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The Relationship between Project-Based Learning (PBL) and Critical Thinking Skills among TVET Students: An English and Aesthetic Education Perspective

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ABSTRACT

Technical and Vocational Education and Training (TVET) face challenges in developing students' critical thinking skills alongside English language proficiency. Conventional instructional approaches often emphasise technical competencies but provide limited opportunities for meaningful learning through aesthetic experiences. To address this gap, project-based learning (PBL) is proposed as a pedagogical approach that integrates active learning, language use, and aesthetic engagement. This study aims to examine the relationship between the implementation of PBL and the critical thinking proficiency of TVET students in English language learning within an aesthetic education framework. A quantitative correlational research design was employed, involving 154 TVET students as the sample. The findings are expected to provide empirical evidence on the effectiveness of PBL in enhancing critical thinking while promoting meaningful and experiential language learning in TVET contexts. The questionnaire instrument utilised has completed a pilot study and demonstrates exceptional reliability, evidenced by an overall Cronbach's Alpha value of 0.911 for 20 study items. Descriptive analysis indicates that the implementation of PBL is high, with a mean of 4.44 and a standard deviation of 0.457. Similarly, the level of students' critical thinking is also high, with a mean of 4.35 and a standard deviation of 0.435. The Shapiro–Wilk normality test indicated that the data distribution for both variables was not statistically normal ($p < .001$). Consequently, the Spearman correlation test was employed to evaluate the study hypothesis. The analysis indicated a significant positive correlation between PBL and students' critical thinking levels ($r_s = 0.634$), thereby rejecting the null hypothesis (Ho). This study demonstrates that the implementation of PBL significantly correlates with the enhancement of critical thinking among TVET students, particularly in English language learning, which prioritises active participation, reflection, and the appreciation of aesthetic education's value. This study indicates that PBL should be implemented as the primary pedagogical in TVET to facilitate holistic, meaningful, and relevant learning aligned with industry requirements.

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1. INTRODUCTION

21st-century education prioritizes the cultivation of higher-order thinking skills, especially critical thinking, as a basis for generating adaptable and competitive graduates. In Technical and Vocational Education and Training (TVET), students are required to not only acquire technical skills but also exhibit sound judgment, problem-solving capabilities, and proficient communication in English, the global lingua franca of industry (Ibrahim, 2022). Nonetheless, English training in numerous TVET environments continues to be mostly teacher-centered and focused on examinations. Such methodologies often emphasize grammatical precision and subject proficiency at the expense of inquiry, reflection, and genuine language application, thereby restricting students' chances to participate in significant and critical learning experiences (Ntshauba, 2024).

This circumstance exposes a substantial pedagogical deficiency in contemporary TVET English education. Despite the industry's requirement for graduates to interact professionally, analyze workplace difficulties, and justify decisions in English, educational approaches frequently isolate language acquisition from occupational situations. Consequently, pupils may obtain superficial linguistic information without cultivating the cognitive and communicative skills necessary for real-world contexts.

Project-Based Learning (PBL) has been suggested as a viable method to rectify these deficiencies. PBL fosters active participation via genuine projects that necessitate student inquiry, collaboration, decision-making, and the creation of significant outcomes. This methodology corresponds with the practical and industry-focused characteristics of TVET (Junisbayeva, 2025). Extensive synthesis evidence corroborates its efficacy. Meta-analytic results demonstrate that problem-based and project-based methodologies substantially enhance learning outcomes and foster critical thinking across various disciplines and educational tiers. Rehman et al. (2023) and Williamson (2024) corroborated that students engaged in PBL had superior improvements in analytical, evaluative, and synthesizing skills relative to their counterparts instructed using traditional techniques. This individual research substantiates the overarching assertions generated from meta-analyses.

In higher and technical education settings, PBL has demonstrated its efficacy in enhancing reasoning via genuine problem-solving activities. Wang (2022) and Ospankulova (2025) discovered that students engaged in PBL demonstrated enhanced skills in justification, alternative evaluation, and the application of theoretical knowledge to practical situations. In English language education, Project-Based Learning (PBL) has been linked to enhancements in communicative competence and reflective thinking. Mariotti (2024) indicated that the implementation of PBL in ESL and ESP classrooms improved students' communication skills, problem-solving abilities, and metacognitive awareness. In TVET contexts, incorporating English into genuine occupational tasks enables students to view language as a means for professional thinking and workplace communication, rather than solely as an academic discipline.

Recent research indicates that integrating PBL with creative teaching approaches may enhance its effectiveness. Fatima et al. (2025) established that the amalgamation of project-based learning with a flipped classroom paradigm markedly enhanced vocational students' critical thinking and creativity. Research in mathematics and science education demonstrates that PBL improves conceptual application and reasoning abilities (DongJin & Mohamad Ashari, 2025; Mayasari & Syuhada, 2024). These findings collectively underscore the interdisciplinary efficacy of PBL.

Nonetheless, current PBL research exhibits numerous inadequacies concerning TVET English pedagogy. Numerous studies investigate Project-Based Learning (PBL) in general education, STEM, or higher education contexts, with scant attention to English instruction in vocational environments. Secondly, research frequently assesses overall academic performance instead of specifically investigating the advancement of critical thinking inside linked language-vocational frameworks. Third, inadequate focus

has been placed on how Project-Based Learning (PBL) might integrate features of aesthetic education such as reflection, value development, and significant engagement to enhance cognitive processing.

Academics have underscored the necessity for organized and methodical PBL module development to enhance results. Tampubolon and Sipahutar (2024) observed that students' critical thinking abilities are moderate, highlighting the necessity for effectively structured PBL frameworks. Buchman (2024) also noted that even high-ability learners necessitate specialized instructional strategies to enhance critical reasoning. Although alternative student-centered methodologies, including game-based language learning (Aydın & Çakır, 2020) and semantic inquiry-based instruction (Heron & Palfreyman, 2023), promote higher-order cognitive processes, they do not explicitly incorporate vocational authenticity alongside structured project design within TVET English contexts.

Aesthetic education provides an additional conceptual layer by highlighting introspection, creativity, values, and significant learning experiences (Schultz, 2025). Aesthetic components, when integrated into PBL, can be implemented through reflective project assessment, ethical communication methods, and intentional language use. Goshu and Ridwan (2024) established that reflective and participatory project involvement enhances the development of critical thinking. The efficacy of PBL is significantly contingent upon instructional design, teacher facilitation, and contextual implementation (Yu & Zin, 2023). Consequently, a systematic and context-specific examination is necessary to ascertain how PBL might effectively augment critical thinking in English education inside TVET environments (Willis, 2023).

While PBL is broadly acknowledged as an effective learner-centered methodology, empirical evidence from China and Malaysia indicates that its efficacy is significantly contingent upon contextual adaptation. Guo, Saab, Post, and Admiraal (2020) revealed that organized scaffolding markedly impacted the efficacy of PBL on students' higher-order thinking in Asian educational settings. A Malaysian quasi-experimental study by Jamaludin and Osman (2014) also shown that PBL enhanced conceptual knowledge and reasoning abilities; however, the extent of improvement was significantly influenced by instructional design and instructor facilitation. The data suggest that PBL effects cannot be generalized without considering contextual variables, like curriculum alignment and language competence levels.

In the Chinese setting, research indicates that although PBL improves collaborative and analytical abilities, cultural learning norms and assessment frameworks may influence its cognitive effects. Han, Capraro, and Capraro (2015) conducted a meta-analysis of Asian populations, including China, revealing moderate impact sizes for the development of critical thinking, while highlighting diversity across fields and the fidelity of implementation. This corresponds with Malaysian research by Abdul Halim, Meerah, and Osman (2010), which indicated that inquiry-oriented methodologies enhanced students' reasoning solely when explicit reflective elements were integrated into instruction. These studies collectively indicate that improvements in critical thinking are not inherent results of PBL; instead, they rely on organized reflection and contextual authenticity—key components of the current study.

Concerning aesthetic value, Chinese educational research has progressively associated meaningful learning with introspective involvement and emotional investment. Li and Liu (2022) investigated experiential learning design in Chinese higher education and discovered that students' perceived meaningfulness and reflective depth strongly forecasted higher-order thinking outcomes. While not frequently expressly termed "aesthetic education," these theories implement aesthetic value through quantifiable indications such as reflective journaling, creative output, and perceived task significance. In Malaysian contexts, these features have been linked to student-centered pedagogies that incorporate values and genuine problem-solving (Jamaludin & Osman, 2014). These findings underscore the necessity of assessing aesthetic involvement instead than regarding it solely as a philosophical concept.

Collectively, studies from China and Malaysia underscore three crucial insights. The efficacy of PBL is contingent upon the quality of its implementation and its connection with the context. The development of critical thinking necessitates explicit reflecting and evaluative elements, rather than simply the execution of projects. Third, significant and value-driven engagement conceptually connected with aesthetic education can be implemented and assessed utilizing structured instruments. Nevertheless, limited research has concurrently investigated the incorporation of PBL, critical thinking, and aesthetic value within a TVET English framework. This study fills the existing gap by integrating these variables within a Malaysian vocational higher education context, assuring contextual coherence while utilizing empirical evidence from similar Asian educational settings.

In conclusion, while numerous studies have demonstrated the efficacy of PBL in enhancing critical thinking, a gap remains in comprehending how to optimally integrate English language and aesthetic education principles within the TVET context (Wen, Yunus & Hashim, 2024). Thus, this study demonstrates that the implementation of PBL significantly correlates with the enhancement of critical thinking among TVET students, particularly in English language learning, which prioritises active participation, reflection, and the appreciation of aesthetic education's value.

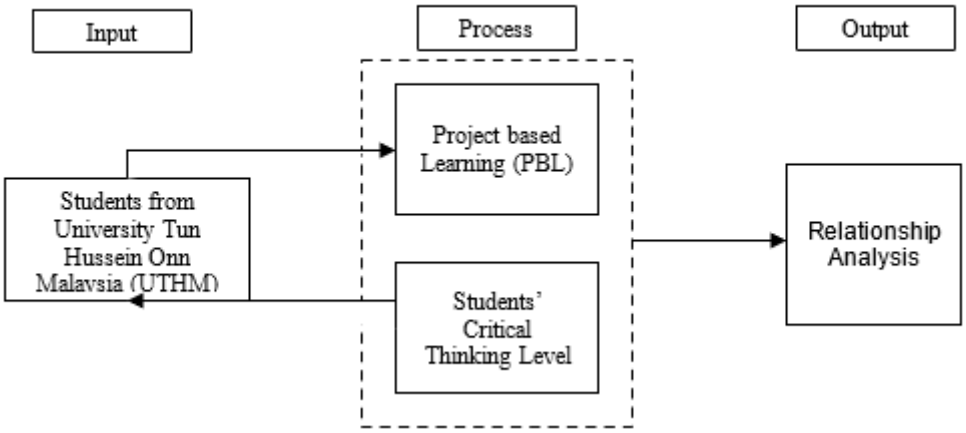

Fig. 1. Conceptual Framework of this Study

The study's conceptual framework, depicted in Figure 1, illustrates the relationship between various factors influencing students' enrolment decisions. The framework categorizes the independent variables into social perceptions and peer and parental influence, with the dependent variable being the enrolment decision influenced by these factors. The conceptual framework of this study, illustrated in Figure 1, demonstrates the relationship between PBL methods and students' critical thinking levels. The framework categorizes the independent variable as the identification and implementation of suitable PBL methods aimed at fostering critical thinking. The dependent variable is the students' critical thinking level, which is measured through their perceptions following PBL implementation. The framework also examines the relationship between the suitability of PBL methods and the level of critical thinking, highlighting how effective PBL contributes to cognitive development.

2. METHODOLOGY

This study employed a quantitative cross-sectional correlational design to examine the relationship between the implementation of Project-Based Learning (PBL) and students' critical thinking in a TVET English

context. The correlational approach was selected because the study aimed to determine the strength and direction of association between two measured variables perceived suitability of PBL implementation and students' critical thinking levels without manipulating instructional conditions. A cross-sectional design was deemed appropriate as data were collected at a single point in time following students' exposure to PBL-based instruction. The study was conducted at Universiti Tun Hussein Onn Malaysia (UTHM) and involved 154 students enrolled in courses that explicitly implement PBL elements. Participants were selected using purposive sampling to ensure that all respondents had direct experience with PBL activities in their coursework. This sampling strategy was justified to maintain contextual relevance, as the research sought to evaluate PBL practices within an authentic TVET learning environment.

Data were collected using a structured questionnaire comprising three sections: (1) demographic information, (2) perceived suitability and implementation characteristics of PBL, and (3) students' critical thinking levels within English learning tasks. Items were measured using a five-point Likert scale to enable quantitative analysis. The instrument was adapted from established critical thinking and PBL implementation frameworks to ensure content validity. Prior to data collection, the instrument underwent expert validation, and a pilot test was conducted to assess reliability using Cronbach's alpha coefficients. Descriptive statistics (mean and standard deviation) were used to determine overall levels of PBL implementation and critical thinking. Inferential analysis, specifically Pearson's correlation, was performed to examine the relationship between the suitability of PBL methods and students' critical thinking levels. This analytical procedure was selected to align with the study's objective of identifying the degree of association between variables. All statistical analyses were conducted using appropriate statistical software, with significance levels set at $p < .05$.

This methodological approach enables systematic examination of how PBL practices relate to critical thinking development within a TVET English setting, while maintaining empirical rigor through validated instruments and statistical analysis procedures.

2.1 Population and Sample Study

Researchers employ sampling techniques to systematically and carefully select a group of respondents from a larger population. Appropriate sample selection is essential to ensure that the research findings fairly and accurately represent the overall population under study. In this research, simple random sampling was applied. According to Noor, Tajik & Golzar. (2022), simple random sampling refers to a method in which every member of the population has an equal probability of being selected as a study sample. The population of this study consists of 250 students from UTHM who are directly involved in the implementation of PBL within their academic courses. The selection of university students as the study population is appropriate, as higher education environments emphasize the development of critical thinking skills through active learning approaches such as PBL. Previous research by Hasan et al. (2024) also supports the use of university students as relevant respondents in studies related to the effectiveness of PBL and the development of higher-order cognitive skills. Based on the sampling table, the total population comprises 250 students, from which 154 respondents selected as the study sample. The systematic application of this sampling method is expected to provide an accurate representation of university students' perceptions

Table1. Study of a Research Sample

Sample	Faculty	Number of Respondents
Universiti Tun Hussein Onn Malaysia (UTHM) Student	FPTV	68
	FKEE	20
	FPTP	9

	FKMP	18
	FKAAB	19
	FSKTM	20
	Total	154

2.2 Participation Criteria

The participation criteria for this study include students who are enrolled as full-time students at UTHM. In addition, the respondents consist of students who were taught using clear and easily understandable approaches during the implementation of projects at various stages of their courses. Students enrolled in the aforementioned courses throughout the academic semester are also responsible for ensuring that their learning experiences are aligned with the course objectives. In this sample, only students who expressed interest in participating as respondents were involved in the study.

2.2 Research Instrument

A content validation process was implemented before data collection to verify the questionnaire accurately measured the intended constructs. The tool underwent evaluation by two subject-matter experts possessing recognized academic and professional credentials pertinent to the study. The first expert is a senior academic in Technical and Vocational Education and Training (TVET), possessing over 15 years of expertise in curriculum creation, project-based learning implementation, and vocational pedagogy at the higher education level. The second expert specializes in educational psychology and critical thinking evaluation, has substantial experience in instrument creation and validation research. The term “academic and professional expertise” in this study denotes the experts’ formal qualifications (doctoral degrees in pertinent educational disciplines), peer-reviewed publications concerning PBL and critical thinking, experience in supervising postgraduate research, and active participation in curriculum design and instructional innovation. Their collective knowledge guaranteed that the instrument was assessed from both educational (TVET and PBL application) and psychometric (critical thinking measurement) viewpoints.

Each questionnaire item was meticulously assessed according to three principal criteria: (1) relevance to the construction being measured (PBL implementation and critical thinking), (2) clarity and suitability of language for UTHM students, and (3) conformity with the operational definitions and study objectives. The experts received the construct definitions and a validation checklist to facilitate their assessment. They were additionally requested to offer qualitative feedback and specific suggestions for enhancement. In response to their feedback, multiple items were amended to improve conceptual accuracy, diminish ambiguity, and guarantee contextual appropriateness within a TVET English learning setting. Modifications encompassed rephrasing technical terminology, enhancing Likert-scale statements to more accurately represent observed learning behaviors, and augmenting the coherence between items and theoretical characteristics of critical thinking. The iterative refinement procedure enhanced the instrument's content validity and contextual relevance.

The validation process confirmed that the questionnaire exhibited significant content relevance, conceptual coherence, and practical applicability for use among UTHM students. Thus, the instrument is anticipated to produce data that are valid, reliable, and congruent with the aims of investigating the correlation between PBL implementation and students' critical thinking within a TVET framework.

Table 2. Instrument for Distribution of Items

Section	Item	Likert scale
A Respondent Profile	4 Item	None
B Project based Learning	5 Item on Effectiveness of PBL	1 - 5
	5 Item on Implementation Process PBL	1 - 5
C Students' Critical Thinking Level	10 Item	1 - 10

2.3 Instrument Validity

Instrument validity was conducted to ensure that the instrument used accurately measures what it is intended to measure. In this study, content validity of the instrument was reviewed by two experts in the fields of education, PBL, and critical thinking. Suggestions and feedback provided by the experts were used to improve the questionnaire items in terms of language clarity, content suitability, and alignment with the study objectives. This process aimed to ensure that the research instrument achieved a high level of validity.

One of the specialists was in Technical and Vocational Education and Training (TVET). The selection of experts was predicated on their academic and professional expertise to guarantee that the instrument evaluation was suitable for the implementation of PBL and the enhancement of critical thinking skills. Their knowledge facilitated the evaluation of the instrument from various viewpoints, encompassing educational theory and critical thinking skills. Each questionnaire item was assessed according to numerous critical factors, including content relevancy, clarity of meaning, and alignment with the study constructs. The experts' feedback was effectively utilized to refine item structure, vocabulary, and to augment responders' comprehension among UTHM students.

Overall, this process ensured that the research instrument possessed a high level of validity. As a result, the instrument is expected to produce accurate, reliable, and objective-aligned data. In conclusion, this approach ensured that the questionnaire was not only valid in terms of content but also practical and suitable for use among UTHM students, in line with the study's aim to evaluate the implementation of PBL and students' critical thinking skills.

2.4 Pilot Study

A pilot study was conducted prior to the actual study to test the reliability and clarity of the questionnaire items. A total of 30 students were selected as the pilot study sample. The data obtained from the pilot study were analysed to determine the reliability of the research instrument using Cronbach's Alpha coefficient. The pilot study involved 30 UTHM students who possessed characteristics and backgrounds like those of the actual study sample, which consisted of 154 respondents. The selection of the pilot sample was based on the recommendation that a certain percentage of the actual study sample be used, ensuring that the questionnaire items were suitable for use across different academic programmes and accurately reflected the real context of the study.

Data obtained from the pilot study were analysed using Cronbach's Alpha, a standard method for assessing the reliability of research instruments. The overall Cronbach's Alpha value for the instrument was 0.911 across 20 questionnaire items, indicating a high level of internal consistency. This satisfactory reliability coefficient demonstrates that the instrument is stable, consistent, and appropriate for use in the actual study. Consequently, it provides confidence that the data collected will be valid and reliable. In addition, the findings from the pilot study enabled the researchers to refine the questionnaire items, including adjustments to terminology, item arrangement, and sentence clarity, to ensure that the instrument was easily understood by the target respondents.

3. RESULT

3.1 Descriptive Statistics

Descriptive statistics were used to describe the general characteristics of the data for both study variables. This analysis involved three main indices, namely the mean, standard deviation and range. The mean was used to indicate the central tendency of the score distribution, the standard deviation represented the degree of dispersion of respondents' scores from the mean, while the range indicated the overall variation between the highest and lowest scores. The high mean values for both variables indicate that the students' level of PBL Implementation and Critical Thinking Level is high. The low standard deviation values indicate that the response scores are uniform. The moderate range indicates that the score variation is not too wide.

Table 3. PBL in English and Aesthetic Education Result

No	Item	Mean	Standard Deviation	Interpretation
Effectiveness of PBL				
1	PBL helps me understand learning topics more deeply.	4.39	0.629	High
2	I remember learning content more easily when learning through projects.	4.42	0.655	High
3	I can apply the theory learned in real situations through project implementation.	4.4	0.299	High
4	The projects implemented increase my interest in the subject being studied.	4.43	0.625	High
5	PBL makes learning sessions more interesting and enjoyable.	4.46	0.715	High
Implementation Process PBL				
1	The assigned projects present a challenge commensurate with my capabilities.	4.4	0.681	High
2	Project assignments motivate me to independently seek supplementary information.	4.49	0.629	High
3	PBL enables me to engage in active collaboration with peers.	4.52	0.585	High
4	The instructor offers sufficient direction during the project execution process.	4.35	0.710	High
5	The undertaken projects enhance my creative capacity in learning.	4.50	0.586	High
	Average	**4.436**	**0.457**	**High**

The study findings indicate that the implementation of PBL in English and aesthetic education is highly effective. The overall mean of 4.436, accompanied by a standard deviation of 0.457, indicates a consistent and favourable level of agreement among respondents regarding this approach. The elevated interpretation for all items suggests that PBL is an efficacious pedagogical method in fostering comprehensive mastery of the English language and an appreciation for aesthetic values in education. The findings indicate that PBL enhances students' comprehension of English content (mean = 4.39) and improves retention of linguistic input through project activities (mean = 4.42). Within the realm of aesthetic education, the executed projects enhance students' engagement in language acquisition (mean = 4.43) and render learning sessions more captivating and pleasurable (mean = 4.46). The incorporation of aesthetic elements, including creativity, expression, and art appreciation in PBL, can enhance students' emotional engagement and motivation in language acquisition.

The study findings indicate that PBL enables students to apply English language theory in practical contexts through the execution of authentic projects, including presentations, creative writing, or aesthetic performances (mean = 4.40). The minimal standard deviation for this item (SD = 0.299) indicates a strong consensus among respondents, thereby reinforcing the efficacy of PBL as a method that facilitates meaningful and contextual learning. This methodology aligns with the tenets of aesthetic education, which prioritizes reflective, expressive, and experiential learning opportunities. The findings indicate that challenging projects tailored to students' abilities (mean = 4.40) and active collaboration with peers (mean = 4.52) significantly enhance English language communication skills and aesthetic appreciation within the PBL implementation process. The enhancement of students' creative capacity (mean = 4.50) demonstrates that PBL facilitates the cultivation of imaginative and aesthetic skills in language acquisition. Sufficient lecturer support and guidance during project implementation (mean = 4.35) facilitates a focused and significant learning process. The findings of this study affirm that PBL is an effective method for enhancing English language acquisition through aesthetics and creativity.

Table 4. Critical Thinking Level in English and Aesthetic Education Result

No	Item	Mean	Standard Deviation	Interpretation
1	I can distinctly recognise the primary issue prior to seeking a resolution.	4.30	0.606	High
2	I can differentiate between the primary issue and the secondary issue in a situation.	4.28	0.691	High
3	I assess the veracity of information prior to utilising it in decision-making.	4.34	0.630	High
4	I can synthesise information from diverse sources to comprehend an issue.	4.31	0.681	High
5	I can impartially assess the merits and demerits of an argument.	4.35	0.662	High
6	I can discern the implicit assumptions in an opinion or information.	4.34	0.699	High
7	I evaluate various perspectives prior to forming conclusions.	4.42	0.603	High
8	I can propose rational solutions to a problem.	4.35	0.621	High
9	I can devise innovative solutions when confronted with a challenge.	4.31	0.662	High
10	I reassess my thoughts upon task completion.	4.49	0.551	High
	Average	**4.350**	**0.435**	**High**

The data suggest that respondents exhibit a high degree of proficiency in employing critical thinking skills, which are essential for mastering English Language and Aesthetic Education. The average score of 4.350 indicates the respondents' capacity to transcend fundamental literacy comprehension and engage in more profound analysis. In aesthetic education, this "High" level demonstrates that respondents possess the cognitive preparedness to appreciate works of art and literature not only superficially but also to comprehend the implicit meanings embedded within them. In the realm of English literacy, the capacity to assess diverse viewpoints (item 7, mean = 4.42) and discern implicit assumptions (item 6, mean = 4.34) is paramount. Respondents exhibited exceptional proficiency in literary criticism, actively interrogating nuances and biases within texts rather than passively accepting them. This capability aligns with the objective of aesthetic education, which underscores "perceptual acuity," defined as the discernment of nuanced distinctions between primary and secondary concepts in a narrative or artistic work (item 2, mean = 4.28).

Subsequently, this data underscores the respondents' potential for generating creative and innovative outputs. Aesthetic education necessitates that individuals confront challenges with unconventional solutions, as evidenced by a mean score of 4.31 for the item "developing innovative solutions." In English creative writing, this refers to students' capacity to synthesize information from diverse sources (item 4, mean = 4.31) to construct an original and persuasive argument or narrative. This capability demonstrates the successful integration of rational reasoning skills with creative expression in the teaching and learning process. The practice of reflection, which achieved the highest score (item 10, mean = 4.49), is the most crucial component in aesthetic and linguistic development. In English studies, the processes of revising writing (editing and proofreading) and assessing the emotional impact of a work of art enable respondents to attain a greater degree of intellectual maturity. This metacognitive awareness guarantees that each aesthetic creation or verbal expression is the outcome of deliberate contemplation, thereby enhancing the overall quality of artistic appreciation and linguistic proficiency.

Table 5. PBL and Critical Thinking Level

Variables	PBL	Critical Thinking	Mean (M)	Standard Deviation (SD)
PBL	1	0.634	4.436	0.457
Critical Thinking	0.634	1	4.350	0.435

The findings of the study indicate that there is a significant correlation between the implementation of PBL and students' levels of critical thinking. This suggests that when students participate in PBL activities, they not only enhance their theoretical understanding of concepts but also improve their ability to think critically. Project-based activities encourage students to analyse problems, evaluate alternative solutions, and draw conclusions based on evidence. Therefore, this approach not only strengthens students' academic understanding but also develops essential critical thinking skills, which are crucial for addressing learning challenges and real-world situations beyond the classroom.

3.2 Review of Data Normality Correlation Assumption

The normality of the score distributions for each variable was examined using the Shapiro–Wilk test. The analysis results indicated that the significance values for both variables were $p < .001$, suggesting that the data distribution was statistically non-normal. However, due to the large sample size ($n = 154$) and the nearly symmetrical shape of the histograms, the data can be considered approximately normal in practice, in accordance with the Central Limit Theorem.

3.3 Relationship of Linear

The linear relationship between each variable was examined using a scatterplot. Observations indicated that the data points were distributed in an upward trend from the lower left to the upper right, suggesting a positive linear relationship between PBL and Critical Thinking Level in English and aesthetic education. Therefore, the linearity assumption is satisfied.

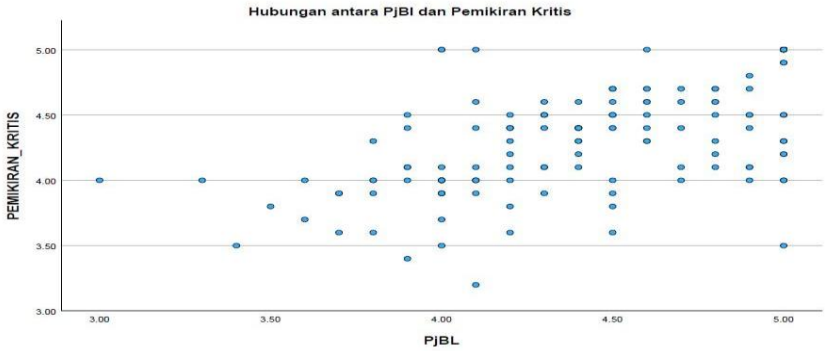

Figure 2: Scatterplot of linear relationship between PBL and Critical Thinking Level

3.4 Selection of Correlation Test

Based on the nature of the data and the objectives of the study, the Pearson correlation test was chosen to determine the relationship between PBL and Critical Thinking Level. This test was deemed appropriate because both variables were measured on a continuous scale. In addition, the data distribution was found to be approximately normal in practice, in line with the requirements for parametric analysis. The relationship between the independent and dependent variables also exhibited a linear pattern, thereby satisfying one of the main assumptions of the Pearson correlation test. Furthermore, the large sample size of the study allowed for the robust and effective application of this test. Therefore, the Pearson correlation test is considered suitable for determining the direction, strength, and significance of the relationship between PBL and Critical Thinking Level in this study.

3.5 Correlation Analysis

A Pearson correlation analysis was performed to investigate the relationship between critical thinking and PBL. The correlation coefficient of $R = 0.634$, $P < 0.001$, and a sample size of $N = 154$ indicate a robust and statistically significant positive relationship between PBL and critical thinking. This correlation value indicates that a rise in the implementation of PBL correlates with an enhancement in students' critical thinking levels. Conventional interpretations of correlation strength deem a R value greater than 0.50 as strong. Consequently, these results indicate that PBL has a substantial and significant correlation with students' critical thinking abilities.

Table 6. Results of Pearson correlation analysis between PBL and Critical Thinking Level

Variable	r	Sign. (p)	n

PBL with Critical Thinking Level	0.634	<.001	154

The Pearson correlation coefficient indicates a significant positive relationship between each variable. The correlation value of r = 0.634 suggests that the relationship is moderate to strong. This implies that as the level of PBL implementation increases, students' Critical Thinking Level also increases.

4. DISCUSSION

The application of PBL enhances English language acquisition and critical thinking abilities in vocational contexts. The study results indicate elevated scores on both variables, with TVET students participating in PBL exhibiting significant critical thinking abilities, so affirming that the project-based methodology can improve active and reflective engagement in English language within vocational training contexts. These findings align with existing data indicating that PBL fosters critical thinking via authentic learning experiences. The contextual and problem-based learning framework seems to establish a robust basis for enhancing students' critical thinking skills. PBL facilitates profound cognitive engagement with activities, the application of theoretical concepts in practical contexts, and the proficient use of English for professional discourse and learning. A study by Song et al. (2025) demonstrated a substantial enhancement in critical thinking scores following the integration of PBL into English language education within the Chinese environment.

The significance of PBL in vocational education in China enhances the pertinence of learning. Genuine projects in TVET cultivate analytical reasoning and intricate problem-solving, hence enhancing students' comprehension of real-world issues. This paradigm aligns with the discovery that PBL enhances critical thinking by engaging in tasks necessitating critical analysis and reflection. Despite the non-normal distribution of the data, Spearman's correlation (0.634) indicated a robust positive association between PBL and critical thinking. This indicates that, despite non-normal statistical settings, the association between the variables is substantial both practically and theoretically, aligning with past research on the educational impact of PBL on students' cognitive growth.

The PBL methodology affords students the chance to cultivate reflective thinking through introspection and social engagement. This method aligns with the concepts of constructivism, wherein students derive their own understanding through engagement with projects and peers. Research conducted by Jing et al. (2024) demonstrated that problem-based learning enhances critical thinking within a dynamic educational environment. The efficacy of PBL in enhancing critical thinking is intricately linked to the more authentic aspects of English communication. Students are urged to articulate, express, and elucidate their thoughts in English, leading to a more comprehensive and introspective language experience. This aligns with the evidence that PBL fosters critical thinking skills within a linguistic framework.

This strategy also promotes meta-cognitive thinking among students, consistent with the PBL literature in China. Students not only implement active learning practices but also assess them critically. This aligns with systematic research highlighting the improvement of critical thinking via PBL in the realm of language acquisition in China. This positive link facilitates the incorporation of aesthetic education ideas into project design. Aesthetic education in TVET can cultivate more significant and innovative learning experiences, encouraging students to value the learning process aesthetically rather than solely focusing on the outcome. This aligns with the literature indicating that aesthetic involvement in tasks enhances reflective learning.

The practical ramifications for English language instruction in TVET indicate that PBL facilitates language application in authentic contexts. Students engage with the language not merely in theory, but via practical assignments, enhancing their appreciation for the significance of language acquisition and critical thinking. Nonetheless, prior research has demonstrated that effective implementation of PBL necessitates robust

teacher preparation. The absence of facilitators knowledgeable in this method may diminish the efficacy of PBL implementation and the incorporation of artistic or English components. Additional research within Chinese literature suggests that educators require comprehensive training to proficiently oversee the PBL process.

The research reveals that the formal integration of PBL, critical thinking, English language, and aesthetic learning remains inadequately examined. While numerous studies have examined the impact of PBL on critical thinking in EFL language acquisition, there is a dearth of specialized research within the TVET context that integrates aesthetic education. The findings of this study indicate that PBL is an effective method for enhancing students' critical thinking within the realms of TVET and English language acquisition. The substantial correlation findings demonstrate that an increased adoption of PBL features corresponds with an elevated degree of students' critical thinking, consistent with international research trends.

5. CONCLUSION

This study demonstrates that the implementation of PBL significantly enhances critical thinking skills among TVET students, particularly in English language acquisition. This method promotes active participation, ongoing reflection, and experiential learning, consistent with the principles of language education that prioritize authentic usage and meaning creation. The incorporation of aesthetic education components via creative and expressive activities enhances the significance and enjoyment of learning while emphasizing the comprehensive development of students.

This study's findings indicate that PBL should be the primary pedagogical approach in the TVET context due to its capacity to facilitate holistic, contextual, and industry-relevant learning. By prioritizing collaboration, problem-solving, and critical thinking within an aesthetically driven English language learning context, Project-Based Learning (PBL) enhances academic proficiency while equipping students with essential soft and professional skills for the workforce. Consequently, the systematic and ongoing integration of PBL must be reinforced within the TVET curriculum to enhance the sustainable marketability of graduates.

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7. CONFLICT OF INTEREST STATEMENT

The author declares that there is no conflict of interest regarding the publication of this paper.

8. AUTHORS' CONTRIBUTIONS

Yin Liangyu: Conceptualisation, methodology, formal analysis, investigation and writing-original draft; **Guo Rongmei**: Conceptualisation, methodology, and formal analysis; **Khairul Anuar Abdul Rahman**: Conceptualisation, formal analysis, and validation; **Suhaizal Hashim**: Conceptualisation, supervision, writing- review and editing, and validation.

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