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EFFECTIVENESS OF STEAM APPROACH IN DEVELOPING STUDENTS' COMPETENCES IN SOLVING GEO-ENVIRONMENTAL PROBLEMS

A person's competence consists of understanding the essence of a problem, as well as possessing the skills of its practical solution, using the solution method that best suits a specific situation. The ability to solve a problem is an important aspect of developing geo-environmental competence in students during the learning process. The article considers the importance of STEAM approach for the development of 21st century skills in students and its impact on geo-environmental problem solving in the educational process. The hypothesis of the study suggests that STEAM approach promotes the development of geo-environmental problem solving skills. The methods included a Quasi Experiment with preliminary and final testing. The control group used the Problem Based Learning (PBL) method of learning, while the experimental group used the Project Based Learning (PjBL) method with the integration of the STEAM approach. The findings demonstrated a notable enhancement in the performance of participants in the experimental group. The integration of the STEAM approach not only increased the level of knowledge, but also contributed to the development of key skills, such as critical thinking, creativity and teamwork, as well as significantly increased students' motivation, their activity in problem solving and involvement in group projects. Special emphasis was placed on project activities where students analysed real environmental problems and developed solutions with an interdisciplinary approach. This contributed to a deeper understanding of the subject and practical application of theoretical knowledge. The study showed significant effectiveness of the STEAM approach for teaching geo-environmental disciplines. Despite

the limitations associated with a small sample, the proposed approach confirms its relevance to the modern education system and is recommended for implementation in other educational programmes.

Keywords: geo-environmental problem solving, STEAM-approach, competence, geo-environmental issues, critical thinking.

Introduction

The dynamism of changes taking place in the modern world has necessitated a rethinking of the fundamental principles of functioning of the world education systems [1].

At present, the equal importance of the processes of forming both actual knowledge and relevant practical skills in students is generally recognised in the field of education. The fundamental difference between modern teaching and learning processes is their priority in the formation of students' readiness to use the available knowledge in practice, in addition to the formal possession of it, which is more in line with the essence of skills in demand in the 21st century. All 21st century skills, in particular skills such as co-operation, critical thinking, creativity and effective communication skills, can be developed through activities such as problem solving and projects [2; 3]. One of the competences that is important to develop in geography education is the ability to solve geo-environmental problems. Geo-environmental problem solving skills are important at all levels of education, which requires learners to begin their education with logical, critical thinking and a keen interest in the problems in their environment.

One of the most popular technologies to help learners improve their ability to solve geo-environmental problems is science, technology, engineering, maths and creativity (STEAM) learning. This method of learning is closely linked to the development of 21st century skills, where learners using STEAM not only understand learning concepts, but can relate them to everyday life.

STEAM approach can be implemented through problem-oriented, project and research-based learning. Research conducted by scientists from different countries shows that the application of STEAM approach contributes to the improvement of learning quality, development of critical thinking, improves motivation and cognitive activity by conducting deeper research in the framework of projects [4; 5]. Based on the above, the problem statement of this study is to determine the effectiveness of STEAM-approach, which contributes to the development of students' ability to solve geo-environmental problems.

Taking into account the stated problem, the aim of the study was formulated – to determine the effectiveness of STEAM-approach in the development of students' competences for solving geo-environmental problems in the study of

profile disciplines. The objectives of the research are: to study the peculiarities of the formation of competences for solving geo-ecological problems in the modern education system; to determine the role of STEAM-approach in the development of 21st century skills in students; to evaluate the effectiveness of STEAM-approach in solving geo-environmental problems during the teaching of specialized disciplines.

Materials and Method

The study proposed a hypothesis that STEAM approach contributes to the formation of skills for solving geoenvironmental problems. In the process of the research the method of systematic literature analysis of theoretical and practical material was used, the method of pedagogical experiment was applied. Experimental work was organised on the basis of Zhetysu University named after I. Zhansugurov in Taldykkorgan city on the educational programmes Geography and Geography-History. The study was conducted in the form of a Quasi Experiment and consisted of several stages, the mandatory requirement of which was the implementation of preliminary (Pretest) and final (Posttest) control of students' knowledge.

To increase the validity of the study, the participants were divided into two groups: a control group with 25 students and an experimental group with 23 students. Each group included students with different levels of knowledge identified by Pretest results. This made it possible to take into account the initial level of competences of the participants and ensure a correct comparison of the results.

In the control group PBL was used, in the experimental PjBL using STEAM approach. Descriptive and mathematical statistics methods were used to analyze the data. The results of the Pretest and Posttest were assessed using average values to determine the overall level of knowledge in the groups, as well as using the Student's t-statistical criterion to test the significance of differences between the control and experimental groups. Questionnaire survey by students assessed the perception of PBL and PjBL, with STEAM approach in the learning process.

The objective of this experiment was to find out to what extent the use of the STEAM approach in combination with PjBL improves geo-environmental problem solving skills.

The study involved 10 training sessions, each of 3 hours for 10 weeks.

Results and Discussion

Pretest and Posttest were organised in the course of the study to assess the level of students' knowledge and practical skills in solving geo-environmental problems. Preparation of teaching and control materials, including tasks for Pretest and Posttest, was carried out at the preliminary stage. The tasks included both theoretical questions and practical tasks aimed at identifying students' ability

to analyse and solve geo-environmental problems, which allowed a comprehensive assessment of their preparedness in this area (Figure 1).

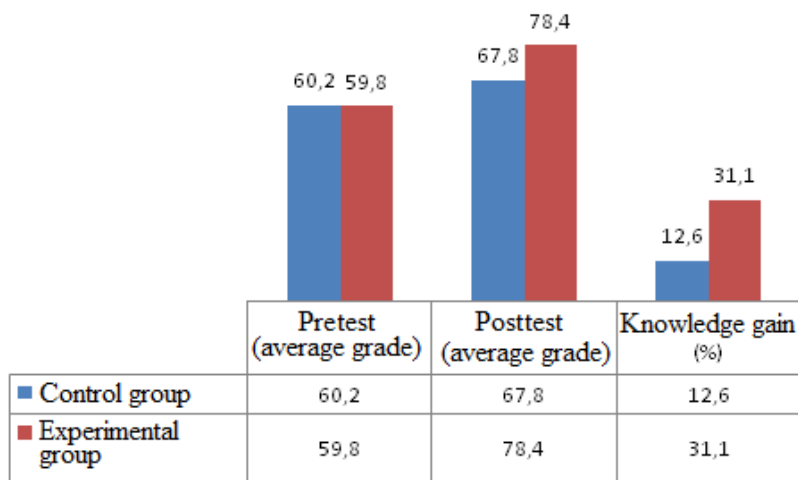


Figure 1 – Average grades of students in the control and experimental groups

According to the data obtained, in the control group the average grade on the Pretest was 60.2 and on the Posttest – 67.8, and corresponds to a knowledge gain of 12.6 %.

In the experimental group, the results were significantly better. The average grade on the Pretest was 59.8 and on the Post test it increased to 78.4, which demonstrates knowledge growth at the level of 31.1 %.

Statistical analysis was performed to test the validity of the differences between the groups (Table 1). The table demonstrates that the performance of the two groups differ on key parameters, with the p-value confirming the statistical significance of these differences.

Table 1 – Research statistics

Parameter	Control group	Experimental group	p-value
Average knowledge gain (%)	12.6	31.1	< 0.01

The analysis of the data presented in the table shows that the average knowledge growth in the experimental group is 31.1%, which significantly

exceeds the control group's indicator of 12.6 %. This result indicates a higher level of mastery of the material by students trained using the STEAM approach and confirms its effectiveness compared to traditional teaching methods used in the control group. The p-value (< 0.01) confirms that the differences between the groups are statistically significant.

The study revealed that applying the STEAM approach in teaching specialized subjects positively impacted students' ability to solve geo-environmental problems. Students in the experimental group achieved significantly better results in problem-solving compared to those in the control group. Moreover, the effect of STEAM approach differed according to the learners' initial knowledge levels on the Pretest, the group with low knowledge level had a positive effect that was higher than the group with PBL method. According to the study's findings, the STEAM approach substantially raises students' motivation to learn both the theoretical and practical elements of the material, enhances their understanding and interpretation of concepts, and supports more comprehensive research in project work [6].

In the experimental group, the training is aimed at enabling students to activate their existing geo-environmental problem-solving abilities. The STEAM approach can help the students to solve problems and solve them with the help of critical thinking [7; 8]. Students were presented with problems related to environmental change and were asked to develop a project to solve these problems. In class, students discuss the problem with their group to identify ideas or insights for the project. They are also asked to design a project that will be created and visualised as an image.

The students then proceed to realise the project idea, design and present the results of their projects so that they can be evaluated on the results of their projects. The stages of geo-environmental problem solving and the creation of this project can help students to improve their problem solving skills in the process of project creation and to identify the most effective ideas in problem solving [9; 10]. This is confirmed by the results of the students' questionnaires, according to which 92.7 % of students believe that PjBL using STEAM approach helped them to understand the topic of environmental change more easily and made them more active in group discussions when solving the assigned tasks, it allows students to acquire cognitive knowledge and skills.

In the control group, teaching was carried out using traditional teaching models, namely PBL with a scientific approach, which gave a lower result than in the experimental group. The students were given tasks within the framework of the study of profile disciplines, where several topics of environmental problems are proposed, such as problems of soil, river, air pollution, as well as the consequences of the transfer of the capital.

The students were presented with articles in order to analyse the problems based on the given questions. The work on this task was done in groups at home so that the work process was not visible. After completing the work, the students demonstrate the findings of their discussions with those present. According to the results of the presentation, the ideas presented are only based on friends' ideas and are based on internet resources, so that the ideas for problem solving do not differ from each other. In this case, PBL has some disadvantages such as lack of enthusiasm of the learners in problem solving, the use of each learner's ideas is not realised and a little more time is required.

The application PjBL using STEAM approach can significantly improve geo-environmental problem solving skills and provides students with opportunities to approach real-world problems in an integrated manner, enhancing their ability to analyze and apply knowledge in practice.

However, a limitation of the study is the small sample size, making it impossible to generalise the results to all students as a whole.

Conclusion

Within the modern education system, the STEAM approach has proven to be an effective tool for developing 21st century skills, including critical thinking, creativity, collaboration, and problem-solving skills. The analysis of the research results confirms the hypothesis about the positive impact of the STEAM approach on the development of students' ability to solve geo-environmental problems. According to the data obtained, the experimental group shows a significant increase in the level of knowledge, amounting to 31.1%, which is several times higher than the results of the control group, where this figure was only 12.6%.

These data indicate a high potential for integrating the STEAM approach into the educational process to form deeper and more comprehensive knowledge in the field of geocology in students. Such a significant increase in the experimental group can be due to the interdisciplinary nature of the approach, which promotes the development of critical thinking, the ability to analyze and solve problems using knowledge from various fields of science.

The effectiveness of the STEAM approach was most evident in the PjBL process, during which students analysed real environmental problems, developed projects and proposed solutions. The application of the approach improved not only cognitive knowledge but also interdisciplinary skills, which is especially important for geo-ecological research.

The results of the participants' questionnaires showed a high degree of motivation and involvement of students in the learning process, which confirms the potential of STEAM approach as an innovative method of education. Despite the limitations of the study, including the small sample size, the results

demonstrate the need for further implementation of the STEAM approach in educational programmes. Expanding the scope of the study to include more students and disciplines may help to provide more extensive and accurate data on the effectiveness of this approach.

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БІЛІМ АЛУШЫЛАРДЫҢ ГЕОЭКОЛОГИЯЛЫҚ МӘСЕЛЕЛЕРДІ ШЕШУДЕГІ ҚҰЗЫРЕТТІЛІКТЕРІН ДАМУДАҒЫ STEAM-ТӘСІЛІНІҢ ТИІМДІЛІГІ

Құзыретті адам мәселенің мәнін түсініп қана қоймай, оны іс жүзінде шеше білуі керек, яғни нақты жағдайларға ең қолайлы шешім әдісін білуі керек.

Мәселелерді шеше білу білім алушылардың экологиялық мәселелерді шешуге оқыту процесіндегі геоэкологиялық құзыреттілігін қалыптастыру үшін маңызды.

Мақалада білім алушылардың ХХІ ғасыр дағдыларын дамыту үшін STEAM-тәсілінің маңызы және оның білім беру үдерісіндегі геоэкологиялық міндеттерді шешуге әсері қарастырылған.

Зерттеу гипотезасы STEAM-тәсілі геоэкологиялық мәселелерді шешу дағдыларын қалыптастыруға ықпал етеді деп болжайды.

Әдістерге алдын ала және қорытынды тестілеумен квази-эксперимент кірді, бақылау тобында проблемалық оқыту, ал эксперименттік топта STEAM-тәсілін қолдана отырып, жобаға бағытталған оқыту қолданылды.

Нәтижелер эксперименттік топ студенттерінің айтарлықтай жақсарғанын көрсетті. STEAM-тәсіл білім деңгейін көтеріп қана қоймай, сонымен қатар сыни ойлау, шығармашылық және топтық жұмыс сияқты негізгі дағдыларды дамытуға мүмкіндік берді, сонымен қатар студенттердің мотивациясын, міндеттерді шешудегі белсенділігін және топтық жобаларға қатысуын айтарлықтай арттырды.

Жобалық қызметке ерекше назар аударылды, оның барысында білім алушылар нақты экологиялық мәселелерді талдап, пәнаралық тәсілмен шешімдер әзірледі. Бұл тақырыпты түсінуді тереңдетуге және теориялық білімді практикалық қолдануға ықпал етті.

Зерттеу нәтижелері геоэкологиялық пәндерді оқытудың STEAM тәсілінің жоғары тиімділігін көрсетеді.

Шағын үлгіге байланысты шектеулерге қарамастан, ұсынылған тәсіл қазіргі білім беру жүйесіне өзектілігін растайды және басқа оқу бағдарламаларына енгізуге ұсынылады.

Кілтті сөздер: геоэкологиялық есептерді шешу, STEAM-тәсіл, құзыреттілік, геоэкологиялық мәселелер, сыни тұрғыдан ойлау.

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ЭФФЕКТИВНОСТЬ STEAM-ПОДХОДА В РАЗВИТИИ КОМПЕТЕНЦИЙ ОБУЧАЮЩИХСЯ В РЕШЕНИИ ГЕОЭКОЛОГИЧЕСКИХ ПРОБЛЕМ

Компетентный человек должен не только понимать сущность проблемы, но и уметь решить ее практически, то есть владеть методом решения, наиболее подходящим к конкретным условиям. Умение решать проблемы важно для формирования геоэкологической компетенции обучающихся в процессе обучения

решению экологических проблем. В статье рассмотрено значение STEAM-подхода для развития навыков XXI века у обучающихся и его влияние на решение геоэкологических задач в образовательном процессе. Гипотеза исследования предполагает, что STEAM-подход способствует формированию навыков решения геоэкологических проблем. Методы включали квази-эксперимент с предварительным и итоговым тестированием, при этом в контрольной группе использовалось проблемное обучение, а в экспериментальной – проектно-ориентированное обучение с применением STEAM-подхода. Результаты показали значительное улучшение у студентов экспериментальной группы. STEAM-подход позволил не только повысить уровень знаний, но и развить ключевые навыки, такие как критическое мышление, креативность и работа в команде, а также значительно повысил мотивацию студентов, их активность в решении задач и вовлечённость в групповые проекты. Особое внимание уделялось проектной деятельности, в ходе которой обучающиеся анализировали реальные экологические проблемы и разрабатывали решения с междисциплинарным подходом. Это способствовало углублению понимания предмета и практическому применению теоретических знаний. Результаты исследования демонстрируют высокую эффективность STEAM-подхода для обучения геоэкологическим дисциплинам. Несмотря на ограничения, связанные с небольшой выборкой, предложенный подход подтверждает свою актуальность для современной системы образования и рекомендуется к внедрению в других учебных программах.

Ключевые слова: решение геоэкологических задач, STEAM-подход, компетенция, геоэкологические проблемы, критическое мышление.

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