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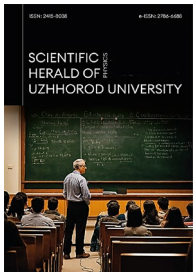

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Methodology for the development of students' cognitive activity when learning the scientific foundations of the course

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Abstract

Relevance. Cognitive activity is an important part of scientific and technological development and is necessary for a modern person to gain new knowledge, self-improvement, comprehensive development, and productive professional activity. In this regard, there is a need to develop cognitive activity in high school and university students.

Purpose. The purpose of this study is to reveal approaches to the development of the cognitive activity of students in the process of studying natural sciences, in particular physics. The role of studying scientific foundations in the process of teaching natural disciplines in the development of the cognitive activity of students was revealed.

Methodology. This study developed and tested a methodology aimed at enhancing students' cognitive activity through the study of scientific foundations, particularly in physics. It involved analyzing cognitive activity components, criteria for their development, and integrating these into a structured approach, which was then implemented and evaluated among high school and university students.

Results. Implementation of the methodology led to a 25% improvement in cognitive activity among high school students (grades 10-11) compared to a 15% increase in university students (1st-2nd years). The more significant gains in high school students suggest that early application of such methodologies can be particularly effective. Observations revealed that university students had generally higher levels of cognitive activity due to more advanced scientific engagement.

Conclusions. The study highlights the effectiveness of targeted methodologies in developing cognitive activity, particularly in high school students. The results advocate for earlier and more focused interventions to enhance cognitive processes, suggesting that integrating research activities into high school curricula could substantially benefit students' academic and professional development.

Keywords: self-development; academic foundation; cognitive processes; active thinking; professional activity.

Introduction

Cognitive activity is necessary for an individual to learn about the surrounding world, obtain new information and the possibility of its application in various spheres of life, adapt to changing environmental conditions, develop psychological and emotional resilience, as well as for self-

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development. In order for cognitive activity to be used effectively by an individual and improve the quality of their life, it must be developed at the stage of education. The development of cognitive activity is an important part of preparing students for admission to higher education institutions and for future research activities, and an important part of preparing students for professional activities, self-development, and self-study throughout their lives. It is possible to effectively develop cognitive activity during the development of the foundations of scientific and research activities in the process of studying natural disciplines, since it is during their study that all cognitive processes are activated in students.

Revealing the features of using active teaching methods as a means of developing cognitive activity, O.N. Evdokimova and A.K. Igizbaeva [1] noted the need for cognitive activity to effectively allocate time in the learning process, generate methods for solving tasks, and stimulate all thought processes. E. Kozhabekova et al. [2], exploring the development of cognitive activity of students through interdisciplinary integration, noted that cognitive activity is necessary to increase motivation for learning, expand students' worldview, and form a holistic view of the environment. R. Begaliyeva et al. [3], investigating the increase in cognitive activity of students through the use of modular technologies, also noted the need to develop students' cognitive activity to obtain high-quality knowledge and build flexibility. The researchers concluded that cognitive activity is aimed at the development of certain patterns of behaviour in various situations, which would be based on scientific concepts, principles, theories and laws, and the ability to use them to solve real-life situations.

Based on the results of the study by A. Akhmetova et al. [4], the development of cognitive activity is effective when using special pedagogical teaching methods, in particular, a cognitive approach, during which students need to act based on previously received information that is stored in memory. It is also possible to effectively develop cognitive activity within the framework of studying natural disciplines. B. Useinov et al. [5] identified a change in approaches to teaching physics to high school students in the Republic of Kazakhstan, within which each student has the opportunity to engage in independent scientific activities, developing research skills, discovering the physical world, and improving their cognitive activity.

The development of cognitive activity through chemistry tasks was studied by B.M. Musa and A.K. Abisheva [6], who came to the conclusion that cognitive activity contributes to the development of students' own research activities, independent search for solutions to emerging problems, and answers to their questions. Natural sciences include tasks with the need to find solutions based on scientific information, which requires students to take a competency-based approach and activate cognitive activity, which can contribute to its development.

Thus, cognitive activity is really a necessary thought process to increase the effectiveness of learning, to form students' ability to self-development, self-improvement and independent search for answers, methods of solving emerging problems. It is necessary to develop cognitive activity within educational institutions using modern approaches and methods, with the help of natural disciplines, since students develop the foundations of scientific concepts, principles, theories, and laws during their study. However, the methods, the effectiveness of which in the development of the cognitive activity of students has been tested and proved, were not found. In addition, there have been no studies that would confirm the effectiveness of a scientific approach to the development of cognitive activity in different age categories of students. Based on this, the purpose of this study is to provide an effective methodology for improving the cognitive activity of students in the process of forming a scientific worldview.

Materials and Methods

The analysis was used to reveal the components of cognitive activity, criteria for its development, and role in the educational process. This method has also been used to analyse approaches to the development of cognitive activity and determine the expected results from their implementation in the educational process. The analysis was used in the preparation of a methodology for the development of cognitive activity during the study of scientific foundations.

To test the developed methodology for the development of cognitive activity in students, a study was conducted among 75 students in grades 10-11 of Secondary School No. 164 and Gymnasium No. 153 named after A. Rozybakiev. The study also involved those students who chose Physics as their core subject for the Unified National Testing (UNT). The age of the students was 15-18 years old, among them 43 were male and 32 were female. To determine the effectiveness of the developed methodology among students of different age categories, a study was conducted among 80 1st and 2nd-year students of the Kazakh Automobile and Road Institute named after L.B. Goncharov. The age of the students was 18-22 years old, among them 50 were male and 30 were female. The study participants were students of such specialities as: Engineering, Motor Vehicles, and Information and Communication Technologies.

The study included two stages: the ascertaining stage, which determined the level of development of cognitive activity and the degree of understanding of scientific foundations in students before the implementation of the proposed methodology; and the control stage, which tested the level of development of cognitive activity and the degree of understanding of scientific foundations in students after the implementation of the proposed methodology. At the ascertaining stage, an author's questionnaire was used, which included 15 questions regarding the cognitive and research activities of students (Table 1).

Table 1. The author's questionnaire to determine the level of development of cognitive activity and understanding of scientific foundations

No.	Question	Answer options			
		Never	Sometimes	Often	Constantly
1	How often do you engage in mental activity in the educational process?				
2	How often do you engage in mental activity outside of the educational process?				
3	Do you read additional literature to gain additional relevant knowledge?				
4	Are you interested in new ideas, theories, and concepts in the field of scientific achievements?				
5	How often do you search for answers to your questions on your own?				
6	How often do you contact teachers to find answers to your questions?				
7	Do you analyse the incoming information before drawing conclusions and taking action?				
8	Are you engaged in self-development and self-improvement?				
9	Are you actively involved in the educational process (participating in discussions, answering questions)?				
10	How often do you attend additional classes for your personal or educational development?				
11	How often do you engage in research activities in the educational process?				
12	How often do you engage in research activities outside of the educational process?				
13	Do you participate in research conferences, projects or other events?				
14	In real life, do you rely on the results of scientific research (others or your own)?				
15	Do you apply the acquired knowledge in practice?				

Source: compiled by the authors.

The subject received 0 points for the answer "Never", 2 points for the answer "Sometimes", 4 points for the answer "Often", and 6 points for the answer "Constantly". As a result, the subject could get from 0 to 90 points, and the level of his cognitive activity was assessed on such a scale:

- 0-20 points – low level of cognitive activity;
- 20-40 points – average level of cognitive activity;
- 40-60 points – sufficient level of cognitive activity;
- 60-90 points – high level of cognitive activity.

The results of the survey demonstrated the level of cognitive activity of students, their ability to research, and a degree of understanding of the scientific foundations and the possibilities of applying scientific concepts in real life. The subjects were also interviewed based on the questionnaire questions. The conversation helped to determine the features of the cognitive activity of the subjects, based on the speed of their responses, the logical construction of the conversation, and also gave a broader idea of the features of the educational process, research activities of the respondents.

To improve the effectiveness of the proposed methodology, interaction with other educational institutions of both the Republic of Kazakhstan and friendly countries was introduced into the educational process. In the course of such interaction, scientific conferences were held, the participants of which were students of selected educational institutions, joint scientific research, discussions, and brainstorming sessions.

After the ascertaining stage, the proposed methodology for the development of cognitive activity during the study of scientific foundations in teaching physics was introduced into the educational process of schoolchildren and students. At this stage, the educational process of schoolchildren and students was monitored. Observation helped to determine how the subjects act in certain situations, how actively they participate in the educational process and how motivated they are to acquire knowledge, which helped to determine the characteristics of their cognitive activity. After 10 weeks of studying physics using approaches from the developed methodology, a control survey was conducted. At the control stage, to check the effectiveness of the proposed methodology in the development of cognitive activity, a survey was conducted using the same questionnaire, and a conversation with the subjects.

This study used the cross-sectional method, the purpose of which was to test the effectiveness of the proposed technique in the development of cognitive activity in students of different ages and educational groups (schoolchildren and students). To compare the results of students in grades 10-11 and students in 1st-2nd years, a comparison method was used, which helped to draw a

conclusion about the level of cognitive development in different age categories of students. The generalisation was used to summarise the results of the study and determine the effectiveness of the proposed methodology for the development of cognitive activity. This method, together with the methods of analysis and synthesis, was used to provide recommendations on the implementation of the methodology in the educational process.

Results

Cognitive development is an important part of the development of an individual's personality, the ability to form the necessary knowledge and skills, applying them in various situations, solving problems, reasoning, and drawing conclusions based on their reasoning. The cognitive development of an individual occurs throughout life and includes the development of memory, speech, attention, and cognitive activity, which, in turn, can affect academic performance in educational, professional and other fields. Researchers define cognitive activity as a process expressed by an intellectual and emotional response to cognition of the surrounding world [1; 7-8]; as the knowledge and skills of an individual that arose from information received and processed from the outside [3; 9].

The development of cognitive activity, like any cognitive process, is gradual and is based on the knowledge that an individual seeks to receive or has already received. To gain new knowledge, the student must be an active participant in the educational process, participate in solving proposed tasks and assignments, actively seek answers to questions of interest, and solve emerging problems in new ways. However, in adolescence, the development of cognitive activity may be complicated, and the ability to apply the acquired knowledge in practice may not be developed.

Teenagers, with a high level of intelligence and mental activity, may be characterised by excessive emotionality, passivity to the educational process, which may affect the ability to assimilate the information received, apply it, and develop their cognitive activity. Teenagers need to be stimulated to cognitive activity, to set such tasks for them, during which they will need to independently seek answers to their questions, independently explore the world around them, and solve the tasks set. To determine the most effective approaches to the development of cognitive activity in students, it is advisable to disclose its components (Table 2).

Table 2. Components of cognitive activity

Component	Description
Motivational	Consists in an interest in cognitive activity and the need for it, in a positive attitude to self-development, self-education, and knowledge of the surrounding world.
Cognitive	Consists in understanding the cognitive process, its organisation in personal activities, in having broad knowledge in certain areas acquired early, and the ability to apply them in various conditions and situations.
Procedural	Consists in the ability to generate new approaches to solving existing problems and tasks, in the flexibility of their actions, the ability to creatively apply the acquired knowledge in practice, creating new forms of activity.
Evaluative	Consists in the developed skills of self-reflection: the ability to evaluate own actions, their consequences, and adjust them in the future based on the information received during the assessment.

It is possible to activate and develop all components of cognitive activity simultaneously during the educational process, in particular, during scientific activities, the basics of which students learn during the study of natural sciences. Students, in turn, in the course of studying natural sciences, can reinforce existing research knowledge with their practical development. The teaching of natural sciences is focused on the development of students' knowledge about the scientific foundations and abilities for research activities. Understanding the scientific foundations and the ability to carry out research activities form a type of thinking among students, during which they can learn to solve problems on their own, look for new ways to solve them, evaluate their actions and their consequences, which is an important part of cognitive activity. Scientific literacy also expands the worldview of students: they can understand and realise the main scientific concepts and ideas, carry out research activities and process incoming information based on its results, realise the impact of research and incoming information on their lives, their activities (educational or professional) and the world around them. It is possible to develop the described skills in students if modern methods and approaches are applied to the educational process, in particular, during learning-research.

Learning-research is one of the modern approaches to teaching schoolchildren and forming their scientific foundations, within which students are given a certain task, which is the starting point of research and should be solved by using existing knowledge, by searching for the necessary information and understanding it. This type of education develops the scientific literacy of students, and a cooperative consciousness if research activities are carried out in pairs or groups and contribute to the development of cognitive activity [10-11]. Learning-research also forms students' systemic worldview: the understanding that, from a scientific standpoint, everything in the world is interconnected. Such a worldview allows students to actively participate in research activities, give preference to information that is scientifically proven, develop their own opinion and worldview based on scientifically proven information, and solve research tasks based on the data obtained, evaluate the results of their research, explain and substantiate them from a scientific perspective [12-13].

An important role in the development of students' research skills and, as a result, the development of

cognitive activity is played by the teacher and the teaching methodology, in conjunction with the applied approaches and innovations. In the course of learning-research, the teacher's duty is to stimulate the cognitive activity of students, to develop skills for applying the acquired knowledge in practice. Thus, an approach that can stimulate cognitive activity and develop practical skills is active learning, which can include problem-based learning methods, teamwork, discussions and brainstorming, and scientific experiments [14-15]. Active learning can also include activities that require students to apply creative and creative skills, and educational games [16-17]. Educational games involve the interaction of participants in the educational process during certain situations and tasks that require problem solving. Educational games that can be used to develop cognitive activity include logic games, and puzzle games. In the course of educational games used in teaching natural sciences, modern technologies such as artificial intelligence and virtual reality, and social networks popular among students, can also be used.

Among the natural disciplines in which cognitive activity can be developed, physics plays a special role. The exceptional role of physical disciplines in the development of research skills and cognitive activity is conditioned by its close relationship with real life and the phenomena of the surrounding world [18]. According to A. Astalini et al. [19], it was on the physical disciplines that the very research training that is now known was based: in the process of which students participate in genuine scientific experiments, independently search for solutions to tasks and generate new approaches to their solution.

In addition, recent studies demonstrate that the study of physics, its scientific foundations, concepts and phenomena, develops students' thinking and activates cognitive activity [20-21]. Based on this, in this study, a methodology for the development of cognitive activity of students was used in the study of scientific foundations in physical disciplines, within which research skills are most effectively formed and, as a result, cognitive activity can be most effectively developed. Based on the information received, a methodology for the development of cognitive activity was compiled, which is presented in Table 3.

Table 3. Methods of development of cognitive activity of students

Method	Description	Expected result
Problem-based learning	It consists in the presence of a certain problem that students must solve using existing knowledge or based on the search and effective application of new knowledge. Problem-based learning can also include the organisation of scientific experiments, during which students need to perform certain manipulations and look for ways to solve the proposed experiment.	Development of students' ability to generate new approaches to solving emerging problems; development of the ability to search for new information, check it for provability before use; development of the ability to evaluate their actions and their consequences, adjust them based on the results obtained; development of practical skills.
Discussions and brainstorming sessions	Consists in discussing the task with other participants in the educational process, finding a common opinion regarding the methods of its solution and their effectiveness.	Development of students' cooperative consciousness, the ability to argue and confirm their opinion with scientifically evidence-based data; development of the ability to objectively assess the possible consequences of their actions.
Educational games	Consists in the use of educational games in the process of studying physical disciplines, in particular: puzzles, logic games, and board games adapted to the development of research skills and the cognitive activity.	Development of students' logical thinking and research skills; development of the ability to creatively approach the solution of tasks.
Use of modern technologies	Consists in using technologies such as artificial intelligence, virtual reality, the Internet and social networks in the process of forming research foundations and developing cognitive activity.	Development of students' creativity and creative thinking; development of skills in using modern technologies necessary for successful research activities.

To test the effectiveness of the developed methodology, an ascertaining experiment was conducted before its introduction into the teaching of physics. The ascertaining stage showed such results. 55% of the surveyed students of grades 10-11 and 64% of the surveyed students of the 1st-2nd years of study were engaged in mental activity in the educational process on a regular basis. However, outside of the educational process, only 35% of the surveyed schoolchildren and 50% of the surveyed students regularly engaged in mental activity. The difference in results could be due to the orientation of higher education towards the application of acquired knowledge in practice: in real life situations or in professional activities, while school education is more focused on obtaining knowledge rather than practical skills. Students of higher educational institutions are more likely to use mental activity outside the educational process, while schoolchildren focus on mental activity within the educational process.

Only 32% of the surveyed schoolchildren constantly searched for answers to their questions on their own, most of the schoolchildren (46%) sometimes independently searched for answers to their questions. Among the students, 57% were constantly looking for answers to their questions on their own. The majority of schoolchildren

(52%) constantly turned to teachers to find answers to their questions. The majority of university students, in turn, turned to teachers to find answers only occasionally (50%). The conversation with the students demonstrated that they doubted the evidence base of the independently found information and believed that the information coming from the teachers was more truthful and authoritative. Such results could indicate that students have more developed independent cognitive activity, while schoolchildren are characterised by the inability to search for the necessary evidence-based information in detail and the need to support cognitive activity from the outside, which demonstrates the need to revise approaches to the methodology of teaching physics and the development of cognitive activity.

Only 33% of schoolchildren constantly analysed information before making conclusions and taking action, most of them (47%) did it only occasionally. Among the students, 50% of the students constantly analysed the incoming information before drawing conclusions and taking action. The conversation with the students demonstrated that the analysis of incoming information is important for them in terms of their future professional activities. The majority of students noted that for the qualitative implementation of their professional activities in the future, the information they use in the educational process and in everyday life must be scientifically sound, proven by scientific research. In addition, the accuracy of information is necessary during educational and, in particular, scientific activities: when completing assignments, writing research papers, participating in research conferences.

35% of schoolchildren were engaged in self-development and self-improvement on a regular basis, most of the students engaged in self-development and self-improvement only occasionally (47%). Among the students, 54% of the students were engaged in self-development and self-improvement on a regular basis. 67% of schoolchildren and 70% of students were constantly actively involved in the educational process. Such results may be due to a high motivation for the educational process, an understanding of its role in self-development, and further professional activity. A conversation with the students under study demonstrated that the educational process is quite interesting for them, however, some noted the lack of use of modern technologies and innovations.

During the conversation, the students noted a high level of interest in the educational process and involvement in the types of activities that teachers use in the classroom. Some students noted that the resources and facilities of educational institutions may be outdated and do not meet modern requirements. Such results indicated the need to use modern technologies in the teaching process and introduce innovations into the educational process. 56% of schoolchildren and 58% of students attended additional classes for personal or educational development on a regular basis. However, a conversation with the subjects demonstrated that schoolchildren, speaking about constantly attended additional classes, most often meant tutors and elective classes aimed at preparing for the UNT. Students among the regularly attended additional classes noted conferences, trainings, and seminars aimed at personal and professional development.

Only 42% of schoolchildren were engaged in research activities in the educational process on a regular basis, while 67% of students who regularly engaged in research activities in the educational process. Such results could be due to the fact that in higher educational institutions research activities are leading, while in secondary educational institutions, research activities are additional and are implemented most often only in the course of teaching natural disciplines. Outside of the educational process, only 25% of schoolchildren were regularly engaged in research activities, while 57% of students were engaged in regular research activities outside the educational institution.

The conversation with the subjects showed that the students did not understand the need for research activities outside the educational process, while students regularly used it outside the educational process to solve problems that arise in real life situations. Similar results were also observed in the ability of the subjects to rely on the results of scientific research in real life. 56% of schoolchildren have never relied on the results of scientific research in real life situations. On the contrary, 58% of the students studied constantly relied on the results of their own or other research in real life situations. In practice, the knowledge acquired at the educational institution was regularly applied by 49% of schoolchildren and 62% of students. Such results could indicate the inability of schoolchildren to think flexibly, to find solutions to various life situations with the help of knowledge gained in the educational process and the need to develop practical skills and the ability to apply the knowledge gained in real life situations.

The average results of the ascertaining stage demonstrated that among schoolchildren, a low level of cognitive activity was noted in 4 subjects, an average level of cognitive activity in 22 subjects, a sufficient level was noted in 17 subjects, and a high level in 32 subjects. Among the students, a low level of cognitive activity was noted in 2 subjects, an average level of cognitive activity was noted in 11 subjects, a sufficient level was noted in 20 subjects, and a high level was noted in 47 subjects (Figure 1). The general results of the ascertaining stage demonstrated that students of the 1st-2nd years of study have more developed cognitive activity than students of grades 10-11. This may be due to the fact that more attention is paid to research activities in the educational process of students, and training and the development of knowledge and skills are aimed at future professional activities, which significantly narrows the number and focus of the disciplines taught.

The education of schoolchildren is more focused on the development of stable basic knowledge in different areas and on preparing for admission to higher education institutions. However, the level of cognitive activity of the subjects at the ascertaining stage was at a fairly high level, which may be due to the fact that the subjects are students of natural and mathematical fields and their cognitive activity develops in one way or another throughout the learning process, even without additional exposure.

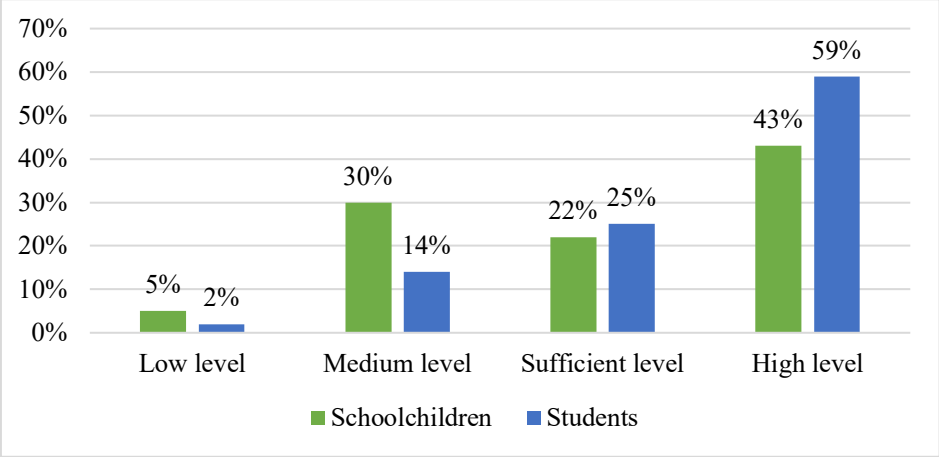

Figure 1. Level of cognitive activity of students in grades 10-11 and students of the 1st-2nd years of study at the ascertaining stage

In the process of implementing the proposed methodology for the development of cognitive activity, the observation demonstrated that schoolchildren were more motivated to new types of activities than students. This could be due to the fact that the methods proposed in the methodology were partly familiar to students. However, it was the students who demonstrated the best results in the learning process during the experiment. Problem-based learning and discussions were easier for them, while it was easier for schoolchildren to work with innovative technologies and take part in educational games. During the conversation with the subjects, it turned out that international interaction introduced into the learning process was useful, as it helped to gain new knowledge, develop communication skills and cognitive activity. To work with some educational institutions, the subjects needed to translate materials from foreign languages, search for information in a foreign language, and study foreign culture and traditions, which contributed to active thinking and, as a result, the development of cognitive activity.

The control stage demonstrated the following results. 65% of the surveyed students of grades 10-11 (+10%) and 70% of the respondents of the 1st-2nd years of study (+5%) were engaged in constant mental activity in the educational process. Outside of the educational process, 47% of schoolchildren (+12%) and 57% of university students (+7%) regularly engaged in mental activity. Such results could be due to the fact that schoolchildren have developed the ability to apply their knowledge in real life situations, developed practical skills and, as a result, cognitive activity. At the control stage, 56% of schoolchildren (+24%) and 67% of students (+10%) regularly searched for answers to their questions on their own. 40% of schoolchildren (-12%) and 45% of students (-5%) constantly turned to teachers to find answers. Such results could indicate that both schoolchildren and students had improved cognitive activity and the ability to independently search, process and evaluate the information received.

The conversation with the subjects demonstrated that the students began to feel more confident when searching for new information and analysing its scientific validity. In addition, the number of schoolchildren who constantly analyse incoming information before drawing conclusions and taking action has increased: 63% at the control stage instead of 43% at the ascertaining stage (+20%). Among university students, this indicator increased slightly: 55% at the control stage instead of 50% at the ascertaining stage (+5%). The difference in positive dynamics may be due to the fact that students of higher educational institutions have a higher ability to analyse information before using it than students of secondary educational institutions.

48% of the studied schoolchildren (+13%) and 60% of the studied students (+6%) began to engage in self-development and self-improvement on an ongoing basis at the control stage. 80% of schoolchildren (+13%) and 82% of students (+12%) were constantly actively involved in the educational process. During the conversation with the subjects, the students noted that the involvement in the educational process became higher due to the introduction of new methods that required greater concentration on the educational process, active participation in it.

The results of schoolchildren and students attending additional classes at the control stage remained almost unchanged: 60% of schoolchildren (+4%) and 60% of students (+2%) attended additional classes for personal or educational development on an ongoing basis. However, during the conversation it turned out that among the schoolchildren there were those who chose scientific activities in different directions as additional classes, which may indicate the development of cognitive activity and increased motivation for research work and understanding of its role in real life. 65% of schoolchildren (+23%) and 75% of students (+8%) were engaged in research activities in the educational process on a regular basis.

Outside of the educational process, 50% of schoolchildren (+25%) and 65% of students (+8%) were engaged in research activities on a regular basis. A significant difference in dynamics could be due to the fact that students' research activity was higher at the ascertaining stage, both during and outside of educational activities. The conversation with the subjects demonstrated that the number of research activities in the educational process of schoolchildren has significantly increased, and the understanding of the possibilities of their application in real life situations has expanded. Thus, positive dynamics were also observed in the regularity of using the results of scientific research (others or their own) in real life

situations. 35% of schoolchildren began to regularly rely on the results of scientific research in real life, and among students, 64% began to regularly rely on the results of scientific research outside the educational process (+6%). This demonstrated an increase in cognitive activity, in particular, an improvement in the flexibility of thinking and practical skills.

The average results of the control stage demonstrated that among schoolchildren a low level of cognitive activity was not noted, an average level of cognitive activity was noted in 2 subjects, a sufficient level was noted in 22 subjects, and a high level was noted in 51 subjects. Among the students, a low level of cognitive activity was not noted, an average level of cognitive activity was noted in 8 subjects, a sufficient level was noted in 13 subjects, and a high level was noted in 59 subjects (Figure 2). The number of students with a high level of cognitive activity increased by 25%, and the number of students with a high level of cognitive activity increased by 15%. There were no subjects among either schoolchildren or students who had a low level of cognitive activity.

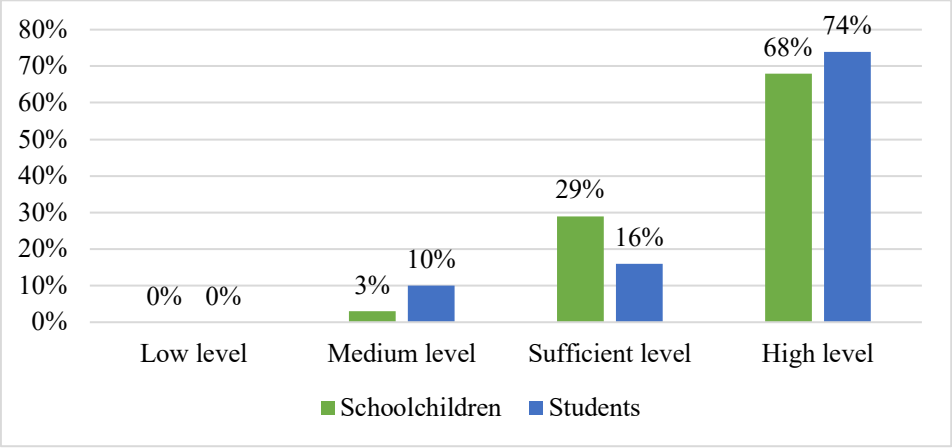

Figure 2. Level of cognitive activity of students in grades 10-11 and students of the 1st-2nd years of study at the control stage

The general results of the control stage demonstrated that the proposed technique can be effective in the development of cognitive activity of students in the study of scientific foundations in the process of studying physics. However, the control stage showed a more positive dynamic in students of grades 10-11 than in university students of the 1st-2nd years of study. This may be due to the fact that higher education is focused on research work, which contributes to the development of cognitive activity and includes the approaches proposed in the methodology. Thus, in the preparation of students and the development of their cognitive activity, the changes could be almost imperceptible. This necessitates the search for new, improved approaches to improve the effectiveness of cognitive development in students of higher educational institutions [22-23]. For more effective implementation of the proposed methodology in the educational process, the following recommendations are provided:

1. The activities of learners should be more focused on obtaining practical skills and working out the knowledge gained during experiments, research, and scientific activities. Any theoretical information should be supported by a demonstration of its application and/or its practical application by learners. For this purpose, video or audio materials, diagrams, tables, and virtual laboratories can be used (using artificial intelligence and virtual reality, they are a safer way to conduct experiments, especially with the lack of experience).
2. The educational process using the developed methodology should be aimed at the active involvement of all participants in the educational process. Each learner should actively participate in all types of activities, for which both individual projects and group work can be used. In the case of individual projects, they should be selected in such a way as to influence the zone of immediate development of students: based on existing knowledge and skills, abilities, the student should use the task to learn new information and carry out previously unknown actions, which corresponds to an individual approach.
3. All research activities should be aimed at actively learning about the world around them, its principles and patterns, understanding their role in the development of themselves as individuals and the world around them, actively researching it and finding approaches to improve it. All assignments should be aimed not only at solving the task, but also at the decision process, at understanding it, at understanding the patterns of the surrounding world, phenomena and the possibility of applying this information in other spheres of life.

Using these recommendations during the implementation of the proposed methodology, the development of cognitive activity can be more effective, and the knowledge and skills that are being formed are of higher quality and with a higher possibility of their use in real life situations.

Discussion

The study found that cognitive development is an important part of an individual's identity and contributes to the development of new knowledge, skills, and the ability to apply them in real life situations. This was supported by G. Orona et al. [24], who investigated the development of cognitive skills in students and referred to cognitive skills as critical thinking, the ability to carry out cognitive activities, in particular, to analyse information and evaluate it. The researchers also suggest that the development of cognitive skills is most effective in the

framework of education, which correlates with the results of this study. According to the researchers, the development of cognitive activity depends on the age of students and their available abilities, on which this study was based.

The important role of education in the development of cognitive activity was also supported by A. Astalini et al. [19], who defined education as a way to gain the necessary knowledge, skills and thinking that will affect the entire lives of students and their professional activities. According to S. Hu et al. [25], conventional teaching methods at this stage of education development are not always effective, which requires reforms and new approaches in teaching and correlates with the results of this study. Experts considered that one of the effective teaching methods in modern education is the research activity of students, which stimulates cognitive activity and consists in the active participation of schoolchildren and/or students in the educational process, the search for new information, its processing and evaluation, the ability to look for new approaches to solving the tasks assigned to them, which also correlates with the results of this study.

It was determined that the most effective way to develop research activities and, as a result, cognitive processes is possible in the course of studying natural disciplines, in particular, physics. This is consistent with the findings of R.M. Gillies [26], who studied the teaching of natural sciences based on a scientific approach. The researcher came to the conclusion that teaching natural sciences using a research approach is effective in the development of cognitive activity, as it promotes active participation in the educational process, encourages students to ask questions, look for answers to their questions, use scientific evidence to explain various processes and phenomena, evaluate them, to coordinate with own opinion and either change it or confirm it with the help of scientific facts. Using research-based learning, students can explore the world around them by combining scientific foundations and laws with real-life situations. In this study, a methodology for the development of cognitive activity was proposed, which is based on problem-based learning, discussions and brainstorming, educational games, the use of modern technologies, and international interaction.

M. Samano [27], who studied the game of "Go" in the development of cognitive activity, came to the conclusion that such logical games can affect the development of cognitive skills, in particular concentration, the ability to reason, analyse information received, solve problems, and creatively approach this process, which fully corresponds to the results this study. The effectiveness of logic games in the development of cognitive activity is also confirmed by E. Martins da Silva et al. [28], who concluded that the introduction of game elements into the educational process comprehensively develops personality, providing an environment in which students not only improve academic skills, but also can experiment, engage in creativity, and creatively approach the educational process.

D. Abidin [16], who revealed the effectiveness of educational games in improving students' cognitive and social skills, conducted a study that demonstrated that educational games in the educational process activate students' cognitive activity, actively involve them in the educational process, contribute to the development of the ability to solve emerging problems and improve not only academic but also personal achievements, which fully consistent with the results of this study. However, the researcher also noted that there may also be certain disadvantages in the use of game elements in the educational process, such as the frivolous attitude of students towards the educational process and the inability of teachers to effectively integrate games into the teaching process.

During the implementation of the developed methodology in the educational process, educational institutions also interacted with other educational institutions, in particular with educational institutions of partner countries. L. Huinong and H. Wei [29], who investigated the impact of international interaction on the development of cognitive activity, concluded that international interaction has a positive impact on the development of cognitive processes, in particular, on cognitive activity, critical thinking skills, and intellectual development in general. The results of the study demonstrated that interaction with foreign students helped students improve their academic performance, communication skills, ways to solve problems, and develop their cognitive activity.

One of the recommendations for the implementation of the developed methodology in the educational process was the use of virtual reality to practice practical skills, in particular, for virtual laboratories. F. Huang [30], who investigated the impact of modern technologies, in particular virtual reality, on the development of skills, came to the conclusion that virtual reality is a useful tool for improving cognitive activity and, in general, the educational needs of people, which correlates with the results of this study. In addition, the expert noted that conventional methods are no longer as effective as they were before, which is why modern technologies can improve the educational process and can be useful for both students and teachers.

The role of teachers in the process of implementing the methodology and in the development of cognitive activity of students is not sufficiently disclosed in this study. Thus, J. Duan et al. [11], analysing the application of research training in biology teaching, noted that it is the teacher who is the person in the educational process who should stimulate students to scientific activity and active participation in solving tasks. However, the study of learning based on the research approach of D. Urdanivia Alarcon et al. [31] demonstrated that teachers are not always ready to apply modern approaches and strategies in the educational process, which requires their training.

Thus, the researchers unanimously agreed that cognitive development, in particular the development of cognitive activity, is an important part of the formation of an individual's personality, and preparation for future professional activity. The researchers also confirmed that it is possible to develop cognitive activity most effectively during the study of natural sciences, but conventional methods cannot be effective at this stage, which requires new approaches. One of the most effective approaches is research activity in the educational process, which is fully consistent with the results of this study.

In this study, a methodology for the development of cognitive activity was proposed, which is based on problem-based learning, discussions and brainstorming, educational games, the use of modern technologies, and international interaction. These approaches to the development of cognitive activity have been identified as effective in the analysed studies. However, this study did not sufficiently reveal the role of the teacher in the process of implementing the developed methodology and in the development of cognitive activity, and according to experts, it is the teacher who can influence the development of the personality of students and their abilities. This requires further research on the preparation of future teachers of natural sciences for professional activity, and professional development of experienced teachers.

Conclusions

This study proposed and verified the effectiveness of the methodology for developing learners' cognitive activity in the process of learning the scientific foundations of the course. Cognitive activity is necessary for students to increase the effectiveness of the educational process, successful research activities, for self-development and self-improvement throughout their lives. It is determined that cognitive activity includes such components as: motivational, cognitive, procedural, and evaluative. Effective development of cognitive activity and all its components at the same time is possible in the process of learning scientific fundamentals during the teaching of natural disciplines, in particular physics. To develop cognitive activity in the process of studying the scientific foundations of the course, a methodology was developed that was based on such approaches as: problem-based learning (which also included conducting scientific experiments), discussions and brainstorming, educational games, the use of modern technologies, and international interaction.

The effectiveness of the developed methodology was tested among 75 students in grades 10-11 of Secondary School No. 164 and Gymnasium No. 153 named after A. Rozybakiev, and among 80 1st and 2nd-year students of the Kazakh Automobile and Road Institute named after L.B. Goncharov. The results of the study demonstrated that students of higher educational institutions have higher cognitive activity than high school students, which may be due to more active research activities of students, more active cognition of the world based on their future professional activities. At the ascertaining stage, 43% of students in grades 10-11 demonstrated a high level of cognitive activity, while among 1st and 2nd-year students, 59% of the subjects demonstrated a high level of cognitive activity. At the control stage, among students in grades 10-11, 68% of the subjects demonstrated a high level of cognitive activity, and among students of the 1st-2nd year of study, 74% of the subjects demonstrated such a result.

Thus, it can be concluded that the proposed method is more effective in the development of cognitive activity of students in grades 10-11, while it is less effective in the educational process of university students, but also shows certain results. This demonstrates the need to change approaches to the development of cognitive activity in students of higher educational institutions. Recommendations for the implementation of the developed methodology are: practical orientation of the tasks assigned to students; active involvement of students in the educational process and the use of an individual approach; focus on learning about the world, its patterns, processes, and phenomena; the ability to use these scientific foundations in real life situations and other life spheres.

In this study, the role of the teacher in the development of cognitive activity, as one of the key figures in the educational process, is insufficiently disclosed. The prospects for further research are the analysis of the cognitive activity of undergraduate students, the adaptation of the proposed methodology based on their needs, and the analysis of the role of the teacher in the development of cognitive activity among students.

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None.

Conflict of Interest

None.

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Методологія розвитку когнітивної активності студентів при вивченні наукових основ курсу

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Анотація

Актуальність. Когнітивна активність є важливою частиною науково-технічного розвитку і необхідна сучасній людині для отримання нових знань, самовдосконалення, всебічного розвитку та продуктивної професійної діяльності. У зв'язку з цим виникає необхідність розвитку когнітивної активності у старшокласників і студентів університетів.

Мета. Метою цього дослідження є виявлення підходів до розвитку когнітивної активності студентів у процесі вивчення природничих наук, зокрема фізики. Роль вивчення наукових основ у процесі викладання природничих дисциплін у розвитку когнітивної активності студентів була виявлена.

Методологія. У цьому дослідженні було розроблено та протестовано методологію, спрямовану на підвищення когнітивної активності студентів через вивчення наукових основ, зокрема фізики. Методологія включала аналіз компонентів когнітивної активності, критеріїв їхнього розвитку та інтеграцію цих елементів у структурований підхід, який був реалізований та оцінений серед старшокласників та студентів університетів.

Результати. Впровадження методології призвело до підвищення когнітивної активності на 25% серед старшокласників (10-11 класи) у порівнянні з 15% підвищенням серед студентів університетів (1-2 курси). Більш значні досягнення у старшокласників свідчать про те, що раннє застосування таких методологій може бути особливо ефективним. Спостереження показали, що студенти університетів загалом мали вищі рівні когнітивної активності завдяки більш просунутому науковому залученню.

Висновки. Дослідження підкреслює ефективність цільових методологій у розвитку когнітивної активності, особливо серед старшокласників. Результати свідчать про необхідність ранніх та більш цілеспрямованих втручань для підвищення когнітивних процесів, що дозволяє припустити, що інтеграція науково-дослідницької діяльності в навчальні програми старших класів може суттєво покращити академічний та професійний розвиток студентів.

Ключові слова: саморозвиток; наукові основи; когнітивні процеси; активне мислення; професійна діяльність.