Available on: https://jsshrs.ep-journals.org/ E-ISSN: 3051-3561 P-ISSN: 3051-3553

Journal of Social Science and Human Research Studies

Volume: 01 Issue: 06 December-2025

Using Project-Based Learning in Elementary Mathematics Instruction

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Published Date: December 31, 2025 **Article DOI: 10.65150/EP-jsshrs/V1E6/2025-12**

ABSTRACT: In the context of competency-based educational reform, the adoption of active instructional approaches in elementary mathematics has become increasingly essential. This study explores the application of project-based learning (PBL) in the design of mathematics instruction for elementary students through a four-step process: goal identification, planning, implementation, and evaluation. First, learning objectives are defined in alignment with curriculum requirements and students' cognitive characteristics. Second, project plans are developed by designing meaningful tasks, organizing collaborative learning activities, and specifying expected learning products. Third, students engage in project implementation by collaboratively addressing real-world problems and applying mathematical knowledge under teacher guidance. Finally, learning outcomes are evaluated through both process- and product-oriented assessment, integrating teacher assessment, self-assessment, and peer assessment. The findings suggest that implementing PBL through a structured four-step process enhances student engagement and supports the development of mathematical competence, problem-solving skills, collaboration, and the ability to apply mathematics in authentic contexts.

KEYWORDS: Project-based learning; elementary mathematics; mathematical competence; instructional design

1. INTRODUCTION

In the context of 21st-century education, increasing emphasis has been placed on developing problem-solving skills, critical thinking, and the ability to apply knowledge to real-life situations, particularly at the elementary level. Elementary mathematics education has undergone fundamental changes, shifting from a primary focus on knowledge transmission and routine computational skills toward the development of mathematical thinking and reasoning**,** mathematical modeling**,** mathematical problem-solving**,** mathematical communication, and the effective use of mathematical tools and learning resources. In addition, the mathematics curriculum promotes integrated problem-solving across disciplines, linking mathematics with subjects such as physics, chemistry, biology, geography, computer science, technology, history, and the arts. This approach creates meaningful opportunities for students to experience mathematics and apply mathematical knowledge in real-world contexts (Ministry of Education and Training, 2018).

Approaching project-based learning reveals that it is a learner-centered instructional method in which students actively engage in inquiry, address real-world problems, and produce meaningful products. This approach is grounded in the progressive educational philosophy of William Heard Kilpatrick. According to Kilpatrick (1926), when learners participate in a given situation, they may exhibit different forms of behavior depending on how their needs are satisfied. He argued that individual behavior is influenced by the extent to which personal needs are fulfilled; stimuli that generate satisfaction or frustration lead to corresponding learner responses manifested through their actions. From this perspective, intellectual capacity plays a guiding role in directing individuals' activities toward specific goals that are expected to satisfy their needs. Kilpatrick further emphasized that human behavior is goal-oriented, with learning emerging as individuals strive to achieve goals that bring personal satisfaction. Learning motivation, therefore, represents the connection between an individual's readiness to act consciously and the pursuit of self-determined goals. Accordingly, the learning process begins with the identification of a goal, followed by exploration and reasoning about possible ways to achieve that goal, engagement in purposeful practical activities, and ultimately the experience of satisfaction upon goal attainment. This sequence facilitates meaningful learning and underpins the theoretical foundation of project-based learning (Kilpatrick, 1918; Beineke, 1998)

Project-based learning (PBL) has attracted considerable attention from educational researchers due to its effectiveness in enhancing learning skills and fostering critical thinking. Harasym et al. (2013) argue that the use of project-based learning can promote students' critical thinking and contribute to the development of ethical reasoning. Similarly, Schmidt, Rotgans, and Yew (2011) emphasize the important role of PBL in activating prior knowledge and facilitating the construction of new understanding. They suggest that working in small groups not only encourages collaboration but also enhances students' long-term retention of knowledge.

Krajcik and Shin (2014) contend that PBL helps overcome superficial learning by enabling learners to develop deep conceptual understanding through the application of knowledge to complex problems similar to those encountered in professional practice. The authors highlight that PBL is particularly well suited to the context of 21st-century education, where learners are expected to develop problem-solving, critical thinking, and collaboration skills. From a theoretical perspective, Sutinen (2013) compared Kilpatrick's project method with Dewey's

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problem-solving method, noting that although both approaches emphasize learning through action, they differ in their goals and pedagogical orientations.

Thomas (2000) proposed five essential criteria for defining authentic project-based learning: (1) projects constitute the core of the curriculum; (2) projects are organized around driving questions or problems; (3) learners engage in constructive inquiry; (4) projects allow a high degree of learner autonomy; and (5) projects are closely connected to real-world contexts. These criteria have since served as a foundational theoretical framework for subsequent PBL research.

Beyond learning outcomes, several studies have demonstrated that students engaged in project-based learning achieve higher academic performance and develop more positive attitudes toward learning, particularly in science education. Research findings indicate that PBL not only improves academic achievement but also strengthens students' self-efficacy beliefs and learning attitudes (Bilgin et al., 2015; Kurt & Akoglu, 2023). In addition, the effectiveness of PBL has been documented in mathematics and science education (Jacques, 2017; Wilhelm et al., 2008). Although PBL has been successfully applied across various educational domains, Kurt and Akoglu (2023) emphasize that its implementation faces several challenges, including teachers' project design capacity, time constraints, and difficulties in assessing student learning outcomes.

However, many scholars emphasize that the effectiveness of project-based learning largely depends on the quality of project design, the level of instructional support provided by teachers, and the use of appropriate assessment systems (Harasym et al., 2013; Pedersen & Hobye, 2020). This highlights the need for further research focusing on the design, implementation, and evaluation of project-based learning in specific subject areas and educational levels. Accordingly, this paper presents key theoretical issues related to project-based learning, including its characteristics and instructional process, and examines its application in elementary mathematics instruction through a concrete project example. The proposed project serves as a practical reference for elementary teachers, supporting them in improving instructional effectiveness and enabling students to achieve the intended learning objectives of the mathematics curriculum.

Project-Based Learning in Teaching

According to Michael Knoll, Kilpatrick's project method primarily focuses on students' learning processes. As a result, the instructional role of the teacher is not clearly articulated within this approach. The central idea of the project method lies in fostering students' intellectual and cognitive development; however, how teachers should organize instructional activities to ensure that learning occurs in accordance with the principles of the project method has not been sufficiently clarified (Campbell, 1995).

Nevertheless, Kilpatrick (1918) argued that the teacher's role is to support the learning process and facilitate students' cognitive development. In this sense, teachers act as facilitators who guide students either directly or indirectly in developing their understanding. The teacher's responsibility is to create learning situations and experiences that motivate students to engage in the learning process and achieve the intended goals (Kilpatrick, 1918; Beineke, 1998; Tenenbaum, 1951).

Based on these perspectives on learning and the role of teachers in project-based learning, the concept of project-based learning in instruction can be defined as follows: Project-based learning is an instructional method in which students undertake complex learning tasks that integrate theory and practice in order to produce a tangible product (Nguyen Huu Hop, 2018).

Characteristics of the Project Method in Teaching and Learning Organization

When implementing the project method, teachers need the capacity to assess learners' situations and to propose motivating tasks that encourage students' active engagement and cognitive development—tasks that essentially constitute a project (Kilpatrick, 1918; Beineke, 1998; Tenenbaum, 1951). In addition to assessing individual learners, teachers must also be able to conduct social assessment in order to design situations and projects that align with educational objectives. Accordingly, teachers' responsibilities include evaluating the applicability of projects to social life, moral development, and democratic values, while ensuring that instructional activities correspond to the demands of the project—namely, that they genuinely reflect learners' interests and concerns regarding the proposed tasks (Kilpatrick, 1918; Tenenbaum, 1951). A particular challenge faced by teachers is how to sustain learners' interest in projects for as long as possible and in a purposeful manner (Kilpatrick, 1918). From this perspective, the key characteristics of the project method in organizing educational activities can be summarized as follows:

- **Practice-oriented focus:** Project topics are derived from real-life situations in social contexts, professional practice, and everyday life. Project tasks should involve problems that are appropriate to learners' developmental levels and cognitive capacities. Learning projects with social relevance help connect school-based learning with real-life and societal contexts. Under ideal conditions, project implementation may generate positive social impacts.
- **Learner-interest orientation:** Students are involved in selecting project topics and learning content that match their abilities and personal interests. Moreover, learners' interests should be continuously fostered throughout the project implementation process.
- **Complex and interdisciplinary nature:** Project content integrates knowledge from multiple disciplines or subject areas in order to address complex tasks or problems.
- **Action orientation:** Project implementation involves a combination of theoretical inquiry and the application of theory to practical and hands-on activities. Through this process, theoretical understanding is examined, reinforced, and expanded, while learners' action skills and practical experience are developed.
- **Learner autonomy:** In project-based learning, students are expected to actively and independently participate in all stages of the instructional process. This requirement both demands and promotes learners' responsibility and creativity. Teachers primarily assume the roles of advisors, facilitators, and supporters. However, the level of learner autonomy should be appropriate to students' experience, capabilities, and the complexity of the tasks.
- **Collaborative work:** Learning projects are typically carried out in groups, involving collaboration and task distribution among group members. Project-based learning requires and cultivates readiness and skills for teamwork among participants, including collaboration among

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students, between students and teachers, and with other social stakeholders involved in the project. This characteristic is also referred to as the social dimension of learning.

- **Product orientation:** During project implementation, the outcomes are not limited to theoretical gains; in most cases, learning projects result in tangible products derived from practical and hands-on activities. These products may be used, disseminated, or presented publicly.

2. RESULTS AND DISCUSSION

Process of Implementing the Project Method in Teaching

From the perspective of learners' psychological development during the learning process, Kilpatrick proposed a theoretical framework for the project method consisting of four distinct phases.

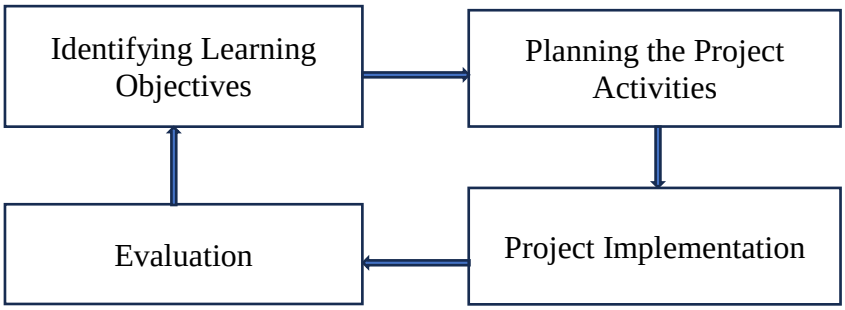


Figure 1. Kilpatrick's Theory of the Project Method (Kilpatrick, 1918, p. 333)

Figure 1 illustrates that William Heard Kilpatrick's learning theory is grounded in four stages. These include: (1) identifying objectives in order to generate learners' motivation to engage in a project and their readiness to achieve a specific goal through their own actions; (2) consciously planning individual actions; (3) undertaking practical actions to achieve goals that are feasible and attainable; and (4) evaluating the degree of satisfaction with the outcomes achieved. Kilpatrick argued that a learning activity cannot be effectively motivated if learners do not clearly understand the object of their motivation. Likewise, planning and realizing an activity are not possible without a consciously defined goal toward which learners are directed. If learners wish to evaluate something, they must have a point of reference for what is being evaluated—namely, the goal established for the activity. When learners act in order to achieve a defined goal, Kilpatrick conceptualized this process as learning (Kilpatrick, 1918).

An example of motivation-driven learning connected to a process is illustrated through students constructing a kite, as presented in Kilpatrick's theory of the project method. Stage 1: Identifying the goal, which is to construct a kite and make it fly. Stage 2: Planning how to construct the kite properly, determining what knowledge and skills are required and how the kite can be made to fly. Stage 3: Implementing reflective thinking about the characteristics of the kite and identifying ways to achieve the intended outcome. Students then take action based on their explorations to make the kite fly, thereby generating a sense of satisfaction. Stage 4: Evaluating the outcomes of the kite-making process described above, which represents the learning process as it unfolds.

Mathematics Content at the Primary School Level Applicable to the Project-Based Learning Method

Table 1: Elementary Mathematics Contents Suitable for Project-Based Learning

No.	Grade	Mathematics Content	Example Project
1	Grade 1	Counting and comparing numbers within 10–20; basic geometric shapes	Exploring Objects Around Me
2	Grade 1	Comparing lengths (longer–shorter)	Measuring School Supplies
3	Grade 2	Addition and subtraction within 100	My Mini Shop
4	Grade 2	Length measurement (cm, m)	Measuring Our Classroom
5	Grade 2	Time concepts (hour, day)	My Daily Schedule
6	Grade 3	Multiplication and division	Childhood Market
7	Grade 3	Perimeter of rectangles	Designing a Mini Vegetable Garden
8	Grade 3	Measurement of mass and capacity	Planning a Healthy Meal
9	Grade 4	Fractions	Sharing Household Tasks
10	Grade 4	Area of plane figures	Designing a Green Classroom
11	Grade 4	Data collection and representation (charts, graphs)	Surveying Reading Habits
12	Grade 5	Ratio and percentage	Planning a Class Event Budget
13	Grade 5	Area and volume of solid figures	Designing a Children's Playground
14	Grade 5	Integrated real-life word problems	Saving Electricity and Water at School

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Designing Mathematics Lessons in Primary Education

In applying the project-based learning method to the teaching of Mathematics at the primary level, we implemented a model lesson on the topic of **area and volume of geometric figures** (Grade 5 Mathematics) as follows:

- **Content:** Area and Volume of Geometric Figures
- **Project Title:** *Designing a Children's Playground*
- **Duration:** Two class sessions

Procedure	Teacher's Activities	Students' Activities	Purpose of Transformation
Objectives	• Apply knowledge of the area and volume of geometric figures (rectangles, squares, rectangular prisms, cubes, etc.) to a real-world context. • Develop problem-solving competence, mathematical thinking, and mathematical modeling skills. • Foster skills in planning, teamwork, presentation, and reporting of results. • Create a problem situation by posing the question: *"If your school had an empty plot of land, how would you design a playground for younger students?"* • Organize students into groups to discuss and identify the objectives of the project. • Conclude by clarifying the project objectives, product requirements, and the timeline for implementation.	• Listen to the problem situation and share initial ideas. • Participate in group discussions to identify the objectives to be achieved (designing a playground, calculating area and volume). • Record the agreed-upon objectives and reach consensus on group tasks.	Identify the expected learning outcomes and performance requirements for learners in implementing the project.
Project Implementation	**Task Assignment** • Organize students into groups to collaboratively carry out the assigned task: designing a playground within a given area. • Provide suggested components, such as a play area, sandbox, activity zone, and walkways. • Emphasize the requirement to apply mathematical knowledge, particularly concepts related to area and volume.	• Receive the assigned task and ask clarifying questions about the requirements. • Discuss and select appropriate project components. • Identify the mathematical content and concepts to be applied.	• Apply knowledge of the area and volume of geometric figures (rectangles, squares, rectangular prisms, cubes, etc.) to a real-world context.
	• Guide students in developing a project plan. • Help identify the necessary knowledge and skills required for implementation. • Observe and monitor the working process of the groups.	• Engage in group discussions to determine the sequence of tasks. • Assign responsibilities to group members in accordance with individual abilities. • Develop a plan for carrying out the tasks. • Calculate the area and volume of the selected components. • Complete the project products (drawings, models, and reports).	• Develop problem-solving competence, mathematical thinking, and mathematical modeling skills. • Strengthen skills in planning and collaborative teamwork.
	• Provide support when students encounter difficulties. • Remind students to ensure adherence to the project timeline.	Each member carries out their assigned tasks in accordance with the specified timeline.	Develop skills in teamwork, presentation, and reporting of results.

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<table>
<tr><td rowspan="2">Assessment</td><td>• Evaluate the accuracy and feasibility of the financial plan.
• Assess the creativity and effectiveness of the proposed financial solutions.</td><td>• Group representatives present the design and the calculation methods.
• Conduct self-assessment and peer assessment among groups.</td><td>Transformation Outcomes Achieved in Relation to the Objectives</td></tr>
<tr><td colspan="3"><table>
<tr><th>Assessmen Criteria</th><th>Description of Requirements</th><th>Maximum Score</th></tr>
<tr><td>1. Application of mathematical knowledge</td><td>Accurately calculate the area and volume of the components and clearly present the calculation procedures.</td><td>3.0</td></tr>
<tr><td>2. Design of the project product</td><td>Ensure a logical and clear layout; provide a design that is feasible and appropriate to real-world conditions.</td><td>2.0</td></tr>
<tr><td>3. Solving real-world problems</td><td>Propose reasonable design solutions with practical applicability.</td><td>2.0</td></tr>
<tr><td>4. Collaboration and participation in group activities</td><td>Participate actively, demonstrate a cooperative attitude, and complete assigned tasks.</td><td>1.5</td></tr>
<tr><td>5. Presentation and reporting of the project product</td><td>Present ideas clearly and coherently, using appropriate mathematical language.</td><td>1.5</td></tr>
<tr><td>Total</td><td></td><td>10.0</td></tr>
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3. CONCLUSION

The findings indicate that applying the project-based learning method in primary mathematics teaching enables teachers to appropriately identify core mathematical content and the competencies to be developed in students, to align learning objectives with specific learning activities, and to create conditions for students to engage in meaningful and appropriately challenging tasks. Through this approach, students' problem-solving competence, mathematical thinking, and teamwork skills are effectively fostered. The assessment phase does not focus solely on the final product but also emphasizes the evaluation of the learning process, thereby supporting students' self-regulation and the refinement of acquired knowledge and skills. Project-based instructional activities can be implemented beyond the traditional classroom setting, transforming the learning environment and increasing students' learning motivation. In addition, students are provided with opportunities to present their products, which contributes to the development of presentation skills and the ability to analyze the value of their work. The study confirms that the application of the project-based learning method following a four-stage process constitutes an appropriate and feasible approach for teaching mathematics at the primary level, contributing to improved instructional effectiveness and enhanced student learning outcomes. The results may serve as a useful reference for teachers and educational administrators in designing and organizing mathematics teaching activities in line with current educational reform orientations. Nevertheless, like any instructional method, project-based learning has both strengths and limitations. This study primarily highlights its strengths in promoting students' active engagement in learning, providing opportunities for problem solving, and integrating knowledge from multiple subject areas during the completion of project products. However, the application of this method is time-consuming and may pose challenges in accurately assessing individual competencies once a group product has been completed. Therefore, teachers need to design lessons in a highly structured manner and closely monitor the implementation process in order to mitigate these limitations.

REFERENCES

1) Beineke, J. A. (1998). *And There Were Giants in the Land. The life of William Heard Kilpatrick* . New York, Peter Lang.
2) Bilgin. I, Karakuyu. Y, Yusuf Ay. (2015). The Effects of Project Based Learning on Undergraduate Students' Achievement and Self-Efficacy Beliefs Towards Science Teaching. Eurasia Journal of Mathematics, Science and Technology Education. EURASIA J Math Sci Tech Ed, Volume 11, Issue 3, 469-477. https://doi.org/10.12973/eurasia.2014.1015a
3) Campbell, J. (1995). *Understanding John Dewey. Nature and cooperative intelligence.* Chicago and La Salle, IL, Open Court.
4) Harasym, H. P., Tsai, T. C., & Munshi, F. M. (2013). Is problem-based learning an ideal format for developing ethical decision skills? *Kaohsiung Journal of Medical Sciences*, 29(9), 505– 511. https://doi.org/10.1016/j.kjms.2013.05.006
5) Jacques L.A. (2017). What does project-based learning (PBL) look like in the mathematics classroom. *American Journal of Educational Research*, 5(4): 428–433. https://doi.org/10.12691/education- 5-4-11.
6) Kilpatrick, W. H. (1918). *The Project Method.* Teachers College Record.
7) Krajcik JS, Shin N. Project-Based Learning. In: Sawyer RK, ed. The Cambridge Handbook of the Learning Sciences. Cambridge Handbooks in Psychology. Cambridge University Press; 2014:275-297.
8) Kurt, G., & Akoglu, K. (2023). Project-based learning in science education: A comprehensive literature review. *Interdisciplinary Journal of Environmental and Science Education, 19*(3), e2311. https://doi.org/10.29333/ijese/13677

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9) Ministry of Education and Training. (2018). *General education program with experiential activities and experiential and career guidance activities*, issued together with Circular No. 32/2018/TT-BGDDT dated December 26, 2018 of the Minister of Education and Training.
10) Nguyen, Huu. Hop. (2018). *Designing lessons to develop primary students' competencies*. Hanoi: Vietnam National University of Education Publishing House.
11) Pedersen, S., & Hobye, M. (2020). Implications of assessing student-driven projects: A case study of possible challenges and an argument for re exivity. Education Sciences, 10(1), 19. https://doi.org/10.3390/educsci10010019
12) Schmidt H. G, Rotgans J. I & Yew E. H. J. (2011). The process of problem-based learning: What works and why. *Medical Education*, 45(8):792–806. https://doi.org/10.1111/j.1365-2923.2011.04035.
13) Sutinen, A. (2013). Two project methods: Preliminary observations on the similarities and differences between William Heard Kilpatrick's project method and John Dewey's problem-solving method. *Educational Philosophy and Theory*, 45(10):1040–1053. https://doi.org/10.1111/j.1469- 5812.2011.00772.
14) Tenenbaum, S. (1951). *William Heard Kilpatrick: Trail blazer in education* . New York, Harper & Brothers.
15) Thomas, J. W. (2000). A review of research on project-based learning. Autodesk.
16) Wilhelm, J, Sherrod, S & Walters, K. (2008). Project-based learning enviroments: Challenging perservice to act in the moment. *The Journal of Educational Research*, 101(4):220–233. https://doi.org/10.3200/JOER.101.4.220-233

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