

## Teaching Mathematics: The Role of Project-Based Learning

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**Abstract:** Project-Based Learning is a form of instruction that involves students in challenging, real-world projects which gives students an opportunity to investigate and build knowledge via practical application. Students actively participate in the project planning, execution, and evaluation processes, which promotes a sense of freedom and responsibility. Teams of students use their varied views and skills to solve complicated challenges. Their collaboration improves interpersonal, critical thinking, and communication abilities, reflecting the importance of teamwork in real-world workplaces. This article provides an overview of project-based learning, highlighting its key features and benefits in fostering critical skills and knowledge acquisition in mathematics learning.

**Keywords:** Project-Based Learning, Communication, Collaboration, Critical Thinking, Mathematics

### 1. Introduction

As stated by Thomas (2000) “Project-Based Learning is a model that organizes learning around projects” (p. 1). According to him projects are difficult tasks “based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations” (p. 1). Project-based learning (PBL) is a cutting-edge educational strategy that emphasizes student engagement, teamwork, and problem-solving in the real world. It is a form of instruction that involves students in challenging, real-world projects so they may investigate and build knowledge via practical application. PBL places less of an emphasis on rote memorization in the classroom than traditional methods do. Students are given the chance to research issues from the real world, develop hypotheses, plan experiments, and communicate their findings. PBL differs from traditional teaching techniques by incorporating a number of essential components. First, it places a focus on student autonomy, empowering learners to take charge of their learning process. Students actively participate in the project planning, execution, and evaluation processes, which promotes a sense of freedom and responsibility. Second, PBL is fundamentally based on collaboration. Teams of students use their varied views and skills to solve complicated challenges. Collaboration improves interpersonal, critical thinking, and communication abilities, reflecting the importance of teamwork in real-world workplaces.

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Fielding et al. (2007) makes it clear that “rigor, engagement, lesson purpose, and results are hallmarks of excellent instruction” (p. 231). It is possible to say that PBL involves all these characteristics. The advantages of project-based learning for students are numerous. As students take on challenging, open-ended problems, it improves their critical thinking and problem-solving abilities. PBL promotes critical thinking, creative problem-solving, and information analysis in students. PBL also encourages knowledge retention and greater understanding. Students gain a greater understanding of the significance and value of what they are studying by applying theoretical ideas to practical situations. This hands-on learning method encourages a deeper understanding of the material. PBL also fosters crucial 21st-century skills like collaboration, communication, and adaptability. Students get the necessary interpersonal, leadership, and teamwork skills to succeed in the modern workplace.

## **2. Literature Review**

According to Holm (2011) “Project-based learning, is a teaching methodology that utilizes student centered projects to facilitate student learning” (p. 1). More people are realizing that in order to succeed in the modern world, students need to acquire a variety of abilities that go beyond the classroom. PBL is a method of instruction that successfully develops key 21st-century skills including teamwork, communication, and adaptability (Larmer et al., 2015; Hallerman et al., 2011). PBL is fundamentally based on collaboration. Students participate in group projects to solve challenging issues or complete assignments. They acquire the ability to work well together through exchanging tasks, responsibilities, and resources. Students learn vital interpersonal abilities through teamwork, including active listening, empathy, and respect for different points of view. Students must communicate, reach an agreement, and compromise as part of collaborative assignments; these are all essential skills for working in various and interdisciplinary circumstances.

Additionally, another key development through project-based learning are communication skills. Throughout the project, students participate in conversations, presentations, and written reflections. They develop the ability to express their thoughts clearly, engage in active listening, and offer helpful criticism. In the current world, effective communication is crucial because it allows people to express their ideas, work together, and motivate others. Effective communication is vital in the present day because it allows people to clearly express their ideas, work with others in a variety of contexts, and inspire and motivate others to pursue similar objectives. In social, professional, and personal situations, it promotes relationships, fosters understanding, and leads to effective outcomes.

Another critical 21st-century potential that PBL fosters is adaptability. Students work on actual, real-world challenges through project-based learning that may have several solutions or call for flexibility in approach. As new information becomes available, they learn to improvise, change their techniques, and revise their plans. This capacity for adaptation equips students for the fast-paced environment of the contemporary workplace, where they will unavoidably face difficulties that call for adaptability and creative problem-solving. Moreover, project-based learning naturally fosters other crucial abilities like creativity, critical thinking, and self-direction. Students develop their ability to think critically, examine data, and balance opposing viewpoints by working on open-ended projects. They are encouraged to think creatively, come up with original solutions, and take control of their education. Buck Institute for

Education (2014) claims that “PBL is a rigorous, relevant, and engaging instructional model that supports authentic inquiry and autonomous learning for students” (p. 6).

The eight significant features of PBL are (Philen, 2016, p.24):

1. Key Knowledge, Understandings and Success Skills
2. Authenticity
3. Sustained Inquiry
4. Challenging Problem or Question
5. Reflection
6. Voice and Choice
7. Critique & Revision
8. Public Product

Project-based learning (PBL) has attracted an abundance of attention recently as a productive teaching strategy in a number of subject areas, including mathematics. PBL incorporates practical issues, cooperative cooperation, and hands-on activities to actively include students in their learning process. Students are exposed to difficulties or challenges from the real world that provide opportunities for the use of their knowledge and abilities. They collaborate with their classmates and solve challenges by sharing ideas and resources through cooperative cooperation. Students can actively participate and develop a greater understanding of the topic matter through practical application through hands-on activities, which offer experiential learning opportunities.

Project-based learning offers an alteration from the typical classroom environment and gives students the chance to use mathematical concepts in practical settings. Students learn the value and meaning of mathematical concepts beyond abstract formulas and equations by working on real-world projects. Students must comprehend the concepts of geometry, measurement, and structural stability, for instance, in order to design and build a bridge. Students are better able to understand mathematical ideas as they go through these problems because they can see how they are directly applied in real-world situations.

The capacity of project-based learning in mathematics to improve critical thinking and problem-solving abilities is one of its main benefits. Students are encouraged to consider critically, reason, and connect various mathematical concepts rather than just memorizing formulas. Students gain the ability to think creatively, recognize patterns, and develop original ways for finding solutions by working on complicated, open-ended problems. By involving students in genuine, real-world problems, project-based learning in mathematics strengthens students' critical thinking and problem-solving skills. It fosters an increased awareness of mathematical concepts and their practical application through the reinforcement of logical reasoning, pattern recognition, and the creation of multiple strategies.

Without placing sufficient focus on the underlying logic and problem-solving abilities, traditional approaches to mathematics education frequently highlight memorization of formulas and procedures. PBL, on the other hand, offers a useful substitute by immersing students in genuine, real-world mathematics issues. Students in project-based learning are given challenging, open-ended challenges that call for the analysis, evaluation, and application of mathematical ideas. They are urged to exercise critical

thought, divide the issue into components, and come up with numerous solutions. This procedure develops their capacity for logical thought, pattern recognition, and the ability to link various mathematical ideas.

Apart from that, project-based learning encourages students to participate in problem-solving activities that correspond to real-world situations. Students attain a deeper comprehension of how mathematics is used in many circumstances by solving real-world challenges. They improve understanding of the importance and applicability of mathematical ideas and develop more learning motivation. Plus, PBL promotes excellent teamwork and collaboration by encouraging students to work cooperatively in groups. Students who work together to solve problems can exchange ideas, discuss various strategies, and cultivate insight from one another's viewpoints. They build vital interpersonal skills and learn how to use group intelligence to generate the best answers through this process. Students who participate in project-based mathematics learning demonstrate more strength in the face of difficulties. Trial and error is a common part of projects, and students learn from their errors and modify their approaches as necessary. Through this iterative process, they develop stronger problem-solving abilities and a growth attitude, which encourages confidence in their own capacity for overcoming challenges.

Additionally, PBL develops students' capacity for productive teamwork. Students must share their ideas, consider the viewpoints of their peers, and come to a decision as a group when working on group projects in mathematics. Students gain negotiation and compromise skills as well as a shared comprehension of the issue at hand through collaborative learning. These abilities are essential for success in math as well as other areas of life since they prepare students for their future academic and professional pursuits.

Project-based learning goes beyond merely understanding the fundamentals of mathematical ideas. Students gain a profound understanding of the underlying principles through working on projects that call for application and analysis. Students can identify the connections between many mathematical concepts through projects, which offer a comprehensive view of mathematics.

PBL also encourages students to look at issues from various perspectives, which results in a deeper comprehension of mathematical ideas. Students are encouraged to look for alternative solutions, test hypotheses, and consider their methods as they come across difficulties and barriers while working on their projects. PBL in mathematics helps students to investigate issues from various angles, which results in a deeper understanding of mathematical concepts. Students work on projects and come across various methods, answers, and interpretations of mathematical ideas. This exposure to other experiences encourages a more thorough knowledge of the subject. Students who take into account multiple points of view expand their understanding of mathematics and gain understanding of how various mathematical concepts are related to one another. Their capacity to think critically, connect ideas, and understand the complexity and beauty of mathematical ideas is improved by this multi-dimensional inquiry. With the help of this method, students can develop strong problem-solving skills and a growth attitude.

### **3. Conclusion**

An innovative teaching strategy that fosters teamwork, critical thinking, and problem-solving abilities is project-based learning. PBL encourages greater learning, knowledge retention, and the development of crucial skills needed in the twenty-first century by involving students in real-world, practical projects.

Project-based learning is a potent tool for empowering and inspiring students as education changes to meet the demands of a changing world.

Math project-based learning offers a dynamic and efficient method for involving pupils and enhancing their mathematical abilities. PBL helps students better understand mathematical ideas and develop critical thinking abilities by incorporating real-world situations, cooperative cooperation, and critical thinking. Students develop a greater understanding of the real-world uses of mathematics via hands-on projects, inspiring a passion for the subject that lasts a lifetime. Project-based learning is a formidable tool for educators to unleash students' potential and revolutionize mathematics education as they work to design meaningful learning experiences.

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