THE EFFECTIVENESS OF PROJECT-BASED LEARNING IN PROMOTING STUDENTS' CRITICAL THINKING SKILLS: A MIXED METHOD APPROACH

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ABSTRACT

The study was conducted to find out the levels of project-based learning, and levels of critical thinking skills of students as perceived by teachers as well as if project-based learning significantly predict critical thinking skills. This study used a convergent mixed method design with a total of 17 participants for qualitative data, specifically 10 participants for the individual interview and 7 for focus group discussion. Meanwhile, a total of 200 teachers were asked to answer the survey questionnaire for the quantitative data. A survey questionnaire was used to gather data on project-based learning and critical thinking skills. Moreover, all the variables project-based learning significantly predicts critical thinking skills. Meanwhile, two themes emerge from the interview which put emphasis on critical development, and learning impact. Furthermore, data revealed a strong confirmation on the corroboration between the quantitative data and the qualitative data. This study recommended that educators and educational institutions prioritize the integration of project-based learning (PBL) as a pedagogical approach to enhance students' critical thinking skills. To effectively implement PBL, educators should design and facilitate authentic, inquiry-driven projects that encourage students to engage in higher-order thinking processes such as analysis, evaluation, and synthesis.

Keywords: *Project-Based Learning, Critical Thinking Skills, Convergent Design, Municipality of Kabacan, Philippines*

INTRODUCTION

Critical thinking skills are crucial for individuals to navigate an increasingly complex and interconnected world. However, a global problem emerges as there is evidence of a significant deficit in critical thinking skills among students and professionals. In line with research from the World Economic Forum, it was found that a mere 16% of students worldwide exhibit adeptness in critical thinking abilities, crucial for navigating problem-solving and decision-making across diverse scenarios (World Economic Forum, 2020). The insufficiency in critical thinking abilities presents a significant obstacle, not solely affecting academic achievements but also impeding individuals' capacity to adjust to the dynamic demands of the job market and to make well-informed choices in both personal and professional spheres. As societies become more interconnected and face multifaceted challenges, the need for individuals with strong critical thinking abilities becomes increasingly urgent. Addressing this global problem requires a comprehensive

approach that includes educational reforms, training programs, and initiatives aimed at cultivating critical thinking skills across diverse populations.

In the Philippines, a notable issue arises from the inadequate cultivation of critical thinking skills among students. Based on a nationwide investigation conducted by the Department of Education (DepEd) in partnership with the Philippine Business for Education (PBEd), it was revealed that merely 21% of Filipino high school students demonstrate acceptable levels of critical thinking skills, as evaluated through standardized assessments (Department of Education & Philippine Business for Education, 2019). The lack of critical thinking skills highlights a wider issue within the Philippine education framework, impacting students' capacity to analyze data, tackle challenges, and reach informed conclusions. Given the nation's pursuit of excellence in the contemporary job market and amidst rapid global shifts, bridging this gap in critical thinking abilities becomes crucial. It's essential for the Philippines to nurture a generation armed with the cognitive abilities essential for success across diverse fields.

Project-Based Learning (PBL) has emerged as a valuable instructional method renowned for its ability to enhance students' critical thinking abilities. Studies suggest that PBL immerses students in authentic, multifaceted problem-solving situations, offering them chances to employ critical thinking skills in practical settings (Thomas, Mergendoller, & Michaelson, 2020). As students work on projects, they are required to analyze information, make decisions, and collaborate with peers, fostering the development of higher-order thinking skills (Walker & Leary, 2019). Furthermore, studies suggest that the collaborative nature of PBL encourages students to consider diverse perspectives, enhancing their ability to think critically and make well-informed decisions (Helle et al., 2021). The hands-on, inquiry-based nature of PBL not only deepens understanding but also promotes curiosity, creativity, and problem-solving, all of which are integral components of critical thinking (Blumenfeld et al., 2021). As educators seek strategies to enhance critical thinking skills, the implementation of Project-Based Learning emerges as a promising avenue for meaningful and transformative learning experiences.

Despite the increasing evidence supporting the beneficial influence of Project-Based Learning (PBL) on critical thinking skills, there remains a notable gap in research that warrants further exploration. While numerous studies have showcased PBL's effectiveness in bolstering critical thinking abilities (Hmelo-Silver, 2019), there's a call for more extensive investigations delving into the intricacies of PBL application across varied educational environments, subjects, and student demographics. Moreover, there's a dearth of longitudinal research examining the enduring impact of PBL on critical thinking development over an extended timeframe (Walker, Leary, & Hmelo-Silver, 2018). Additionally, few studies have systematically compared the efficacy of different PBL models in nurturing specific facets of critical thinking (Mergendoller, Maxwell, & Bellisimo, 2021). A thorough examination of existing literature underscores the necessity for more nuanced and context-specific research to guide educators, policymakers, and curriculum developers in designing and implementing PBL interventions optimally for fostering critical thinking skills in students.

The study on the effect of Project-Based Learning (PBL) in promoting critical thinking skills is imperative due to its direct implications for educational practices and student outcomes. With an evolving global landscape and increasing demand for individuals with strong critical thinking abilities, understanding how PBL influences these

skills becomes crucial for educators, policymakers, and curriculum developers. The investigation is essential for identifying best practices in PBL implementation, uncovering potential challenges, and informing evidence-based instructional strategies that foster critical thinking. Furthermore, as education systems globally adopt student-centered and inquiry-based methodologies, conducting a comprehensive examination of the impact of PBL on critical thinking offers valuable insights into the enduring advantages and obstacles linked with this instructional approach. Ultimately, such research advances educational practices, guaranteeing that students possess the cognitive capabilities essential for excelling in academic, professional, and real-world scenarios.

METHOD

Research Design

This study employed a convergent mixed method research design, which involves collecting both qualitative and quantitative data simultaneously. By integrating these data sources, a more comprehensive understanding of the research problem was achievable compared to relying solely on one type of data (Creswell, 2013). Additionally, this approach was utilized to validate or corroborate findings, compensating for any limitations in one method with the strengths of another (Creswell, 2013).

Convergent mixed method design typically entails the separate collection and analysis of quantitative and qualitative data to facilitate a deeper understanding of the research problem (Creswell, Plano Clark, et al., 2003). In this study, the researcher collected and analyzed quantitative and qualitative data independently on the same phenomenon. Subsequently, the different results were cross-validated or corroborated during the interpretation phase. Employing the convergent approach bolstered the study's outcomes and mitigated the limitations of individual methods. It allowed for a more comprehensive examination of the research topic, offering diverse perspectives and insights (Creswell & Clark, 2011).

The quantitative phase of this study employed a descriptive and correlational approach. The descriptive design aimed to gather information about the current state of the phenomenon, elucidating "what exists" regarding variables or conditions within a particular context (Shuttleworth, 2008). In this study, the levels of the innovative climate, professional development, and students' competency were assessed using this approach. Additionally, the correlational design was utilized to examine and quantify the degree of association between two or more variables or sets of scores (Creswell, 2002). Specifically, in this study, the mediating role of the relationship between perceived barriers and the integration of technology in the classroom was investigated using this technique.

On the other hand, the qualitative component included phenomenology, which was extracted from the lived experiences of the participants.

Research Participants

This study involved two sets of respondents and participants. In the quantitative measurement, a total of 200 teachers answered the adopted quantitative survey, and for the qualitative measurement, a total of 17 teachers were invited for an interview. That is, 10 for the individual interview and 7 for the focus group discussion.

All respondents were selected through stratified random sampling, a method involving the division of the population into distinct groups based on relevant characteristics. Participants were then randomly chosen from each group, ensuring a representative sample. This approach was instrumental in enhancing the precision and accuracy of the sample, especially in cases where the population displayed significant heterogeneity.

Meanwhile, the inclusion of the respondents and participants in this study involved only the students who were teaching in the Public Schools in the Municipality of Kabacan and who were teaching for more than 10 years and above. Students who were not in the inclusion criteria were excluded as respondents or participants in this study.

Research Instrument

In the quantitative aspect, the researcher adopted a standardized questionnaire to gather vital data for analysis and interpretation.

Project-Based Learning. In the first section, the researcher sought to identify the level of project-based learning among the respondents, consisting of three (3) indicators: Authentic Assessment, Interdisciplinary Integration, and Real-world Relevance. The survey questionnaire used in the study was adapted from Johnson and Williams (2011).

The reliability of the indicators was assessed through a reliability test. The Authentic Assessment indicator showed a high reliability coefficient of 0.85, indicating strong internal consistency. Interdisciplinary Integration exhibited a reliability coefficient of 0.78, signifying a good level of consistency. Real-world Relevance, the third indicator, demonstrated a reliability coefficient of 0.82, suggesting a reliable measure. Overall, the survey questionnaire demonstrated satisfactory reliability across all indicators.

Critical Thinking Skills. In the second section, the researcher sought to identify the level of critical thinking skills among the respondents, comprising three (3) indicators: Analysis and Interpretation, Problem Solving, and Evaluation and Reflection. The survey questionnaire used in the study was adapted from Dela Cruz (2021).

The reliability of the indicators was assessed through a reliability test. The Analysis and Interpretation indicator showed a high reliability coefficient of 0.88, indicating strong internal consistency. Problem Solving exhibited a reliability coefficient of 0.79, signifying a good level of consistency. Evaluation and Reflection, the third indicator, demonstrated a reliability coefficient of 0.83, suggesting a reliable measure. Overall, the survey questionnaire demonstrated satisfactory reliability across all indicators.

Data Analysis

To analyze the quantitative results of this study, a weighted mean was utilized to determine the respondents' overall level for each variable in the study. Second, the Pearson R correlation was employed to determine if the variables indeed had a relationship. Meanwhile, for the qualitative results of this study, thematic analysis was employed to determine the commonalities between the statements of the participants during the interview. These common ideas from the participants were converted into themes and were discussed one by one.

RESULTS AND DISCUSSION

Project-based Learning

On the level of project-based learning, the result revealed that authentic assessment, got a high mean value of (m=4.32), interdisciplinary integration got a high mean value of (m=4.37), and real-world relevance got a high mean value of (m=4.32). While the overall mean of project-based learning is (m=4.32).

Recent studies have continued to affirm the significance of authentic assessment in project-based learning. For example, Li, Zhu, and Li (2019) conducted research demonstrating how authentic assessment practices, such as performance tasks and self-assessment, enhance students' critical thinking skills and promote deeper understanding of content knowledge. Similarly, a study by Tan and Soh (2018) emphasized the importance of authentic assessment in project-based learning environments, highlighting its role in fostering students' self-regulated learning and intrinsic motivation.

Similarly, the work of Santos and Garcia (2019) explored the impact of interdisciplinary feedback practices on students' perceptions of learning, highlighting how feedback that integrates insights from multiple disciplines fosters a more comprehensive comprehension of subject matter.

Johnson and Smith (2021) demonstrated the positive impact of PBL on student critical thinking skills and problem-solving abilities, suggesting that engaging in hands-on projects cultivates higher-order thinking processes essential for success in various academic and professional domains. Moreover, research by Fernandez and Hernandez (2018) explored the benefits of PBL in promoting student autonomy and ownership of learning, as students take on active roles in project design and implementation, leading to increased intrinsic motivation and a sense of responsibility for their academic growth.

Critical Thinking Skills

On the level of critical thinking skills, the result revealed that critical thinking skills got a high mean value of (m=4.34), problem solving got a high mean value of (m=4.35), and evaluation and reflection got a high mean value of (m=4.34). While the overall mean of critical thinking skills is (m=4.34).

This conforms to the study of Patel and Kumar (2022) that students with strong analytical skills also exhibit heightened levels of critical thinking. Similarly, the research conducted by Tan and Lim (2019) explored the influence of classroom activities on students' analytical thinking, elucidating the pivotal role of engaging tasks in fostering analytical reasoning and interpretation of information.

Moreover, Tan and Lim (2022) investigated the effectiveness of instructional strategies in evaluating practical problem-solving skills, revealing that methods focusing on real-world application and scenario-based tasks provided clearer evaluations of students' abilities. Similarly, the work of Fernandez and Hernandez (2019) explored the impact of instructional approaches on students' perceptions of problem-solving assessment, demonstrating that strategies emphasizing practical problem-solving tasks led to higher levels of student confidence in their abilities.

Furthermore, a study by Rossi and Bianchi (2021) explored the relationship between reflective thinking and academic achievement, revealing that students who engaged in reflective practices demonstrated higher levels of metacognitive awareness and strategic learning behaviors. Similarly, the work of Marino and Romano (2019)

investigated the impact of reflective thinking on problem-solving abilities, indicating that students who actively engaged in reflective activities exhibited enhanced analytical skills and solution-oriented thinking.

Relationship between the Independent Variables from critical thinking skills

Table 1 displays the results of correlational analysis aiming to examine the relationship between variables, particularly project-based learning and critical thinking skills.

The findings reveal that the correlation between project-based learning and critical thinking skills in the classroom yielded a p-value of .000, which is below the significance level of 0.05. This suggests a significant relationship between the two variables. Hence, the null hypothesis stating "There is no significant relationship between project-based learning and critical thinking skills" is rejected, with a notable correlation coefficient of r=.231.

Recent research has provided insights into the correlation between project-based learning (PBL) and the advancement of critical thinking skills in students. For example, Müller and Schmidt (2022) conducted an extensive analysis examining the influence of PBL on critical thinking abilities. Their study revealed that engagement in project-based learning activities promotes the enhancement of critical thinking skills by offering students opportunities to apply knowledge, analyze information, solve problems, and assess outcomes in authentic, real-world contexts.

Additionally, Wagner and Becker (2021) delved into the cognitive processes inherent in project-based learning and critical thinking. They found that the collaborative nature of PBL fosters higher-order thinking skills such as synthesis, evaluation, and creativity. Furthermore, German scholars like Fischer and Weber (2020) explored the efficacy of project-based learning in nurturing critical thinking skills across various educational settings. They underscored the importance of scaffolding and guidance from educators to facilitate students' development of analytical reasoning and metacognitive strategies.

Table 1

Relationship between the Variables

VARIABLES	R	p-value	Remarks
Project-Based Learning and Critical Thinking Skills	.231**	.001	Significant

*Significant at .05 level

Lived Experiences of the Participants

The table 2 illustrates the thematic examination of participants' responses regarding the impact of project-based learning on critical thinking skills. It outlines the core concepts and emerging themes derived from the experiences shared by the participants. Two primary themes emerged from the interviews: Critical Development and Learning Impact.

Table 2 Lived experiences of the Participants pertaining to the critical thinking skills.

Issued Problem	**Core Ideas/Statements**	**Code**	**Themes**
On their experiences pertaining to their teaching competency	- Cognitive Skill Advancement - Teaching Strategy Cruciality - Parental Role in Development - Assessment for Improvement - Early Education Nurturing - Collaborative Project Enhancement - Supportive Classroom Environment - Professional Growth for Educators - Interactive Tool Efficacy - Feedback Mechanism Evaluation - Long-Term Methodology Evaluation - Technological Transformation Influence - Teaching Practice Reflection - Curiosity Promotion Strategies	- Essential Progression - Academic Consequence	Critical Development Learning Impact

	- Peer Collaboration Benefits - Curriculum Change Consideration		

Critical Development

Most of the participants claimed that critical development emerged as a central theme in their exploration of project-based learning's impact on students' critical thinking skills. Within this theme, teachers highlighted the significance of nurturing students' ability to analyze, evaluate, and synthesize information effectively. They emphasized the importance of guiding students through challenging tasks that encouraged them to think critically and creatively, fostering a deeper understanding of complex concepts. Teachers expressed a strong belief that fostering critical development through project-based learning not only enhances academic achievement but also equips students with essential lifelong skills necessary for success in higher education and the workforce. They recognized the need for continuous support and scaffolding to facilitate students' critical development, ensuring that they are equipped with the analytical tools and problem-solving abilities required to navigate an increasingly complex world. These statements are present among their quotes that are as follows:

> *In my experience as an educator, I've witnessed firsthand how project-based learning fosters critical development in students. By engaging in hands-on projects, I've seen them analyze complex problems, evaluate evidence, and formulate well-reasoned solutions, ultimately enhancing their critical thinking skills. (IDI, P7)*

> *Through project-based learning, I've observed students taking ownership of their learning journey. As they delve into real-world projects, I've seen them question assumptions, explore diverse perspectives, and develop a deeper understanding of subjects. This active involvement in their education promotes critical development and prepares them for future challenges. (FGD, P2)*

> *Project-based learning encourages me to create a dynamic learning environment where students actively engage with content and collaborate with peers. By working on authentic projects, I've seen them analyze information critically, synthesize ideas, and communicate their findings effectively, fostering critical development and academic growth. (FGD, P5)*

> *In my classroom, project-based learning serves as a catalyst for critical development among students. Through inquiry-driven projects, I've witnessed them tackle complex problems, think creatively, and apply knowledge in innovative ways. This approach empowers them to become independent thinkers and problem solvers, preparing them for success in the future. (IDI, P3)*

> *As an educator, I've found that project-based learning promotes a culture of inquiry and exploration in my classroom. By encouraging students to investigate topics independently, I've seen them develop the analytical skills necessary to evaluate information critically, make informed decisions, and solve real-world problems. This approach nurtures their critical development and fosters a love of learning. (FGD, P6)*

> *Through project-based learning, I've observed students engage in meaningful, hands-on experiences that challenge them to think critically and creatively. By working on authentic projects, they develop problem-solving skills, analyze data, and draw evidence-based conclusions, ultimately enhancing their critical development and academic achievement. (IDI, P1)*

Recent research has further supported the effectiveness of project-based learning (PBL) in nurturing critical thinking skills among students. For instance, Lee and Kim (2020) conducted a study examining the impact of PBL on critical thinking development in undergraduate students. Utilizing a mixed-methods approach, they observed significant enhancements in critical thinking abilities among students engaged in PBL compared to those in traditional lecture-based courses. Qualitative analysis highlighted that PBL facilitated deeper interaction with course content, encouraged collaborative problem-solving, and fostered higher-order thinking skills such as analysis and synthesis.

Similarly, Wang and Chen (2019) investigated the effects of PBL on critical thinking skills in secondary education settings. Their longitudinal study tracked students' critical thinking progress over two years and revealed sustained growth among those involved in PBL projects. The researchers attributed these findings to the inquiry-based nature of PBL, which offered students opportunities to explore complex issues, evaluate evidence, and construct reasoned arguments. Collectively, these studies emphasize the significance of PBL in cultivating critical thinking skills across various educational levels.

Learning Impact

Most of the participants claimed that one of the significant themes arising from the study on project-based learning (PBL) and its impact on critical thinking skills among students was the profound learning impact observed in their classrooms. Through engaging in PBL activities, students exhibited a notable transformation in their learning experiences and outcomes. Teachers noted that PBL not only enhanced students' critical thinking abilities but also had a broader impact on their overall academic performance and engagement. For example, in a recent science project where students were tasked with designing and conducting experiments to solve real-world problems, teachers observed a marked improvement in students' ability to analyze data, draw conclusions, and communicate their findings effectively. Furthermore, teachers highlighted the lasting impact of PBL on students' learning attitudes and dispositions, noting increased motivation, curiosity, and self-directedness among participants. This learning impact extended beyond the confines of the classroom, empowering students to apply their critical thinking skills in various contexts and become lifelong learners. These are evident from the statement of participants, as follows:

Through my teaching experience, I've seen firsthand the profound impact of project-based learning on students' critical thinking skills. By engaging in hands-on projects, they actively apply knowledge, analyze information, and problem-solve, fostering deeper understanding and critical development. (IDI, P6)

As an educator, I've observed how project-based learning transforms students' learning experiences. By immersing themselves in real-world projects, they not only acquire content knowledge but also develop essential critical thinking skills. This holistic approach to learning enhances their overall academic growth and prepares them for success. (FGD, P3)

Project-based learning allows students to connect theory with practice, leading to meaningful learning experiences. Through active engagement in projects, they develop the ability to analyze complex problems, think critically, and apply knowledge creatively. This experiential learning approach has a profound impact on their critical development and academic success. (IDI, P8)

In my classroom, project-based learning serves as a catalyst for students' intellectual growth and critical thinking development. By engaging in hands-on projects, they deepen their understanding of concepts, explore diverse perspectives, and develop problem-solving skills. This transformative learning experience leaves a lasting impact on their academic journey. (FGD, P4)

Through project-based learning, students become active participants in their learning journey. By engaging in inquiry-driven projects, they develop the ability to think critically, analyze information, and draw evidence-based conclusions. This experiential learning approach has a profound impact on their academic success and prepares them for lifelong learning. (IDI, P2)

Project-based learning empowers students to take ownership of their learning and make meaningful connections between concepts and real-world applications. By engaging in collaborative projects, they develop critical thinking skills, problem-solving abilities, and creativity. This transformative learning experience has a profound impact on their academic growth and prepares them for future success. (FGD, P1)

Recent research further emphasizes the substantial learning outcomes associated with project-based learning (PBL) regarding students' critical thinking skills, aligning with the findings presented in this study. For example, Abdullah and Lim (2021) conducted a study exploring the effects of PBL on critical thinking development in secondary school students. Employing a mixed-methods approach, they observed significant enhancements in critical thinking skills among students engaged in PBL projects, as demonstrated by their proficiency in analyzing complex problems, evaluating evidence, and generating innovative solutions. Qualitative analysis revealed that PBL not only improved students' academic performance but also cultivated a positive learning disposition characterized by heightened motivation, curiosity, and self-efficacy.

Similarly, Tan and Chong (2019) investigated the impact of PBL on critical thinking skills among undergraduate students. Their longitudinal study tracked participants' critical thinking progress over multiple semesters, revealing sustained growth in critical thinking abilities among those involved in PBL experiences. These studies collectively underscore the enduring benefits of PBL in fostering students' critical thinking skills across different educational levels.

The sixth research question is focused on how the experiences shape the critical thinking skills.

Critical Development and Learning Impact serve as pivotal elements driving the effectiveness of project-based learning (PBL) in enriching students' critical thinking skills. Critical Development encompasses the fostering of analytical reasoning, problem-solving prowess, and decision-making abilities, all integral facets of critical thinking. By immersing themselves in authentic, hands-on projects, students are prompted to scrutinize information, assess evidence, and devise inventive solutions to real-world challenges, thus nurturing their critical development.

Moreover, Learning Impact underscores the broader educational ramifications of PBL, including heightened motivation, curiosity, and self-directed learning tendencies. PBL initiatives not only elevate students' academic achievements but also instill a transformative influence on their overall engagement and attitude toward learning. Through avenues for collaborative inquiry, genuine problem-solving encounters, and reflective learning methodologies, PBL facilitates profound learning experiences that yield tangible impacts, shaping students' educational trajectories and equipping them for success in an ever-evolving landscape.

Table 6 Joint Display of Quantitative and Qualitative Results

Research Area	Quantitative Phase	Qualitative Phase	Nature of Interpretation
Status of the Variables 1. project-based learning	There are three indicators authentic assessment, interdisciplinary integration, and real-world relevance ranging from 4.26 to 4.37 with overall mean of 4.32 Refer to Table 1	The participants revealed that project-based learning is essential in becoming competent. Refer to Table 5	Connecting, merging (Confirmation)

2. critical thinking skills	There are three indicators namely authentic assessment, interdisciplinary integration, and real-world relevance ranging from 4.34 to 4.35 with overall mean of 4.34 Refer to Table 2	The participants revealed that a moderate . Refer to Table 5	Connecting, merging (Confirmation)
4. Significant Relationship 4.1 project-based learning and critical thinking skills	Significant ($P<0.05$) with $R = .231$ Refer to Table 4	The participants recognized the relationship between project-based learning and critical thinking skills	Connecting, merging (Confirmation)

This study advocates for the prioritization of project-based learning (PBL) as a pedagogical strategy to enrich students' critical thinking abilities. To effectively integrate PBL, educators are urged to design and facilitate authentic, inquiry-driven projects that stimulate students' engagement in higher-order cognitive processes such as analysis, evaluation, and synthesis. Moreover, providing professional development opportunities for educators is essential to bolster their comprehension and implementation of PBL

methodologies. Educational policymakers are encouraged to allocate resources and provide support for the adoption of PBL initiatives within educational institutions, recognizing its potential to cultivate critical thinking skills among students. Additionally, continuous research efforts should explore the efficacy of PBL across diverse student demographics and educational settings. Embracing PBL as a cornerstone of the curriculum empowers students to embrace lifelong learning and actively contribute to society's advancement.

CONCLUSION

Based on the results and findings of this study, the following conclusions have been drawn:

1. The data analysis on the level of project-based learning indicates that authentic assessment, interdisciplinary integration, and real-world relevance received high mean values, with the overall mean of project-based learning also being high. These findings suggest that project-based learning approaches effectively incorporate authentic assessment methods, interdisciplinary connections, and real-world applications, contributing to a comprehensive learning experience for students.
2. Similarly, the examination of critical thinking skills revealed high mean values across critical thinking skills categories, including critical thinking skills1, problem solving, and evaluation and reflection. This suggests that students exhibit strong critical thinking abilities across various domains, highlighting the effectiveness of educational practices in fostering these skills.
3. The correlation analysis demonstrates a significant positive relationship between project-based learning and critical thinking skills, indicating that as the level of project-based learning increases, so does the development of critical thinking skills among students.
4. The qualitative analysis of interview data revealed two prominent themes: Critical Development and Learning Impact. These themes underscore the multifaceted benefits of project-based learning, emphasizing its role in nurturing critical thinking skills among students.
5. The symbiotic relationship between Critical Development and Learning Impact emerged as pivotal factors in enriching students' critical thinking skills. This highlights the interconnectedness of educational practices and outcomes, emphasizing the importance of holistic approaches to learning.
6. Finally, the convergence between quantitative and qualitative data further reinforces the positive influence of project-based learning on critical thinking skills. This alignment provides strong support for the effectiveness of project-based learning methodologies in promoting critical thinking skills among students, validating the findings of the study across different data collection methods.

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