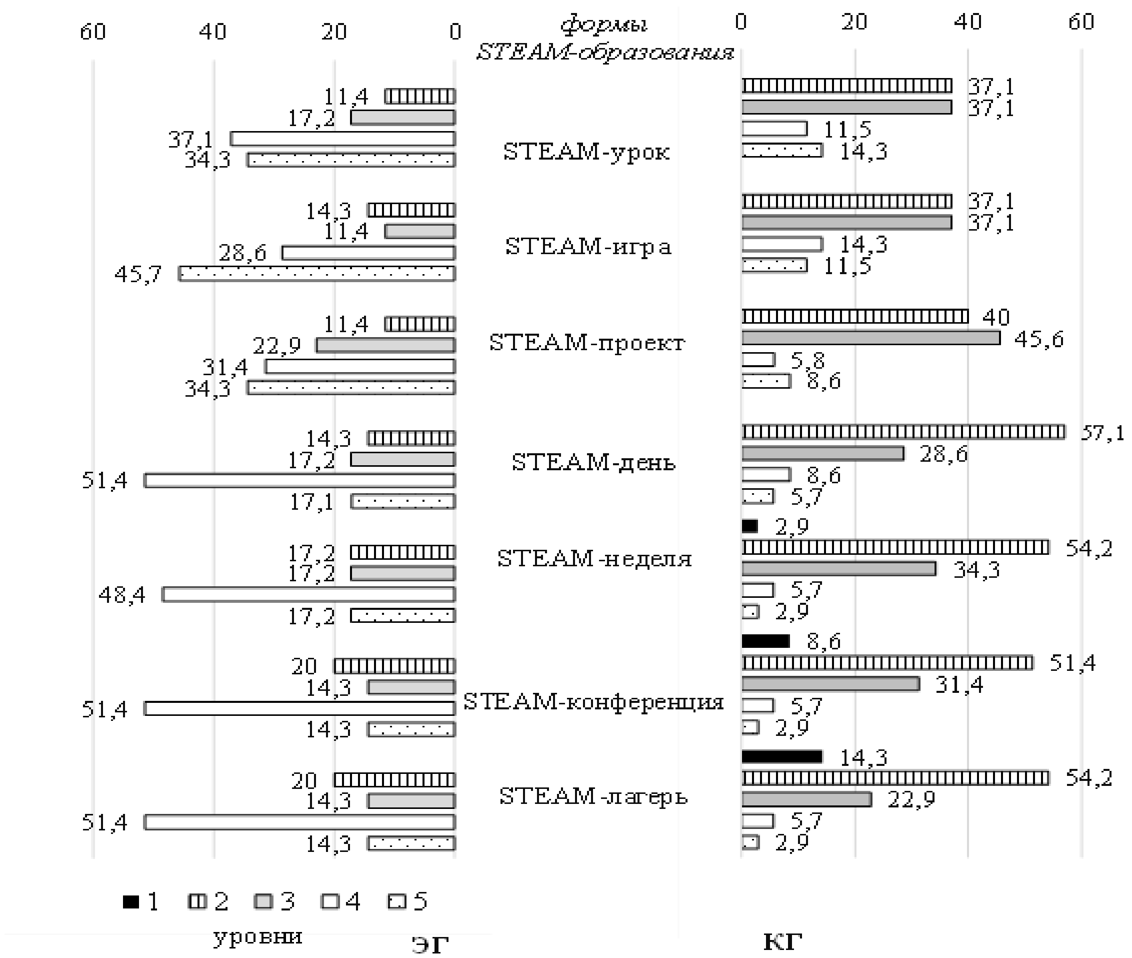

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Figure 2 – Histograms of respondents’ answers to the question “Could you organize and conduct…?”
(1 – no; 2 – with someone’s help; 3 – yes, but it requires extensive preparation; 4 – easily; 5 – already have experience):
(a) experimental group; (b) control group (%)

In the experimental group (EG), readiness to organize and conduct a STEAM lesson (Fig. 2) was higher: 37.1% of respondents indicated that they could do this easily. In contrast, in the control group (CG), the same percentage of respondents reported that they could do it with someone’s help, while an equal proportion stated that they could do it, but it would require extensive preparation.

A significant gap between the EG and CG was observed in responses to the question *“Could you organize and conduct a STEAM game?”*. In the EG, 45.7% of students reported that they already had experience in organizing such activities. In the CG, 37.1% of respondents indicated that they could do it with someone’s help, and the same proportion reported that they could manage it, but it would require considerable preparation.

Differences between the EG and CG were also evident in responses to the question *"Could you organize and conduct a STEAM project?"*: 65.7% of students in the EG reported that they could conduct a STEAM project to varying degrees, as they already had experience in developing scenarios and didactic materials for project-based learning in the STEAM framework, acquired through individual and group assignments during the *"STEAM Approach in Natural Science Education"* course.

Readiness in the CG to organize and conduct STEAM days was much lower: 57.1% of respondents indicated that they could do it only with someone's help. In contrast, 51.4% of respondents in the EG reported that they could organize STEAM days easily, as they had experience developing event plans through practical and independent assignments completed during the course.

Discussion

A similar pattern was observed for other extracurricular forms of STEAM education, such as STEAM days, STEAM conferences, and STEAM camps: in the EG, almost half of the respondents indicated that they could organize and conduct these activities easily, whereas in the CG, approximately half reported that this would only be possible with someone's help.

A correlation was observed between the results of the two questionnaires: respondents' awareness of the various forms of STEAM education was associated with their ability to organize and conduct them.

Figure 3 – Distribution of respondents' answers to the question "Do you have knowledge in other fields (outside your specialty) and are you ready to apply it in your professional activity for the implementation of STEAM education?"

In the experimental group (EG), 51.4% of students reported having knowledge in other fields (outside their specialty) and being ready to apply it in their professional activity during the implementation of STEAM education, whereas in the control group (CG), this figure was only 11.4% (Fig. 3).

Figure 4 – Distribution of respondents’ answers to the question “Do you know the structure of a STEAM lesson?”

Awareness of the structure of a STEAM lesson was higher among students in the experimental group (EG): 54.2% of respondents stated that they knew the lesson stages, compared to only 14.3% of students in the control group (CG) (Fig. 4). Thus, the level in the EG was 39.9% higher than in the CG.

Figure 5 – Distribution of respondents’ answers to the question “How would you assess your competencies in organizing the educational process in the STEAM framework?”

Overall, 37.1% of respondents in the experimental group (EG) indicated that they are competent in organizing the educational process in the STEAM framework and are able to provide recommendations to others, whereas none of the students in the control group (CG) selected this response (Fig. 5). In general, 94.2% of respondents in the CG considered themselves competent in aspects of STEAM education organization, but not at an advanced level. This proportion can be explained by the limited awareness of STEAM education among CG students, which affects their assessment of their own competence in this area.

Thus, the responses of participants from both groups provide grounds to conclude that a system of targeted training for future teachers in the implementation of STEAM education is necessary. Such training is reflected in the increased development of teachers’ STEAM competence. The formation of STEAM competence in future teachers of natural science subjects is most effectively carried out on the basis of a system of methodological training, the key component of which is the academic course *“The STEAM Approach in Natural Science Education.”*

Conclusion

The results of this study on the development of STEAM competence in future teachers of natural science subjects can be used to further improve the training process for both future teachers of natural sciences and educators in other specialties, enhancing their preparedness for the implementation of STEAM education.

BIBLIOGRAPHY

1. Sologub, N.S., Arshansky, E.Ya. *The STEAM Approach in Natural Science Education: A Guide*. Minsk: BSPU, 2023. 384 p.
2. Sologub, N.S., Arshansky, E.Ya. STEAM competence as an integrative quality of a modern teacher. *Bulletin of Vitebsk State University*, 2022, No. 1(114), pp. 54–65.
3. Sologub, N.S., Naumenko, N.V., Aizman, R.I. Assessment of the formation of STEAM competence in future teachers of natural science subjects. *Science for Education Today*, 2023, No. 5(13), pp. 7–30.
4. Solodikhina, M.V., Solodikhina, A.A. Development of graduate students' critical thinking through STEM cases. *Education and Science*, 2019, No. 3, pp. 125–153.
5. Strekalova, N.D., Belyakov, V.G. *Development and Application of Educational Cases: Practical Guide*. Saint Petersburg: Department of Operational Printing, National Research University Higher School of Economics – Saint Petersburg, 2013. 80 p.
6. Ushatikova, I.I. *Game Pedagogy: A Textbook*. Cheboksary: CNS "Interactive Plus", 2019. 144 p.
7. *Homo Ludens: What is a Game and How to Learn to Play* [Electronic resource]. –

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