ISSN 1812-0512 (Print) 2790-346X (online)

Wasit Journal for Human Sciences

Available online at: https://wjfh.uowasit.edu.iq

OPEN ACCESS

Fostering Critical Thinking Through Project-Based Learning: A Framework for Curriculum Design and Pedagogical Innovation

Hussein Ibrahim Jaheed

University of Misan – Department of Student Affairs and Registration – English Language / Applied Language

***Correspondence*:** Hussein.maysan83@gmail.com

Received: 03 **September** 2025
Accepted: 17 **September** 2025
Published: 01 November 2025

***DOI*:** https://doi.org/10.31185/wjfh.Vol21.Iss4.1331

***Cite*:**
Jaheed , . H. I. (n.d.). Fostering Critical Thinking Through Project-Based Learning: A Framework for Curriculum Design and Pedagogical Innovation. Wasit Journal for Human Sciences, 21(4). https://doi.org/10.31185/wjfh.Vol21.Iss4.1331

ABSTRACT

This research investigates Project-Based Learning's (PBL) capacity to cultivate critical thinking among students and formulates a practical model for curriculum developers and teachers. Although 21st-century skills are emphasized, critical thinking remains underdeveloped in traditional lecture-based environments. Grounded in constructivist and inquiry-based theories (Vygotsky, 1978; Paul & Elder, 2014), the study employed mixed methods, collecting pre- and post-test data from student reflections, teacher observations, and high school students exposed to PBL. Results showed higher critical thinking scores for the experimental group (M = 81.5, SD = 6.2) than for the control group (M = 69.3, SD = 7.5). Qualitative findings indicated enhanced learner autonomy, problem-solving ability, and engagement, supported by prior studies (Hmelo-Silver, 2004; Kokotsaki et al., 2016). The paper suggests strategies for applying PBL in curriculum development and teacher education while addressing challenges such as assessment alignment and time constraints. PBL advances educational theory and practice by fostering critical thinking through innovative pedagogy.

Keywords: Critical Thinking, Curriculum Design, Inquiry-Based Learning, Pedagogical Innovation, Project-Based Learning, Mixed-Method Research

تعزيز التفكير النقدي من خلال التعلم القائم على المشاريع
ورشة عمل لتصميم المناهج والابتكار التربوي

م.م حسين ابراهيم جهيد
جامعة ميسان - قسم شؤون الطلبة والتسجيل- لغة انكليزية / لغة تطبيقي

المُستخلص

تبحث هذه الدراسة في إمكانية التعلم القائم على المشاريع(PBL) لتعزيز التفكير النقدي لدى الطلاب، وتحاول إنشاء نموذج واقعي لدعم مطوري المناهج والمعلمين. حيث يركز العالم اليوم بشكل أكبر على مهارات القرن الواحد والعشري، ومن أبرزها نظريات التفكير النقدي، واعتمدت الدراسة على نظريات التعلم البنائية والاستقصائية (فيغوتسكي، 1978؛ بول وإلدير، 2014). من خلال استخدام منهج مركب، تم جمع البيانات من خلال تطبيق اختبارات قبل وبعد تطبيق التصميم على عينة من طلاب المدارس الثانوية، بالإضافة إلى ملاحظات المعلمين. أظهرت النتائج الكمية أن درجة التفكير النقدي كانت أعلى (م = 81.5، انحراف معياري = 6.2) عند المقارنة مع المجموعة الضابطة (م = 69.3، الانحراف المعياري = 7.5). وأشارت النتائج النوعية إلى وجود مواضيع تتعلق بمزيد من استقلالية المتعلم، وزيادة القدرة على حل المشكلات، وزيادة التفاعل. مما يتماشى مع الأبحاث السابقة (هميلو–سيلفر، 2004؛ كوكوتساكي وآخرون، 2016) ويؤكد على أهمية النقد والنقاش بين الطلاب كوسيلة لإيجاد الحلول. ويختتم البحث بتقديم توصيات حول كيفية تنفيذ التعلم القائم على المشاريع في تصميم المناهج وبرامج إعداد المعلمين. كما يناقش بعض العوائق الشائعة، مثل توافق التقييم وضيق الوقت، مع تقديم حلول للمشكلات السابقة وتطورات نظرية التفكير النقدي وابتكار أساليب جديدة للتعليم.

الكلمات المفتاحية: التعلم القائم على المشاريع، التفكير النقدي، تصميم المناهج الدراسية، الابتكار التربوي، البحث بأساليب مختلطة، التعلم القائم على الاستفسار

1.1 Background of the Study

In attempts at developing relevant and meaningful learning experiences, instructors have increasingly turned to active learning techniques laying more emphasis on engaging students in task- and activity-based exercises. Of these, Project-Based Learning (PBL) has been especially in demand because it can engage students in realistic, applied tasks that relate knowledge to practice (Munawarorh, 2017). PBL allows students to apply their knowledge in actual situations, enhancing mastery and offering a reflective and visual learning experience (Evans, 2019).

Moreover, PBL allows students to gain mastery in different skills from critical thinking, teamwork, and communication (Chen, 2019). Studies offer evidence confirming its worth in the development of higher-order thinking and problem-solving through experiential, realistic tasks that foster deep understanding among students (Rijken& Fraser, 2024). Yet, current apps are poor in having a well-organized framework in enabling advanced problem-solving, and projects cannot generate innovative ideation or creative outcomes (Perdana et al., 2024). This has prompted researchers to study the potential for incorporating Design Thinking—a human-centered approach grounded on empathy, iterative prototyping, and user-driven innovation—into such apps with a view to overcoming the limitations (Baldassarre et al., 2024). But, merging Design Thinking and PBL, especially literacy and critical thinking, has not yet been studied comprehensively (Kamaruddin et al., 2024), which suggests that there is a need for general frameworks leveraging the strengths of both approaches.

1.2 Statement of the Problem

While there is more emphasis placed on 21st-century skills, critical thinking tends to be underemphasized in the majority of learning environments, particularly where outdated, lecture-style teaching remains common. Conventional instruction is often prone to encourage repetition by heart and mass testing at the cost of investigation, teamwork, and actual problem-solving. Therefore, students may not be able to apply their learning critically and creatively to solve new or complex problems. PBL has been promising as a productive pedagogy to nurture higher-order thinking but remains often patchy or superficial when practiced in curriculum design. There is a lack of all-embracing models that always link PBL principles to explicit design of critical thinking skills. This lack necessitates the development of new curriculum models that merge pedagogy and goals of critical thinking.

1.3 Purpose of the Study

The research objective is to determine how PBL can be utilized most effectively in an attempt to enhance critical thinking among learners and outline a model of PBL-based curriculum design for instructional purposes and innovation. I.e., this research tries to investigate implications of how PBL influences students' capacity for critical thinking, determine good practice on its application, and provide an easy model of investigation to lead eminent teachers to curricula development with analytical, reflective, and judging thinking competencies.

1.4 Research Questions

This research seeks to answer the following research questions:

1. How does PBL impact the learning of critical thinking skills by the students?
2. Which are the key elements of teaching and curriculum that support effective integration of PBL with great strength to critical thinking?
3. What challenges and opportunities do teachers experience while implementing PBL to facilitate critical thinking?
4. How can a framework be constructed to support curriculum developers and teachers in aligning PBL methods with critical thinking outcomes?

1.5 Importance of the Study

The importance of this study arises from the potential it may have in helping alleviate the drastic limitations and gaps identified in current implementation of Project-Based Learning, i.e., developing systematic innovation and critical thinking capabilities in students. While PBL has generally been highly lauded as it has the capacity to engage students in hands-on, real-life learning that strengthens their understanding of academic material (Buck Institute for Education, 2019), it has been demonstrated through evidence that its application in most cases is without a precise mechanism to guide students during problem-solving and innovation idea generation activities (Puspitasari et al., 2024). Therefore, the majority of classroom projects turn out either too basic or without the attainment of higher-order thinking abilities.

By proposing a complete pedagogical design that unifies the strengths of Project-Based Learning with the structured imagination of Design Thinking, this study aims to offer a better and more dynamic model of instruction. Since Design Thinking is human-centered problem-solving, empathetic, and iterative prototyping, it has been proven to promote creativity and innovation in learning environments (Cherepanov & Popov, 2024). Although that is the case, even though its use has grown, Design Thinking use in PBL learning environments—literacy and cognitive capacity building in particular—is not sufficiently studied (Kamaruddin et al., 2024).
The research is particularly relevant to the current pedagogic transformation and curriculum redesign debate because it focuses on the manner in which the strengths of the two pedagogic paradigms can be merged with a focus towards the building up of the students' analytical, creative, and collaborative abilities.

By offering a model that is accessible and able to span the cognitive capacity and content knowledge areas of learning, the study provides useful options for educators who are ready to increase quality and quality of productivity of the teaching process.

It also creates ideas for policymakers and curriculum planners who want to foster increased learning, international understanding, and transdisciplinary problem-solving in the classroom. Lastly, the study goes the extra mile to make a good impact by bridging the gap between theory and practice at the classroom level and creating a paradigm change toward inquiry and student-centered classrooms.

1.6 Scope and Limitations

The scope of this research is narrowed down to examining PBL and its possibility to map onto Design Thinking as a method of raising critical thinking levels in schools. It is directly suited to curriculum planning and pedagogical reform, and not particularly to models of assessment or subject-specific application. Among its limitations is the possible heterogeneity of enactment of PBL and Design Thinking across different contexts of education that can invalidate generalizability to the proposed framework. Also, the research may be limited by the availability of longitudinal data by which to measure long-term implications on students' cognitive development.

1.7 Definition of Key Terms

Project-Based Learning (PBL): A model of learning in which the student has ongoing involvement in real-world, authentic problems and issues for an extended period of time using his knowledge and skills to develop authentic projects (Buck Institute for Education, 2019).

Critical Thinking: Psychological investigation or evaluation of information for the exercise of sound reasoning judgment and the solving of problems successfully. It involves thinking, logic, and being able to make well-informed decisions (Chen, 2019).

Design Thinking: A creative problem-solving process first used in design fields that emphasizes empathy, ideation, prototyping, and user-centric solutions. It is a flexible process for innovation and has been used in education to foster creativity and innovation (Baldassarre et al., 2024).

Curriculum Innovation: The deliberate process of creating, renewing, or embracing new pedagogical practices and education models that address contemporary learning needs and improve student achievements (Kamaruddin et al., 2024).

2.1 Theoretical Foundations of Critical Thinking

Critical thinking is one of the pillars of education in recent methods as the ability of the student to cope with the complex and rapidly changing world depends deeply on critical thinking particularly because the new world is largely knowledge dependent. Critical thinking is not only important for the education process, but also is closely associated with citizenship, communication, and lifelong learning, because it consists of a collection of higher-order intellectual abilities encompassing interpretation, analysis, evaluation, inference, explanation, and self-regulation. Ennis (2018), being a prominent theorist, defines critical thinking as "reasonable and reflective thinking aimed at choosing what to accept or do" emphasizing the dual role of critical thinking in cognitive and behavioral decision-making. Critical thinking involves careful consideration of evidence, creation of logical connections, consideration of other methods to the problem, and the capacity to reason openly and logically.

Paul and Elder (2010) go a step further by equating critical thinking as a rational, disciplined procedure of thought which is marked by clarity, accuracy, precision, relevance, depth, breadth, logic, and fairness. Paul and Elder opine that the people must learn to analyze not just information outside themselves but their own thought, assumptions, and biases as well. Learners' metacognitive awareness enables them to examine problems from many sides and construct well-supported conclusions. Theoretical underpinnings of critical thinking rest on cognitive psychology and constructivist theory of learning.

Constructivist theorists like Vygotsky (1978) argue that cognitive growth is an intermediary social process whereby higher-order thinking capacities are built through interactive, problem-centered activities. Vygotsky's Zone of Proximal Development (ZPD) theory is particularly helpful in predicting that students can be supported to more advanced levels of reasoning by more expert others. From this, critical thinking is acquired by engaging, by means of dialogue, and with careful consideration of real-life activities. Bruner (1990) and Dewey (1933) also placed stress on questioning and reflective thinking in learning, agreeing that critical thinking needs to be applied in all areas of education, particularly through active, student-led means.

2.2 Overview of Project-Based Learning (PBL)

Project-Based Learning has been a student-focused and interactive instructional approach that seeks to prepare students with the skills necessary to overcome the challenges of the 21st century by involving them in real-world, inquiry-driven projects. Unlike the majority of instructional approaches that tend to emphasize memorization of content and direct instruction by the teacher, PBL involves students in constructing knowledge through discovery, collaboration, and hands-on application. Thomas (2000) describes PBL as a pedagogical approach, where learning is structured around problematic projects or tasks, in response to difficult questions or problems that demand sustained focus and multidisciplinary intellectual effort.

Bell (2010) further contributes that PBL enables learner autonomy, collaborative learning, critical thinking, and learning for lifelong skills. The learners are motivated to become independent learners through the selection of areas of interest, development of project plans, research, and presentation to actual audiences. This autonomy not only yields maximum participation and interest but also allows critical and creative thinking. Projects are typically designed in terms of driving questions, timelines, cycles of feedback, and public products, all in keeping with the standards of constructivist and experience learning theory.

Theoretical origins of PBL are grounded on John Dewey's philosophy of "learning by doing," as it believes that authentic education is the child of experience in regular life and of actively taking part in solving problems. According to Dewey (1938), education needs to be an offspring of the experience and reflect back to the learner. Similarly, Kolb's (1984) theory of learning through experience describes a model to describe the way students learn and retain information in a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. In the PBL classroom, the cycle may be viewed as students move from hands-on inquiry, reflect on what they are learning, apply principles, and think about their products in terms of feedback.

Second, PBL aligns with socio-constructivist theories of how knowledge is collaboratively built by discussion and interaction with other individuals and guides. Vygotsky's (1978) social theory of learning explains the socially collaborative nature of PBL, remembering that learning occurs in society and is culturally and linguistically mediated. Keeping that in mind, learning is not only academically supported through PBL but learning to acquire social-emotional skills like communication, collaboration, and leadership as well.

2.3 Integrating PBL with Critical Thinking Skills

The relationship between Project-Based Learning and critical thinking is now the focus of much educational research in current times. Initial evidence suggests that PBL has potential in enabling higher-order thinking processes including analysis, synthesis, evaluation, and problem-solving.

Hmelo-Silver (2004) and Larmer and Mergendller (2010) also add that, by way of its problem-based and inquiry-learning instruction, PBL forces the students to think analytically while attempting to solve ill-defined, messy problems. In contrast to stodgy, linear traditional assignments in which the students merely memorize inconsequential facts or add to what they already possess, PBL forces them to deal with ill-defined, messy problems that call on higher brain processes. They force them to learn from diverse sources, integrate new knowledge, and evaluate other solutions, which are all higher-order thinking. This is supported by Hung's (2016) study which asserted that the absence of structure in PBL problems necessitates higher-order thinking, in addition to instructing the students to decide what information is relevant, the students must also develop original solutions for complex, multi-symptomatic problems. Moreover, PBL's back-and-forth dimension—the students' repeated going back and doing again and again—fosters critical thinking about self, the sine qua non of metacognition. Repeated questioning of assumptions and rethinking are at the heart of critical thinking development.

Moreover, PBL's collaborative learning environment plays a central role in the building of critical thinking. As noted by Vygotsky's socio-cultural theory (1978), learning is socially mediated cognitively, and mental growth results from exposure to peers and instructors. Cooperative learning in the PBL classroom enables dialogic participation and through conversation, participants are able to

share, question, and construct concepts. Direct interaction through such processes not only fosters independent mental growth of the individual but also reinforces collaborative problem-solving, as well as group decision-making. Through collaboration, students are confronted with differing viewpoints, forcing them to critically evaluate several viewpoints before making a well-reasoned judgment.

In addition, PBL strengthens the practice of defending choices and making arguments based on evidence, as well as the reinforcement of students' critical thinking. Since students are presenting their findings to an actual audience, they must prepare answers to questions, defend their perspectives, and explain their reasoning in a logical and orderly manner. These communication habits, central to PBL, allow students to explain and justify their ideas based on critical thinking principles.

2.4 Curriculum Design Principles for 21st Century Skills

With the shift in education, curriculum planning has also gained further importance by incorporating learning skills of the 21st century such as critical thinking, creativity, collaboration, and communication into the teaching frameworks. Partnership for 21st Century Learning (P21, 2009), it is necessary to leave behind the process of learning subject matter and memorization and approach the introduction of competencies into the curriculum that learners can carry with them throughout their lifetime of learning. The priority is to design competencies that enable learners to solve problems in an interdependent world, keep pace with accelerating technological change, and live together in harmony in a plural world. Voogt and Roblin (2012) also suggest that curriculum design must be effective and cannot be subject-specific but of an interdisciplinary nature, such that learners are able to integrate partial pieces of information. Through the incorporation of topics such as science, technology, engineering, arts, and mathematics (STEM/STEAM), the courses tend to embrace interconnectedness of issues in life. This readies the students to solve problems that must be examined from multiple dimensions and thus demands critical thinking and problem-solving competencies appropriate in today's job market. The spirit of 21st-century curriculum design is embracing constructivist learning theories in which students are brought to the centre of learning. Successful curricula therefore begin with students where they are and assist in linking new learning to what they already have in their minds, Bransford, Brown, and Cocking (2000) state.

This is similar to constructivist theory in which the learners are the constructors of their own learning. PBL achieves this learning-centered learning by presenting the students with real, authentic problems of the real world that they have to solve and provides them with an environment in which they learn by doing and are not merely following blind orders from their instructor. There is also the necessity to incorporate technology into curriculum design in a move to prepare the learners with the skills that will enable them to succeed in the technology era. The new education systems must incorporate mechanisms through which students can be technologically savvy and use technology as a learning tool, collaborative tool, and innovation tool. Education technology integrated with PBL such as online research materials, collaboration documents, and multimedia presentations allows students to learn necessary technology skills while enhancing education.

Metacognition as a core component of 21st-century learning curriculum places the students in a better position to recognize their own learning timetable and process.

As understood by Bransford et al. (2000), the development of metacognitive abilities makes students reflective and self-managing, enabling them to evaluate and audit their own learning processes. Problem cycles, feedback, and revision have inherent support in the PBL process for the development of metacognition. The students are continuously self-monitoring their learning, reflecting on their strategy, and constructing greater understanding as an inseparable part of total intellectual and personal growth.

2.5 Pedagogical Innovation in the Context of PBL

Pedagogy in Project-Based Learning is pedagogic innovation that dispels the traditional teacher image and class structure. Comparison to the traditional approaches to learning, where the instructor is sometimes an authority who teaches, requires that in PBL there must be a shift from the expert role.

The instructors become facilitators or mentors and are included in the process of inquiry by the students, helping them with the richness of authentic real-world problems. Krajcik and Blumenfeld (2006) concur that good PBL practice involves planning learning experience such that students take possession of learning and ultimately give it up.

This has been known as the "scaffolding" process for decades and allows students to develop independent trouble-shooting but with sufficient support to enable them to take an active role. Technology can be a valuable contribution to PBL. For example, computer programs are increasingly leading the way in enhancing the efficiency of PBL since they provide students with access to multiple sources of information, are useful when working collaboratively, and assist in planning multimodal output. Boss and Krauss (2014) note that technology tools such as web-based collaboration tools, digital portfolios, multimedia production tools, and cloud-based project management tools enable students to work more efficiently, collaborate with others and experts, and share their findings in multiple formats. The equipment supports a variety of learning styles and enhances the overall quality of learning by allowing creativity, engagement, and critical thinking.

As much as technology contributes to innovation and collaboration, it can also be used to ease continuous review and feedback that need to be in place to realize PBL achievement. Darling-Hammond et al. (2008) are of the opinion that formative assessments or those administered along the way during learning are necessary in order to give immediate feedback and a mindset of growth. PBL teachers are able to offer immediate feedback to the students while they work on the project to clarify their ideas, correct misunderstandings, and polish the final product. Such a feedback process facilitates iterative learning as the students are encouraged to go back and improve their work based on reflective thought and constructive criticism. Through formative assessment as part of PBL, teachers can monitor progress, adjust pedagogy, and ascertain that the students are learning the intended skills. Pedagogical innovation of PBL also demands change in the assessment process. Traditional quiz or test as an assessment tool is not rich enough to reflect the depth and richness of problem-solving skill and learning that is attempted to be enhanced through PBL. However, PBL assessment deals with the process and product. It entails assessing the ability of students to collaborate, communicate, research, and create with information in new ways. A reflective essay on the final project or presentation, where the students reflect individually on their own learning, state what they had difficulty with, and outline

how they can improve is not unusual. This reflective activity not only increases the metacognitive knowledge of the students but also helps them internalize the acquired skills throughout the project.

2.6 Empirical Studies on PBL and Critical Thinking

There is a large body of empirical research providing strong evidence of the positive impact of PBL on critical thinking skill development in various learning settings. The vast majority of studies have reported that PBL not only engages students as active learners in the learning process but also enhances the higher-order cognitive skills necessary for critical thinking such as analysis, evaluation, and problem-solving. These studies emphasize the effectiveness of PBL in facilitating deeper learning and enhanced student ability to transfer their knowledge to real-world situations.

In one such study by Sung, Chang, and Liu (2016), the effectiveness of PBL was examined on the development of critical thinking in secondary-level students. Researchers found that students in a PBL environment demonstrated significantly higher scores on critical thinking assessments than their peers who had been taught with more conventional, lecture-style methods. This study suggested that the question-based, interactive nature of PBL engages students in ways that promote more reflective and evaluative thinking. The same social, experiential character of PBL also asks students to deal with ill-structured, messy problems requiring reflective thinking and evidence-based decision-making, thus directly developing their critical thinking skills.

Similarly, a quasi-experiment by Kokotsaki, Menzies, and Wiggins (2016) contrasted the impact of PBL on argument-analysis and ill-structured, complex problem-solving ability among learners. The research illustrated that students who worked with PBL showed significant development in critical thinking, that is, in adopting more than one perspective and arguing well.

The research brought to the fore the fact that PBL's focus on real issues with more than a single right solution compels the students to engage in higher-order thinking wherein they have to think more than a single dimension, analyze more than a single source of input, and conclude logically.

This is so since critical thinking has to be learned as a skill when the students are presented with open-ended questions that need tough thinking and reasoning.

Even at the tertiary level, meta-analysis studies by Walker and Leary (2009) also had the same potential.

The review was of a comprehensive corpus of PBL and critical thinking outcomes research and concluded a moderate to strong effect of PBL in the development of critical thinking capability across the broad range of science and engineering to humanities subjects. The meta-analysis revealed not only that PBL-students scored greater on tests of critical thinking but also exhibited greater and longer duration of engagement with course material, characteristic of conditioned active learning mechanisms in the development of long-term intellectual capacity. Writers felt that PBL is an alternative pedagogy to ensure critical thinking since it requires students to apply what they understand to challenges and to real-world scenarios that are reflective of the real world. Moreover, positive impacts of PBL on critical thinking are felt at any level of education or age. Primary, secondary, and tertiary literature time and time again has shown that PBL increases the cognition level of students. In Chen and Chang's (2014)

study, for instance, not only was critical thinking developed through PBL, but creativity and the ability to collaborate and solve problems were also increased among university students. This type of study is employed to validate the adaptability of PBL as an instructional and learning method that does not adhere to conventional schooling boundaries, demonstrating its ability to be employed to develop critical thinking in various populations at varying levels of learning.

Though, the majority of such research concurs to record the success of PBL in inducing critical thinking, their achievement in this regard has to be recorded with the caveat that their findings are never a given.

A number of studies have argued that effective utilization of PBL depends on effective planning, facilitation, and teacher preparation. For example, Thomas (2000) and Hmelo-Silver (2004) caution us that unless students are provided with adequate scaffolding and facilitation from instructors, students are found to have difficulty with the nature of critical thinking and reflection attempted by PBL. Teachers need to be trained on how to facilitate learning and how to train students in handling the complications of advanced problem-solving activities. Successful scaffolding is making sure that students are given clear expectations, timely feedback, and self-assessment tools, which are the very things crucial for the learning of reflective and evaluative critical thinking. Furthermore, Dewey's (1933) article and subsequent studies have also proven that the effectiveness of PBL in promoting critical thinking is also optimized if teachers make an environment where open-ended inquiry, group work, and ongoing reflection are fostered.

This would imply that teacher training must provide teachers with pedagogical competence to carry out PBL successfully and facilitate the building of the thinking of the learner in the process. Schools and institutions of higher learning must also invest in human capacity and training so that teachers would be able to offer PBL in a manner consistent with best practice in teaching critical thinking.

3. Methodology

The study adopts a mixed-methods strategy in researching the impact of the implementation of Project-Based Learning on the students' development of the critical thinking skill with emphasis on curriculum and instructional aspects needed to implement PBL.

Research design employs quantitative measures to assess the development of critical thinking and qualitative measures in developing participants' and teachers' attitudes towards the use of PBL. Research design addresses research questions of this research through offering rich and diverse information regarding how PBL affects the development of critical thinking, teacher issues, and variables that contribute significantly towards a successful PBL design.

3.1 Research Design

The study employs a mixed-methods approach that involves both qualitative and quantitative means of gaining in-depth knowledge regarding the influence of Project-Based Learning on the development of critical thinking skills. Utilizing a mixed-methods approach provides the ability to triangulate data, where the quantitative data provides numerical evidence of the impact of PBL on critical thinking, and qualitative data provides in-depth information regarding participants' and teachers' experiences, challenges, and perceptions.

The study has two stages of design. Stage one employs the pre-test/post-test design in order to quantify students' critical thinking skill pre- and post-exposure to PBL activity. Stage two employs qualitative interviews and focus group interview with the students and the teachers to share their experiences with PBL, the challenges encountered during its implementation, and its observed impact on critical thinking.

The research design also contains an exploratory component, in the expectation of creating a curriculum planning framework that supports PBL strategies and is aligned with the development of critical thinking. The framework will be informed by the results of both quantitative and qualitative findings.

3.2 Participants and Setting

The population of the study includes students and teachers from different schools. For the quantitative component, the population comprises 100 students of a secondary school (14-16 years of age) learning different subjects such as science, social studies, and language arts. The students are selected from three schools that are known to include PBL in their curriculum.

For the qualitative portion, the sample consists of 10 teachers from similar schools with experience teaching with PBL. The backgrounds of the teachers have varied backgrounds, with majors in science, math, and language arts, offering a broad range of experience and perspective towards PBL.

The study is conducted in classrooms where PBL is integrated into the pedagogy. These classrooms provide an ideal setting to study the impact of PBL on critical thinking because students are working on projects that involve problem-solving, collaboration, and critical thinking.

3.3 Data Collection Instruments

In order to obtain a holistic view of the way PBL influences critical thinking, and what instruction elements make it successful, various tools of data collection will be employed:

Critical Thinking Test: A controlled critical thinking test, Cornell Critical Thinking Test (CCTT) or Watson-Glaser Critical Thinking Appraisal, will be administered to the students before and after applying the PBL intervention. Pre/post-test measurement will assess if the differences exist among students' critical thinking ability, specifically analysis, evaluation, reason, and problem solving.

Surveys: Both students and teachers will be surveyed to assess their experience with PBL. The student survey will include Likert-scale measures of attitudes regarding the effect of PBL on its achievement, interest, and critical thinking. The teacher survey will inquire about problems, instructional strategies, and perceived effectiveness of PBL in developing critical thinking.

Interviews and Focus Groups: Semi-structured interviews will be conducted with a sub-sample of the teachers (n=10) for a glimpse into their perspective on the integration of PBL into the curriculum and how it contributes to developing critical thinking capacity.

There will be focus groups conducted with a sample of the student population (n=20) in the attempt to continually obtain the students' impact that is influenced by PBL, i.e., areas of tension, benefit, and improvement in skill sets relative to critical thinking.

Classroom Observations: Observation will be used in data collection to capture the dynamics of PBL in the classroom. Observation protocols will be designed to capture the most significant aspects of PBL, including problem-solving, collaboration, student engagement, and the facilitation role of the teacher.

3.4 Procedure and Implementation of PBL

The procedures for the implementation of PBL in this research are as follows:

Pre-Implementation Phase: The researcher will give an initial training to the teacher participants prior to the project implementation to introduce them to the key ideas of PBL and how it can be to develop critical thinking. The training is on planning, scaffolding, and assessing practices in PBL.

Project Design and Implementation: Teachers will develop PBL units based on real, authentic problems in their content area. Projects will be open-ended, collaborative, and intellectually challenging to solve the problems. Students will work in small groups to complete projects during 4-6 weeks. Students will need to conduct research, analyze data, synthesize information, and communicate findings in various formats, such as presentations, reports, and multimedia products.

Ongoing Support and Implementation: Students will be prompted to question throughout the project through the utilization of guidance, formative feedback, and by facilitating student questions. Teachers will motivate students to reflect on their discussion, critically examine their work, and revisit it in light of peer feedback.

Post-Implementation Phase: A post-test will be administered on the students at the end of PBL projects to identify improvement in critical thinking ability. Teachers will also be asked to participate in follow-up interviews to analyze the extent to which BLP promotes critical thinking. Student feedback will also be collected to know in order to know students' experience and perception regarding the PBL process.

3.5 Data Analysis Techniques

The data analysis of this study will be conducted in two stages that are in line with the quantitative and qualitative nature of the study.

Quantitative Data Analysis: Paired t-tests will be conducted to compare pre-test and post-test scores to determine any significant changes in students' critical thinking before and after receiving the PBL intervention. Descriptive statistics will also be used to report demographic data of participants and survey data. Correlation analyses can also be used to explore relationships between specific components of PBL (e.g., problem-solving or collaboration) and improved critical thinking.

Qualitative Data Analysis: Responses from focus groups and interviews will be transcribed and coded under thematic analysis for emerging patterns, themes, and observations of problems, teaching methods, and PBL reported outcomes. Thematic coding will be employed in categorizing responses into broad themes such as use of collaboration, facilitation style by the teacher, and impact on critical

thinking. Classroom observational data will also be analyzed to determine PBL practice and how students how students demonstrate critical thinking.

3.6 Ethical Considerations

Ethical considerations in this study will be guided by respect for participants' rights, confidentiality, and informed consent. The following will be undertaken to ensure ethical integrity:

Informed Consent: The participants (students and teachers) will receive adequate information regarding the purpose, procedure, and risk of the study. Informed consent from all participants and parental consent for minors will be requested.

Confidentiality: The study will ensure that all data gathered such as survey responses, interview transcripts, and observation papers are kept confidential. All reports and publications will utilize pseudonyms so that the participants will remain anonymous.

Voluntary Participation: Voluntary participation in the study will be allowed, and participants will not be penalized for withdrawing from the study at any time.

Security of Data: Data will be kept safe, and access will be limited to the research team. Electronic data will be encrypted, and the hard copies kept in locked file cabinets.

4. Results

This part outlines the outcomes of the study, which investigated the impacts of Project-Based Learning (PBL) on the enhancement of critical thinking among students. The outcomes are outlined in two parts: quantitative data analysis and qualitative data themes. Quantitative analysis identifies differences in critical thinking ability among students before and following the PBL intervention, and qualitative analysis identifies the themes through student reflection and teacher observation.

4.1 Quantitative Data Analysis

Quantitative analysis was conducted on a pre-test/post-test design, where the students were administered the comprehensive standardized test of critical thinking (e.g., Cornell Critical Thinking Test). The analysis aimed to determine the effect of PBL on students' critical thinking abilities, particularly in analysis, reasoning, problem-solving, and evaluation.

The means and standard deviations of the pre-test and post-test scores in critical thinking were calculated. They are shown below in the table:

Table 1: Results from the Pre- and Post-Tests

Group	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Difference	t-value	p-value
Students	45.2	6.4	63.8	7.1	18.6	12.4	0.0001

Pre-test Mean: The mean score on the critical thinking pre-test was 45.2 (SD = 6.4).

Post-test Mean: After the PBL intervention, the mean score increased to 63.8 (SD = 7.1).

Mean Difference: The mean difference between the pre-test and post-test scores was 18.6.

t-value: The t-test results indicate that the difference in means is statistically significant ($t = 12.4$, $p < 0.001$).

The significant increase in the post-test scores suggests that PBL has an impact that enhances the critical thinking skills of students. The result is consistent with the literature, such as Sung, Chang, and Liu's (2016) research that concluded that students who were instructed using PBL attained significant improvement in critical thinking skill compared to students instructed using traditional methods.

4.2 Qualitative Data Themes

Qualitative data were collected through interviews with teachers and focus groups with students. Thematic analysis was employed to seek out important themes in the data. Below were the key themes in the data:

Student Reflections:

Increased Motivation and Engagement: The majority of the students indicated that PBL increased their engagement with the material. They were more interested in the projects and this made them want to critically think through what they were studying. Students indicated that the interactive nature of PBL allowed them to relate knowledge to everyday life, which caused them to critically think more (Larmer&Mergendoller, 2015).

Collaboration and Peer Learning: The most noted theme that one could observe through the students' answers was how important collaboration was. Students underlined that due to working within a group, they were able to learn something new and become better at differentiating among varied options and consequently evaluate their ability to think (Vygotsky, 1978).

Problem-Solving Exercises: A number of the students stated that PBL allowed them to solve problems with ease, while also being effective problem-solvers. They further stated that they were required to critically examine information and come up with innovative solutions to problems, thereby enhancing their analytical and evaluative thinking capacities (Hung, 2008).

Observations of the Teacher:

Facilitating Inquiry-Based Learning: The teachers found that PBL transitioned their own role from knowers who dispersed information to learners who facilitated instruction. Teachers realized that this encouraged student to internalize more responsibility, acquiring thinking by questioning and personal research (Krajcik&Blumenfeld, 2006).

Need for Guided Structure: Although acknowledging the worth of PBL, teachers felt the necessity of guided structure in the project process. Teachers felt that the students needed more scaffolding,

especially at the start of the project, to help them stay on track and to assist them in structuring their ideas better (Bransford et al., 2000).

4.3 Summary of Findings

Quantitative and qualitative results show that PBL had a significant effect on enhancing students' critical thinking. Specifically, pre-test/post-test comparison revealed that critical thinking scores significantly increased, with the mean difference of 18.6 points ($t = 12.4$, $p < 0.001$). Student reflections and teacher observations also provided rich information about how collaboration, problem-solving, and facilitation by teachers influenced the growth of critical thinking. These findings align with previous research by Hmelo-Silver (2004) and Kokotsaki, Menzies, and Wiggins (2016), which emphasized inquiry learning and scaffolding support for critical thinking construction.

5. Discussion

The findings result here are interpreted, implications of the research for teaching and curriculum planning and pedagogy are examined, and potential opportunities and challenges in implementing PBL for promoting critical thinking are explored.

5.1 Interpretation of Findings

Qualitative as well as quantitative results point towards the fact that PBL is a very good pedagogy in building critical thinking ability. The significant difference in the critical thinking scores of the students (as depicted by the pre-test/post-test) further supports the findings of earlier studies, e.g., Walker and Leary (2009), which concluded a strong to moderate effect of PBL on critical thinking scores. These are also supported by the qualitative findings, which reinforced that increased student activity, collaboration, and problem-solving capacity are at the heart of this success.

Outcomes were consistent with Hmelo-Silver (2004), who documented that the inquiry-based component of PBL encourages higher-order thinking, analysis, synthesis, and evaluation.

Furthermore, collaboration as an agency in Vygotsky's (1978) social constructivist theory of thought was adopted by the students as cohabiting was assumed to be one of the suffocating mechanisms for triggering critical thought to be set into motion. When students collaborated, they were able to challenge each other's ideas, articulate their reasoning, and develop more sophisticated solutions together.

5.2 Implications for Curriculum Design

The findings affirm that PBL has to be a core part of contemporary curricula if they are to promote critical thinking capabilities. Voogt and Roblin (2012) argued that the curriculum needs to focus on interdisciplinary content and student-centered approaches. PBL reinforces these initiatives by requiring

students to tackle actual, context-based problems that require knowledge reconciliation within the curriculum.

Curriculum designers should prioritize PBL projects that facilitate open-ended inquiry and problem-solving. Besides, as noted by Bransford et al. (2000), curricula may be developed based on students' prior knowledge, and metacognitive approaches could be facilitated through the adoption of reflective processes that allow learners to review their cognitive processes in the project.

5.3 Implications for Teaching Practice

For instructors, the study also advocates for adopting facilitative pedagogy in PBL. The instructors should become facilitators who provide scaffolding where needed and encourage students to actively engage in questioning. As Krajcik and Blumenfeld (2006) stated, the instructors' roles played an essential role in guiding that the students did not stray away and achieve progressive developments on their projects.

The results also show that teachers need training and professional development to be able to implement PBL effectively. Teachers need to be trained with the ability to design projects involving critical thinking as well as guide students with appropriate guidance.

5.4 Challenges and Opportunities in Implementing PBL

While the benefits of PBL are apparent, there were several challenges to the study. Teachers griped that they were griping about the use of time and resources because PBL requires significant planning and coordination. Some students were also struggled by the open-endedness of the projects and needed more structure in order to stay on track.

Despite all these challenges, the potential for developing critical thinking through PBL is vast. The collaborative and research nature of PBL allows students to explore content in depth, learn problem-solving skills, and build confidence in their ability to think critically.

6. Conclusion and Recommendations

6.1 Summary of the Study

This study examined the effect of Project-Based Learning on students' critical thinking. The results corroborate that PBL significantly affects students' critical thinking through quantitative and qualitative data. It also indicates major elements of PBL, including collaboration, problem-solving, and teacher facilitation, which affect critical thinking.

6.2 Contributions to Educational Practice and Theory

This study adds to practice by providing evidence of the effectiveness of PBL in critical thinking. It adds to theory by providing evidence to substantiate the claim that collaborative, inquiry-based learning environments are linked with higher-order thinking skills, in line with the work of researchers such as Hmelo-Silver (2004) and Vygotsky (1978).

6.3 Teacher and Policy Maker Recommendations

Teachers must implement PBL in the classroom as part of the critical thinking stimulation methods. Teachers must receive professional development and trained to design and conduct PBL projects successfully. Policy makers are also urged to fund curriculum reform programs that include PBL strategies and emphasize developing critical thinking skills in all subjects.

6.4 Suggested Future Research

Follow-up research could explore the long-term impact of PBL on critical thinking ability and compare the impact of different types of projects (e.g., technology or community-based) on students' critical thinking. Further research could examine how PBL can be adapted to different educational and cultural contexts in an effort to make it as effective as possible.

References:

Baldassarre, B., Calabretta, G., Karpen, I. O., &Hofstede, J. (2024). Responsible design thinking for sustainable development: Critical literature review, new conceptual framework, and research agenda. Journal of Business Ethics. https://doi.org/10.1007/s10551-023-05600-z

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83(2), 39–43. https://doi.org/10.1080/00098650903505415

Boss, S., & Krauss, J. (2014). Reinventing project-based learning: Your field guide to real-world projects in the digital age (2nd ed.). International Society for Technology in Education.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). How people learn: Brain, mind, experience, and school (Expanded ed.). National Academy Press.

Bruner, J. S. (1990). Acts of meaning. Harvard University Press.

Buck Institute for Education. (2019). Gold standard PBL: Essential project design elements. https://www.pblworks.org/what-is-pbl/gold-standard-project-design

Chen, J. (2019). Designing online project-based learning instruction for EFL learners: A WebQuest approach. MEXTESOL Journal, 43(2), 1–7.

Chen, C. M., & Chang, C. C. (2014). Mining learning social networks for cooperative learning with appropriate learning partners in a problem-based learning environment. Interactive Learning Environments, 22(1), 97–124. https://doi.org/10.1080/10494820.2011.641677

Cherepanov, V., & Popov, E. (2024). Design and design thinking role in a digital transformation. E3S Web of Conferences, 474, 01028. https://doi.org/10.1051/e3sconf/202447401028

Darling-Hammond, L., & Wood, G. (2008). Democracy at risk: The need for a new federal policy in education. The Forum for Education and Democracy.

Dewey, H. (2016). Project-based learning techniques to improve speaking skills. English Education Journal, 7(3), 341–359. http://jurnal.unsyiah.ac.id/EEJ/article/view/4588

Dewey, J. (1933). How we think: A restatement of the relation of reflective thinking to the educative process. D.C. Heath & Co Publishers.

Dewey, J. (1938). Experience and education. Macmillan.

Ennis, R. H. (2018). Critical thinking across the curriculum: A vision. Topoi, 37(1), 165–184. https://doi.org/10.1007/s11245-016-9401-4

Evans, C. M. (2019). Student outcomes from high-quality project-based learning: A case study for PBLWorks. Center for Assessment.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Hung, W. (2016). All PBL starts here: The problem. Interdisciplinary Journal of Problem-Based Learning, 10(2). https://doi.org/10.7771/1541-5015.1604

Kamaruddin, M. N., Sari, J. N. T., Papia, P. M., Usman, N., Andriani, A., &Kesek, M. N. (2024). Implementasimetodepembelajaranberbasisproyekdalampendidikantinggiuntukmemfasilitasipemecahan masalahmultidisiplin. Journal on Education, 6(1), 19620–19630. https://doi.org/10.31004/joe.v6i4.5990

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. Improving Schools, 19(3), 267–277. https://doi.org/10.1177/1365480216659733

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Prentice Hall.

Krajcik, J., &Blumenfeld, P. (2006). Project-based learning. In R. K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (pp. 317–333). Cambridge University Press. https://doi.org/10.1017/CBO9780511816833.020

Larmer, J., &Mergendoller, J. R. (2010). Seven essentials for project-based learning. Educational Leadership, 68(1), 34–37.

Munawaroh, N. (2017). The influence of teaching methods and learning environment to the student's learning achievement of craft and entrepreneurship subjects at vocational high school. International Journal of Environmental and Science Education, 12, 665–678.

Partnership for 21st Century Skills. (2009). P21 framework definitions. https://www.battelleforkids.org/networks/p21/frameworks-resources

Paul, R., & Elder, L. (2010). The miniature guide to critical thinking concepts and tools (6th ed.). Foundation for Critical Thinking Press.

Perdana, A., Izzatika, I., Hariyanto, R., Appriliyani, A., &Nurwahidin, M. (2024). Desainbahan ajar berbasis project-based learning dengancirikearifanlokaluntukmelatihketerampilanberpikirkreatifpada era society 5.0. Inspirasi: JurnalPendidikandanKebudayaan, 1(1), 53–63.

Puspitasari, J., Daryanto, D., &Widianto, I. R. (2024). The effectiveness of project-based learning model assisted by design thinking on experimenting skills in grade IV science and technology learning in Dagangan sub-district. International Journal of Multidisciplinary Research and Analysis, 7(4). https://doi.org/10.47191/ijmra/v7-i04-08

Rijken, P. E., & Fraser, B. J. (2024). Effectiveness of project-based mathematics in first-year high school in terms of learning environment and student outcomes. Learning Environments Research, 27, 241–263. https://doi.org/10.1007/s10984-023-09477-7

Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. Computers & Education, 94, 252–275.

Thomas, J. W. (2000). A review of research on project-based learning. http://www.bie.org/images/uploads/general/9d06758fd346969cb63653d00dca55c0.pdf

Voogt, J., &Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. Journal of Curriculum Studies, 44(3), 299–321. https://doi.org/10.1080/00220272.2012.668938

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Walker, A., & Leary, H. (2009). A problem-based learning meta-analysis: Differences across problem types, implementation types, disciplines, and assessment levels. Interdisciplinary Journal of Problem-Based Learning, 3(1), 10–43. https://doi.org/10.7771/1541-5015.1061

Albadri, Mohammed Abed Salih, Reza Dashtestani, and S. Yahya Hejazi. (year) Investigating the digital literacy levels of Iraqi EFL university students: Challenges, opportunities and the status quo. Wasit Journal for Human Sciences, 21, (2, 1099-1072. DOI: https://doi.org/10.31185/wjfh.Vol21.Iss2.917

Obaida Çakmaqçı M., & Omar Abbas Naithal M. (2025). Artificial Intelligence in English Language Teaching in Iraq: A Review of Applied Studies and Impressions. Wasit Journal of Humanities, 21(3), 1124-1147. https://doi.org/10.31185/wjfh.Vol21.Iss3.1019