

INCREASING THE EFFICIENCY OF PROJECT-BASED LEARNING DURING MATHEMATICS TEACHING AT SCHOOL

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Abstract

Project-Based Learning (PBL) is an educational approach that emphasizes the development of learners, critical considering problem-solving, collaboration, and communication skills through the completion of a project that integrates various academic subjects. PBL involves learners in a hands-on, experiential learning process, where they work collaboratively to investigate a complex question or problem and create a product or solution that demonstrates their learning. PBL encourages learners to take possession of their learning by engaging them in the project planning, research, and presentation processes. PBL has been found to progress learners' academic accomplishment as well as their inspiration and engagement in learning. PBL is a valuable educational approach that can prepare learners for success within the 21st-century working environment by developing skills that are highly valued by employers, such as critical thinking, problem-solving, creativity, and collaboration.

Keywords: mathematics, mathematical education, pedagogy, project-based learning, learning methods

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МЕКТЕПТЕ МАТЕМАТИКАНЫ ОҚИТУ ҮДЕРІСІНДЕ ЖОБАЛАП ОҚИТУДЫҢ ТИІМДІЛІГІН АРТТЫРУ

Жобалап оқыту (ары қарай PBL-Project Based Learning) – әртүрлі оқу пәндерін біріктіретін жобаны орындау арқылы оқушылардың сыни ойлауын, мәселені шешуді, ынтымақтастықты және коммуникация дағдыларын дамытуға ерекше мән беретін білім беру тәсілі. PBL әдісі оқушыларды күрделі мәселені зерттеу үшін бірлесіп жұмыс істеуге негізделген тәжірибе арқылы практикалық оқу үдерісіне алып келеді және оның нәтижесінде белгілі бір өнімге немесе шешімге қол жеткізіледі. Оқушы осы әдіс арқылы жобаны жоспарлауға, зерттеуге және таныстыру процестеріне ынтымақтасуға артады. PBL әдісі оқушылардың оқу жетістіктерін, сондай-ақ олардың оқуға деген ынтымақтасуын және қызығушылығын жақсартатыны анықталды. PBL сыни тұрғыдан ойлау, мәселелерді шешу, шығармашылық және ынтымақтастық сияқты жұмыс берушілер жоғары бағалайтын дағдыларды дамыту арқылы оқушыларды 21-ші ғасырдағы жұмыс орнында табысқа дайындайтын құнды білім беру тәсілі болып табылады.

Түйін сөздер: математика, математикалық білім беру, педагогика, жобалап оқыту, оқыту әдістері

Аннотация

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ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ ПРОЕКТНОГО ОБУЧЕНИЯ МАТЕМАТИКЕ В ШКОЛЬНОМ ОБРАЗОВАТЕЛЬНОМ ПРОЦЕССЕ

Проектное обучение (далее PBL-Project-Based Learning) – это образовательный подход, который делает упор на развитие у учащихся критического мышления, навыков решения проблем, совместной работы и общения посредством выполнения проекта, объединяющего различные академические предметы. PBL вовлекает студентов в практический процесс обучения, основанный на опыте, когда они совместно работают над исследованием сложного вопроса или проблемы и создают продукт или решение, демонстрирующее их обучение. PBL поощряет студентов брать на себя ответственность за свое обучение, вовлекая их в процессы планирования проектов, исследований и презентаций. Было обнаружено, что PBL улучшает успеваемость учащихся, а также их мотивацию и вовлеченность в обучение. PBL – это ценный образовательный подход, который может подготовить

учащихся к успеху на рабочем месте в 21 веке, развивая навыки, которые высоко ценятся работодателями, такие как критическое мышление, решение проблем, креативность и сотрудничество.

Ключевые слова: математика, математическое образование, педагогика, проектное обучение, методы обучения.

Introduction

In the strategic plan for the development of education of the Republic of Kazakhstan, "The main task of the education system is to introduce new technologies of education, to inform education, to access international communication networks, to obtain education aimed at the formation, development and professional training of an individual based on national and universal human values, scientific and practical achievements. to create the necessary conditions" - as pointed out, one of the main tasks of every teacher at present time is to constantly improve teaching methods and master new pedagogical technologies. Also, President of Kazakhstan Kassym-Jomart Tokayev claimed that "On this issue, we need a fresh approach and new methods, as well as we need to rely on international experience" [1], he noted that it is necessary to use internationally recognized methods.

Project-Based Learning (PBL) is an instructional approach that emphasizes active learning through the completion of a project that addresses a real-world problem or challenge. PBL has gained popularity in recent years due to its potential to improve learner engagement and learning outcomes. PBL is becoming increasingly popular in schools and universities as it offers numerous benefits such as enhancing critical thinking, creativity, collaboration, and communication skills. This research article aims to investigate the impact of PBL on learner learning and to explore best practices for implementing PBL in different educational settings as mentioned by Bakhisheva [2].

Benefits of implementation of PBL in mathematics courses

Firstly and most importantly PBL allows learners to acquire practical skills. Research has shown that PBL has several benefits for learners. One of the main benefits is that it promotes the development of 21st-century skills, such as communication, collaboration, and critical thinking. PBL also helps learners develop a deeper understanding of the content by applying it to real-world problems. Additionally, PBL has been shown to increase learner motivation and engagement, as learners are more invested in solving authentic problems. Most of the world's leading countries evaluate their education system, the purpose, content, and technologies of education based on its results. The current main goal of education is not only to acquire knowledge and practice but also to find, analyze and rationally use the information for social and professional qualifications.

Project-based learning is a learning methodology based on the practical application of knowledge in projects. It involves the active participation of learners in the learning process and sets them tasks that need to be solved using the knowledge and skills acquired in the curriculum. In Kazakhstan, project-based learning is one of the most effective approaches to education.

Currently, in Kazakhstan, project-based learning is widely used in higher educational institutions and schools. For example, the School of Project-Based Learning has been opened in Astana, where training is based on solving real projects together with business partners. Also, project-based learning is conducted at Nazarbayev University, Almaty Graduate School of Management, and other educational institutions in the country. 'The teacher's task is not to convey information to children, but to teach them what to do with it' mentioned Nikke Keskinen, director of High Tech Academy located in Astana, Kazakhstan [3].

In general, project-based learning in Kazakhstan allows learners not only to gain theoretical knowledge but also to acquire practical skills that will be useful to them in their future careers. It also promotes the development of creative thinking, communication skills, and leadership qualities. Thanks to this method of learning, graduates can successfully adapt to the requirements of the modern labor market.

And now, if we come to the question of where this important technology originates from, we can see that the use of the "project method" in the teaching process begins in the 17th century. In 1671, for the first time in Paris, the Royal Academy of Architecture announced a competition for the most beautiful projects among learners. Since then, the name of the method "project" - "project" has been entered. Therefore, a project, project-based learning is an intention, ultimate idea, and action in the direction of changing the content of a certain object, improving it, supplementing it, and implementing a plan.

We know that this method has been used since 1905 in the teaching practice of scientists S. T. Shatskyi and N. K. Krupskaya in the history of USSR countries. According to the researchers, this method was used in teaching practices of industrial schools until the 20th century. Since 1965, the design method has been used at the international level. Scientists attribute the main reason for returning to this method "to consider the problem in its development". That is, learners look at the theory several times in action to solve a real problem, as a

result of which they have the opportunity to evaluate how their work is done, the work done with their own hands brings them satisfaction and self-confidence. Scientists have given great importance to the advantages of this technology. In this regard, J. Dewey, V. Kilpatrick, etc. scientists conclude that children's psychological aspiration, intention, and inclination to perform tasks play a crucial role in the learning process.

V. Kilpatrick claimed the PBL method as an "intention from the heart". According to him, working on a project is divided into 4 stages: thinking, planning, execution, and evaluation. All these actions should be performed without the participation of the teacher. Only then will the learner be able to see the results of his actions, and he will be able to assess what he is capable of. "If a girl invents the model of the dress she will wear in the future, chooses the necessary materials for it, measures it herself, fits it and sews it with great interest and hard work, this is a real example of design technology" pointed Kilpatrick. And J. Dewey insisted that the learner's action should be a joint action with the teacher. Because the learner may not have enough knowledge to complete the activity, the teacher believes that before performing the activity, the learner should go through all the stages of thinking. That is, he believed that the teacher's help in managing and organizing the learner's cognitive activity was necessary. One of the main requirements for a specialist at present time is the ability to work with various information in any situation, that is, the intellectual development of an individual.

In this case, the learner searches for a solution to the problem in his practical activity, so that he can see its result, he notices the importance of the acquired theoretical knowledge and remembers it. This process allows a person to master the methods of solving various situations, and forming business abilities. This is the essence and didactic role of the PBL method. When the design method is used in its true sense, it is very effective in solving any problem using acquired knowledge and business skills, in showing a way out of it, or at least in determining the direction of its solution.

Secondly, PBL enhances the relationship between teachers and learners. Kubiak and Vaculová [4] argue that PBL "promotes identical respect, support, and understanding, creating an effect on learner- learner and learner-instructor relationships" PBL helps teachers have better relationships with their college learners and get to realize them. It's miles actual that closer relationships are useful for instructors and college learners. In this regard, Van den Bergh et al. mentioned: "There is an occasion for both parties – learners and instructors –to cooperate more closely: they come to know each other better and become more personally and informally involved" [5]. It is highly possible that better relations could be a result of more close negotiations between teachers and learners.

It's highly imaginable that the relationship between teachers and learners in mathematics courses is enhanced as a consequence of the PBL structure, as it's said by teamwork. The collaboration within each group when PBL offers learners opportunities to share thoughts and acquire from each other. It's clear that sometimes learners may conflict to query assistance from lecture teachers in front of the complete class. However, these "introverted" learners can seamlessly get encouragement from peers within the group or ask the teacher to assist within only his or her group. This is an extremely essential benefit that PBL offers for them. An extra indication is that PBL makes it conceivable for teachers to remain concentrated on the issue of any group without being frustrated with attention, as it is very difficult to work with the complete class at once.

Thirdly PBL improves communication between learners. Another significant issue is that PBL also improves communication among learners. According to the replies of my participants in math courses, the relationship between learners working in groups improves. The answers showed that learners who had common project work felt responsible for each other and tried to contribute equally to the work.

According to Van den Berg et al., one of the most important benefits of PBL is that learners learn to deal with conflicts between group members in each group. The group work nature of PBL perhaps is the critical factor that enhances the learner-learner relationship. It encourages learners within any group to confirm one another with the intention of having a higher last grade. The current project makes them unite and work as one complete organism. It's conceivable that learners working in groups have greater relationships within these groups because whereas they negotiate with one another on the issue they additionally get opportunities to better know one another and become friendlier. They acquire separate roles in the group, communicate, discover their partners, and share ideas.

Fourthly, PBL assists teachers maintain discipline and take in a sympathetic atmosphere in the classroom. Based on Bell [6] discipline is part of the three major results of PBL. It's worthwhile to reference that teachers in this survey perceived PBL as a proper advance that assists them to maintain discipline in the classroom, organizing learners in groups, and managing them easily. Good relationships between teachers and learners, along with amongst learners within the groups may become the purpose for enhancing discipline and

building a determined environment in the classroom. This outcome is in agreement with the findings of Hugerat [7], who found that PBL learners are more actively participating and interested in their own acquiring than learners whereas familiar lessons, which assisted teachers witness the general atmosphere in the classroom as less nervous and less difficult.

As we see the concepts of project-based learning were widely adopted in the USA, the UK, and many other countries. In project-based learning, theoretical knowledge and its real-world implementation were logically combined.

The PBL's goals and objectives are to:

– Teach students how to learn on their own, applying their knowledge to solve new cognitive and practical problems;

– Assist in the development of student's communication skills;

– Instill in students the ability to use research techniques, including gathering data, analyzing it from various perspectives, establishing hypotheses, and the capacity to draw conclusions.

It is best to emphasize the key characteristics of the ideas of "project-based learning," "project method," "project," "educational project," and "project activity" when disclosing the execution features of a project.

There are six main stages when using "project-based learning":

1. identifying the problem (choosing a topic);

2. planning your own activities;

3. formalization (modeling of a specific situation);

4. implementing of own ideas (with the involvement of programming technologies);

5. analysis and evaluation of the results obtained (with adjustments, if necessary); 6. registration of the practical result of the development and its public defense (with a demonstration of the finished software product)

Fifthly PBL develops definite talents and capabilities in learners. Some mathematics teachers at the school pointed out that PBL improves learners' skills and abilities, citing many different examples, and they named the most popular 21st-century skills such as creativity, critical thinking, communication and collaboration skills, and presentation skills. Interestingly, the skills mentioned by my participants appear among the twelve most common skills identified in the PBL literature by Nicola & Allison [8].

Also, Tamim and Grant [9] stated that "different capabilities of the learners were unveiled that would or stay unnoticed in an acquainted achieving and testing environment". This supposedly denotes that learners have several distinct talents and capabilities that are able to be noticed and developed by implementing PBL. It looks like that PBL builds that atmosphere properly for these hidden abilities to be disclosed and improved. In the course of familiar lessons, learners are bounded by the subject content material of the curriculum delivered by teachers, however, dealing with convincing PBL assigned tasks needs learners to find more deeply and acquire more on that specific issue or topic as mentioned by Bell, Tamim & Grant and Larmer & Mergendoller & Boss [10]. The project-based method encourages students to be involved through active participation in a mental and physical activity that requires in-depth research; it is a method that takes into account the product and the output by students to show that they have understood the topics of the lesson and also the process pointed by Bilgin et al., [11] As a result, learners may become sightlier and more become highly knowledgeable on the topic.

Sixthly PBL offers learners real-world exercise. Most of the key benefits of PBL are that this progress needs learners to proceed to the field and do the practical part of the mathematics project. Learners acquire more than are involved actively in a hands-on approach. As mentioned by Kubiato and Vaculová that the first step to successfully integrating PBL into the classroom is the practice-based nature of knowledge and learning. This suggests that exercise plays a big part in PBL implementation.

It is important to note that most skills and abilities are discovered and improved through practice during PBL. Different abilities of learners can be discovered and developed only through practical PBL activities. These talents and skills can help learners become better problem solvers and researchers, as Bell points out. Moreover, Bell found that PBL additionally prepares learners for approaching job markets and emphasizes the significance of PBL in growing appropriate talents in learners and getting them ready for triumph in the twenty-first century.

In accordance with Larmer et al., "PBL prepares learners for college, careers, and citizenship". Additionally, the findings of Baumgartner and Zabin [12], claimed the significance of exercise whilst PBL in raising the depth of understanding. Moreover, Z. Osmanova and Zh. Seysenbaeyva [13] includes that the effectiveness of design education is not only to adapt the child to science from school age, but also to lead the

student to research, business and cognitive enthusiasm, ability to solve various problems by improving creativity, ingenuity, and new scientific research by seeing, hearing and remembering. In this way, we can ensure that students are empowered to make their own decisions about this situation, taking into account their individual characteristics and the availability of support materials.

PBL business activities have been planned around meaningful issues that are crucial to them. Moreover, they add that in the course of PBL learners are interested in real-world business activities like adult professionals are. In this regard, Larmer and Mergendoller assume that learners have to not just duplicate details from books and the web onto a poster. Based on them, PBL offers learners with actual inquiries that assist them find replies to the questions that are crucial and entertaining to them, which may lead them to new findings and ideas. As a result, learners have a chance to settle their own conclusions and reply to the problem. Baumgartner and Zabin reference that “PBL can make access relevant to the genuine world” and claims that “PBL offers the perfect program to exemplify the real world”.

And we can see how project-based learning can be used in math classes to establish learners in the role of active individuals, reveal their potential, foster their own unique creativity, and encourage the pursuit of new knowledge. The implementation of projects makes it possible to create a personality-developing situation that allows one to realize creative forces and to ensure the development of knowledge, own opinion, and own style of activity. Students are included in real creative activity, which not only attracts novelty and unusualness, entertainment, which in itself becomes the strongest incentive for cognitive interest but also develops the need to identify problems and resolve emerging contradictions. And also project activity allows organizing an appeal to the subjective experience of learners, and also emphasizes the recognition of the uniqueness and originality of each student.

For a mathematics teacher, the most alluring thing about this method is that in the handle of working on an educational project, students:

- it gets to be conceivable to carry out approximate, “estimated” activities that are not promptly assessed by a strict controller - a teacher;
- the establishments of systemic considering are born;
- the aptitudes of putting forward hypotheses, shaping issues, and looking for contentions are shaped;
- develop imagination, creative ability, and fantasy;
- purposefulness and organization, judiciousness and undertaking, and the capacity to explore in a circumstance of vulnerability are brought up.

In addition, within the handle of project implementation, there's a characteristic learning of joint mental activities. Children learn to understand, compare different points of view, and argue their points of view. The use of these teaching aids in the system of pedagogical activity allows students to improve the skills of independent work and move on to independence in the study of individual issues, and then topics. This is manifested in the ability to set a goal, design your actions, select the content and means to achieve the goal, and control the results. Having methodological knowledge, students learn to apply the acquired methods of activity, combine them, and create new ones. The cognitive activity of students, organized during the defense of projects, allows the student to consistently occupy various communicative positions: from passively listening to understanding, asking questions, supplementing, and clarifying the work of others. And then - in the ability to express and argue a point of view, to understand and accept the point of view of another, without destroying his own, able to see ways to improve or develop any point of view.

The implementation of the PBL method in mathematics courses gives each student the right to find himself within the framework of the lesson, including in independent cognitive research. Unlike traditional pedagogical technologies based primarily on reproductive cognitive activity, the project method teaches children to set goals on their own and find means to achieve them and teaches them responsibility for their actions.

If we apply the project method in mathematics lessons in the system, then students have positive dynamics in the development of general educational skills, skills, and methods of activity, namely: cognitive, information-communicative, and reflective activities

Particular attention should be paid to monitoring students in terms of the goal of the pedagogical activity, to organize their project activities in order to help everyone find an individual style of activity. This will allow the teacher to make adjustments to their pedagogical activities and optimally organize the educational process. Monitoring the general learning skills, skills and ways of students' activities allow us to draw a conclusion about the completeness, depth, awareness, and strength of their knowledge.

Conclusion

The conclusion will summarize the study's findings and provide recommendations for implementing PBL in mathematics education courses. The study's findings will contribute to the growing body of research on PBL and provide valuable insights for educators and policymakers interested in improving learner engagement and learning outcomes. Overall, PBL has several benefits for learners, including the development of 21st-century skills, a deeper understanding of content, and increased motivation and engagement. However, PBL also presents some challenges, including designing meaningful projects and assessing learner learning. To overcome these challenges, teachers can follow best practices, such as starting with clear learning objectives, providing guidance and support, encouraging collaboration, and using authentic assessments.

Based on the research of Kazakh and foreign scientists, the findings show that the implementation of PBL in mathematics lessons:

- allows learners to acquire practical skills;
- enhances the relationship between teachers and learners;
- improves communication between learners;
- assists teachers to maintain discipline and take in a sympathetic atmosphere in the classroom;
- develops definite talents and capabilities in learners;
- Offers learners real-world exercise.

Overall, PBL has the potential to transform education in Kazakhstan by promoting learner-centered learning and enhancing critical thinking and problem-solving skills. Its implementation in educational institutions across Kazakhstan shows promising results and offers a glimpse of a brighter future for education in the country.

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