ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23

American Academic publishers, volume 05, issue 11,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

PEDAGOGICAL EXPERIMENTAL WORK ON DEVELOPING STUDENTS' PROBLEM SOLVING COMPETENCE

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Abstract: This scientific article studies the effectiveness of cognitive educational technologies in developing students' problem-solving competence on an experimental basis. Based on the cognitive approach as the theoretical basis of the study, its effectiveness in practice was tested through a pedagogical experiment. The article analyzes the stages of experimental work, the methods used - questionnaires, tests, observations and interviews. It is also shown that problem tasks, cases, quests and scenario exercises serve to develop students' functional literacy, critical and creative thinking.

Keywords: cognitive educational technology, problem-solving competence, functional literacy, “Design thinking laboratory”, “Interactive thinking map”, “STEM-quest” experimental work, pedagogical methodology.

Introduction.

In modern pedagogical research, it is important to demonstrate how effective scientific ideas and theoretical foundations are in practice. Therefore, the implementation of any methodological approach or educational technology in practice is tested through experimental work. Pedagogical experimental work is a step-by-step process that serves to substantiate a scientific hypothesis, test a theoretical model in practical conditions, and determine its effectiveness.

The use of cognitive technologies in the educational process and the development of problem-solving competence in students is theoretically justified, and its practical effectiveness is proven through experimental work. This process shows how effective it is in increasing functional literacy in students, developing critical and creative thinking, and forming knowledge and skills that meet PISA requirements.

The importance of experimental studies for pedagogical research is that theoretical ideas are checked through them, the advantages and disadvantages of various methodological solutions are determined, and the obtained results serve as a basis for general conclusions and methodological recommendations. In this way, experimental work increases the practical value of scientific research, serves as an important foundation for improving pedagogical models and updating the educational system.

Methods.

Various methods and tools were used to determine the effectiveness of experimental work and to test the scientific hypothesis. Among them, questionnaires, tests, observation and interview methods were of particular importance, each of which served to comprehensively assess the development of problem-solving competence in students. The questionnaire method was used to determine the personal opinions, attitudes and motivation of students. The questions were mainly about their interest in the lesson process, difficulties encountered in completing problem tasks and positive changes observed in themselves. This information made it possible to analyze the internal motives and personal development of students.

Tests were used as the main assessment tool for experimental work. They determined the theoretical knowledge, functional literacy and ability to find solutions in problem situations of

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students. The tests were of two types: initial tests (at the beginning of the study) and final tests (at the end of the study). They made it possible to compare the dynamics of students' development.

The observation method was used to assess the activity of students during the experimental sessions, their participation in the lesson, and their ability to work together. The teacher and the researcher recorded each student's independent expression of ideas, participation in finding solutions, and contribution to teamwork on special observation sheets. The interview method was used to conduct individual interviews with students and teachers. In this process, in-depth information was collected about the advantages of the experimental sessions, the difficulties encountered, and the possibilities for using more effective methods in the future. The interview results were analyzed in conjunction with the questionnaire and tests, helping to make the research conclusions reliable.

In the content of the practical work, cognitive educational technologies were used as one of the central factors of the learning process. In particular, problem tasks, case methods, quests and scenario exercises served to enhance the cognitive activity of students in the learning process, to direct them to independent research and creative thinking. Problem tasks allowed students to apply theoretical knowledge in real-life situations. For example, a task in mathematics such as “Analyze prices in the local market and develop an optimal purchasing plan” required the student to use not only calculations, but also economic logic. In natural sciences, the task “Develop a plan of practical measures to reduce the impact of sources of pollution in urban air” was used, which directed students to environmental thinking.

In the case method, real-life situations were analyzed. In the subjects of mother tongue and literature, students were given the case “Compare the heroes of the work with an analogous situation in modern life and propose a solution to the problem”. In the subject of information literacy, the case “Select accurate and reliable information from online information sources” was organized. This method developed students' critical thinking, information selection and comparative analysis skills.

Quests served to activate the educational process in a playful way. In the “Life Path Map” quest in mathematics, students had to perform calculations to reach different points. In the “Ecological Expedition” quest in natural sciences, they were engaged in assessing the level of cleanliness of a water source and drawing conclusions based on laboratory results. In the mother tongue lessons, the task was to find symbolic expressions in the text and reveal their spiritual content through the quest “In the Trace of Lost Meaning”.

Role-playing games and socially significant situations were created in scenario-based exercises. For example, in the natural sciences scenario “Energy-efficient city”, students played the roles of an architect, engineer and ecologist and developed a plan for building a sustainable city. In the information technology scenario “digital security”, students played the roles of various characters and proposed solutions to dangerous situations on the Internet.

New methods that had not been used in research before were also introduced in the experimental work. For example:

“Design thinking laboratory”: students prepared a prototype in the process of creating innovative solutions to social problems. This method was integrated into natural sciences and technology lessons.

“Interactive thinking map”: in literature and history lessons, students searched for connections between the heroes of the work and historical events using a visual map.

“STEM quest”: a quest prepared on the basis of interdisciplinary integration, in which students simultaneously combined knowledge of mathematics, physics and computer science to solve

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real-life tasks. In general, the used cognitive educational technologies and new methods added to them enriched the content of experimental work and served as an effective tool in forming students' problem-solving competence.

Results.

Analysis of the results of experimental work is an important stage that ensures the scientific reliability of pedagogical research. Because without an objective and systematic analysis of the results obtained during the experiment, it is impossible to draw a complete conclusion about the effectiveness of the applied methodology or educational technologies. Therefore, in the analysis process, not only numerical indicators, but also qualitative changes in the knowledge, skills and attitudes of students are studied in depth. This process allows us to comparatively identify the differences between the experimental and control groups, determine the dynamics of development through initial and final indicators. Analysis of the results shows, in particular, the extent to which problem-solving competence has been formed, how critical and creative thinking, functional literacy and collaborative work skills have developed. Also, by analyzing the results, it becomes clear in what ways the applied cognitive educational technologies were effective and what areas need to be focused on for their further improvement in the future. Thus, the analysis process is of decisive importance in combining the theoretical foundations of research with practice and drawing scientific and practical conclusions for the national education system.

Special criteria and indicators were developed in the process of assessing problem-solving competence. They served to conduct experimental work on a scientifically sound basis and objectively evaluate the results. The main criteria were functional literacy, the ability to make decisions in a problematic situation, critical and creative thinking, the ability to work with information, and the skills of finding solutions in collaboration. Specific indicators of each criterion were assessed through indicators. For example, the ability to apply knowledge in life issues, select and analyze sources, and draw correct conclusions from digital data were identified as indicators of functional literacy. The indicators of problem-solving competence included indicators such as the ability to understand a problematic situation, develop solution options, and make new proposals based on a creative approach and justify them with logical evidence.

The experimental work was carried out in educational institutions in different regions of our country, and their diversity in terms of content and conditions ensured the reliability and comprehensiveness of the research. In particular, specialized state secondary school No. 5 in Karmana district of Navoi region, school No. 17 in Narpay district of Samarkand region, and school No. 44 in Kasbi district of Kashkadarya region were selected for the experimental process. The work carried out in these institutions took into account various regional opportunities, educational environments, and levels of cognitive development of students. Experimental and control groups were formed in each school, and the effectiveness of the methodological model developed on the basis of cognitive educational technologies was tested in them. Problem tasks, cases and quests, scenario exercises were introduced into the lesson processes, and their impact on the development of functional literacy and problem-solving competence in students was studied. Thus, the results of the work carried out in different regions were compared with each other, making it possible to draw objective conclusions about the overall effectiveness of the methods used.

A sufficient number of participants was included in order to conduct the experimental work reliably and objectively. A total of 342 students participated in the study. Part of them was allocated to the experimental group, and the other part to the control group. This distribution

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made it possible to conduct a comparative analysis of the effectiveness of the cognitive educational technologies used in the experiment with traditional teaching methods.
When forming the groups, the age characteristics, knowledge levels, and cognitive development opportunities of the students were taken into account. This ensured that the differences between the experimental and control groups were manifested only through the effect of the applied methodology. Thus, the inclusion of 342 students further increased the scientific reliability of the research results and their practical value. In the experimental work, the assessment of students' problem-solving competence was carried out on the basis of specific criteria and indicators. Because problem-solving is a multifaceted process that combines critical and creative thinking, functional literacy, logical analysis, and collaboration. Therefore, in the system of criteria, not only the level of knowledge acquisition, but also its application in life situations, the development of various solutions and the potential for making the right decision were taken into account.

Table

Criteria and indicators for evaluating students' problem-solving competence

№	**Criteria**	**Indicators**
1	Functional literacy	– apply knowledge to real-life situations; – search for and analyze sources of information; – draw conclusions from tables, diagrams, and charts.
2	Decision making in a problem situation	– understanding the context of the problem; – proposing different solutions; – logically justifying the decision.
3	Critical and creative thinking	– compare different points of view; – propose new ideas and solutions; – support an opinion with evidence and reasons.
4	Activity of cognitive processes	– ability to effectively direct attention and perception; – purposeful use of memory; – logical analysis and generalization.
5	A culture of collaboration and communication	– participate in finding solutions in collective activities; – express opinions freely and clearly in dialogue; – take into account the opinions of others.

In general, the developed criteria and indicators made it possible to comprehensively evaluate the problem-solving competence of students. Through them, it was determined to what extent functional literacy increased, how creative and critical thinking skills were developed, and how the ability to find solutions in problem situations was formed. The criteria and indicators served as a solid scientific foundation for comparative analysis of the results of experimental and control groups, showing dynamic changes and justifying the effectiveness of the applied cognitive learning technologies.

Discussion.

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The content of the tests was organized in close harmony with the PISA tasks and functional literacy requirements. This is because the PISA assessment system is aimed at determining not only students' theoretical knowledge, but also their ability to apply it in real-life situations, creatively approach problems, and think critically. From this point of view, the tasks and exercises used in the tests were also developed in accordance with the PISA criteria. First, in the tasks prepared in mathematics, students were tasked not with using abstract formulas, but with finding solutions based on real-life calculations. For example, in tasks such as "Calculating energy consumption in the household and creating a savings plan" or "Optimizing a personal budget," they used economic logic in addition to calculations.

The tasks in natural sciences were based on ecological and biological situations. For example, situations such as “Efficient use of water in agriculture” or “Ways to reduce the impact of waste on the environment” required students not only to have theoretical knowledge, but also to analyze various sources of information, draw comparative conclusions, and provide practical recommendations.

In the native language and literature, students were given tasks to work with the text in accordance with the PISA requirements. They were expected not only to find the meaning of words, but also to understand the main idea of the text, analyze the author’s position, and express a personal attitude. For example, tasks such as “Compare the decision of the hero of the work with a modern life situation and draw a well-founded conclusion” also developed students’ reasoning and socio-emotional literacy.

In information literacy activities, issues such as searching for information from various sources, distinguishing between reliable and incorrect information, and following digital safety rules were considered. For example, the task “Analyze two types of information obtained from online information portals and justify which one is reliable” fully complies with the PISA criteria. Thus, the content of the experimental work was formed in accordance with the PISA tasks and served to increase functional literacy among students, develop the skills of finding practical solutions to problems, and effectively use knowledge in various life situations. This created an important scientific and practical basis for bringing the national education system closer to international standards.

In the effective organization of experimental and test work, the correct formation of experimental and control groups is of great importance. Because the reliability and objectivity of the results obtained are determined precisely by comparing the two groups. In this process, scientifically based rules were used.

Firstly, attention was paid to the similarity of the educational program, grade level, and learning environment of both groups. That is, the experimental and control groups were selected from classes that studied the same curriculum, had an average number of students, and had similar cognitive development opportunities. This allowed for a fair comparison of the results.

Secondly, the level of knowledge and psychological preparation of the students in the groups was taken into account. Classes with average or higher indicators in terms of attention, memory, thinking, and creative abilities were selected. This made it possible to fully apply cognitive educational technologies in experimental exercises.

Thirdly, in order to ensure the objectivity of the distribution, attention was paid to the fact that the groups were equal or close in number and that the socio-economic status of the students did not differ significantly.

Methodical model, problem assignments, cases, quests and scenario exercises prepared on the basis of cognitive education technologies were introduced to the experimental group. In the control group, lessons were organized based on traditional teaching methods. In this way,

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conditions were created for the difference between the two groups to show the effectiveness of the methodology used.

The effectiveness of experimental work largely depends on how to organize the educational environment. Therefore, the educational process was established in accordance with the requirements of cognitive technologies. In doing so, an educational environment was created in the classrooms that ensures active participation and cooperation. In terms of location, it was considered an important condition to prepare the students in a form that allows them to work in groups and pairs, to ensure freedom of movement in the classroom, and to prepare the necessary visual and multimedia tools.

Interactive tools were widely used in the educational process. In particular, it was possible to effectively use visual-verbal models through electronic boards, projectors and laptops. This activated the cognitive process in students and helped them perceive knowledge more clearly. In addition, the opportunity was created to present problematic tasks in a visual and interesting way through infographics, mind maps and digital simulations.

The educational environment created conditions for students to independently search and work together. In case-method exercises, separate workplaces were allocated for groups, and interactive tasks were prepared for quests and scenario exercises. This served to develop cooperation, communication culture and creative thinking skills in students. Attention was also paid to psychological comfort in the educational environment. A stimulating environment was created for students to express their opinions freely, search for new ideas without fear of mistakes. As a result, students' motivation increased, and experimental exercises had a positive effect on their personal and social development.

Conclusion.

The results of the experimental work showed that the use of cognitive educational technologies was highly effective in forming the problem-solving competence of students. Students' theoretical knowledge was applied to real life situations through problem assignments, cases, quests and scenario exercises. In this process, they developed functional literacy, critical and creative thinking, and independent decision-making skills. Therefore, the practical significance of the methodology was scientifically based.

As a result of the comparative analysis of the initial and final indicators, the dynamic growth of the students of the experimental group was evident. Many students at the lower level advanced to the intermediate and higher levels, and their creative reasoning and reasoning skills were strengthened. And in the control group, the changes were not significant, which confirmed the specific advantages of cognitive technologies. Thus, the development of competence took place in a gradual and stable direction.

During the experiment, students' teamwork and cooperation skills also increased. Group and pair training developed in them the culture of finding solutions together, sharing ideas and communication. As a result, students have increased social flexibility and civic responsibility. This showed that not only cognitive, but also socio-pedagogical factors are important in the development of problem-solving competence.

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ISSN: 2692-5206, Impact Factor: 12,23
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