COMMENTARY

Tapping into the Potential of Project-Based Learning by Exploring the Core Elements in Its Implementation

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"The whole of science is nothing more than a refinement of everyday thinking."
-Albert Einstein

PROJECT-BASED learning (PBL) is a student-centered instructional approach (Bhat & Dar, 2023), with which, students learn by actively engaging in a complex project that involves activities like project design, problem-solving, decision-making, and investigation. A project in PBL typically entails challenging questions or tasks, and students develop knowledge and skills through inquiry and problem-solving over an enduring period. PBL's benefits are many, such as the capability to enhance student motivation levels and cognitive engagement in the learning process (Blumenfeld et al., 1991) and its potential to improve students' language proficiency, critical thinking ability, and communication skills in language education (Du & Han, 2016). Benefits like these have drawn wide attention of the education world to PBL, leading to its popularity and large-scale application at all education levels. On the other hand, certain studies find that PBL does not suit all subjects and students (Aristidou, 2020) and may demand excessive time and resources. In heavily loaded courses with inadequate equipment of teaching resources, PBL's outcomes can be hampered (Handrianto & Rahman, 2018). Also, enacting PBL poses additional challenges to both the teacher's instructional organization and the students' learning attitudes. Nevertheless, its benefits by far outweigh its shortcomings. To fully utilize the former, it is necessary to develop thorough understanding of the essential elements in PBL's implementation.

Larmer and Mergendoller (2010) identify seven essential elements of meaningful PBL. (i) A need to know: Instead of making the project feel like busywork, the teacher can successfully activate students' need to know content by initiating it with an "entry event" that engages interest and sparks questioning. An entry event can be almost any

thing: a video, a lively discussion, a guest speaker, a field trip, or a piece of mock correspondence that sets up a scenario. (ii) A driving question: A good driving question captures the heart of the project in clear, compelling language, which gives students a sense of purpose and challenge. The question should be provocative, open-ended, complex, and linked to the core of what the teacher wants students to learn. (iii) Student voice and choice: It is important to ensure students' autonomy in implementing the project, allowing them the freedom to choose the topic within the driving question, research method, and what product to create. Meanwhile, the teacher can decide on the range of choice according to their own teaching style and students' actual needs. (iv) 21st century skills: A project should give students opportunities to build such 21st century skills as collaboration, communication, critical thinking, and the use of technology. A teacher in a project-based learning environment explicitly teaches and assesses these skills and prompts students to frequently assess themselves. (v) Inquiry and Innovation: In PBL, students begin with their own questions, search for resources and the discovery of answers, and ultimately generate new questions, test ideas, and draw their own conclusions. With real inquiry comes innovation, i.e., a new answer to a driving question, or a new product, or an individually generated solution to a problem. (vi) Feedback and revision: Formalizing the processes of feedback and revision during a project helps raise the awareness of creating high-quality products and performances in students. There are different forms of feedback to be adopted in PBL, including direct feedback from the teacher, mutual evaluation of each other's work in students, and feedback from experts or adult mentors. (vii) A publicly presented product: When students need to present their work to a real audience, they care more about its quality. The audience can include parents, peers, and members of the community. In addition, a few specific models for PBL's implementation have been advanced, such as the six-, eight-, and ten-step models (Du & Han, 2016). Despite the variations in their processes, all these models share the following pivotal steps: defining the question, laying out the plan, enacting research activity like investigation, drawing conclusions, presenting and evaluating the project product.

Exploration of PBL's theories and practical applications is ongoing. Systematic surveys of existing practical cases and research experiences help pinpoint central elements in PBL's implementation, providing valuable references and insights for future research and practices. *Implementation of Project Based Learning (PjBL) in Mathematics Education: A Systematic Analysis of International Practices and Theoretical Foundations* in this issue is an encapsulation of PBL applications in global mathematics education and its theoretical underpinnings. The research results of the study reveal that PBL is effective in improving students' academic achievement and 21st century skills but also faces challenges in its execution, such as inflexible schedules and inadequacies in professional skills of teachers. Also, the study gives a summary of the core implementation steps for PBL in mathematics teaching, which offers implications for improving PBL' implementation in other subjects (Himmi, 2025).

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