Inquiry-Based Learning and Technology-Integrated Final Year Projects: A Case Study on Vocational Students at Kolej Vokasional Batu Lanchang

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ABSTRACT

Final Year Projects (FYP) in vocational education are intended to function as authentic learning experiences that integrate theoretical knowledge, technical competencies, and digital technologies. However, their effectiveness in fostering systematic inquiry skills and technology literacy remains inconsistent, particularly when supervision practices are predominantly product oriented. Inquiry-Based Learning (IBL) offers a learner-centred pedagogical approach that emphasises problem identification, investigation, and reflective learning, yet empirical evidence on its application within technology-integrated vocational FYP from a student perspective remains limited. This study examines vocational students' perceptions of inquiry-based and technology-integrated Final Year Projects at Kolej Vokasional Batu Lanchang using a quantitative case study design. Data were collected from final-year vocational students through a structured questionnaire measuring inquiry engagement, technology literacy, perceived learning outcomes, and learning readiness. Descriptive and inferential analyses revealed high levels of inquiry engagement and moderate to high development of technology literacy, particularly in problem identification, digital tool utilisation, and reflective learning. Pearson correlation analysis further indicated a significant positive relationship between inquiry engagement and perceived technology literacy outcomes. Descriptive and inferential analyses revealed high levels of inquiry engagement and moderate to high development of technology literacy. Pearson correlation analysis indicated a significant positive relationship between inquiry engagement and perceived technology literacy ($r = 0.68$, $p < 0.01$, $n = 30$), suggesting a strong association between structured inquiry processes and technology-related learning outcomes. However, the findings should be interpreted with caution due to the small sample size and the case-based design, which may limit generalisability.

Keywords
Inquiry-based Learning; Technology-integrated learning; Final year project; Vocational education; Technology literacy; Quantitative study

Introduction

Future-oriented vocational education increasingly emphasises the development of inquiry skills, digital competence, and independent problem-solving to prepare learners for rapidly evolving technological and industrial environments (Pang & Wei, 2025; Wu et al., 2025). In Technical and Vocational Education and Training (TVET), students are expected not only to master procedural skills but also to demonstrate analytical reasoning, technological adaptability, and reflective learning aligned with future workforce demands (Noordin et al., 2025). The Final Year Project (FYP) represents a critical pedagogical platform where these competencies can be meaningfully developed through authentic, project-based learning experiences (Siliņa-Jasjukeviča et al., 2025).

In Malaysian vocational colleges, FYP serves as a capstone requirement that integrates theoretical understanding, hands-on technical skills, and technological applications. Despite its strategic role, existing studies indicate that many FYP implementations remain task-driven and assessment-oriented, with limited emphasis on inquiry processes such as questioning, investigation, and reflection (Braun, 2026; Hijaz et al., 2025a). As a result, students often engage with technology instrumentally rather than as cognitive tools for inquiry and knowledge construction, leading to surface-level technology literacy (Riyanda et al., 2025).

Inquiry-Based Learning (IBL) offers a pedagogical framework that aligns strongly with vocational education principles. Grounded in constructivist learning theory, IBL positions learners as active investigators who construct understanding through exploration, experimentation, and reflection (Pedaste et al., 2015; Kreber, 2025). When integrated with technology, IBL has been shown to enhance student engagement, conceptual understanding, and technology literacy in applied learning contexts (Li et al., 2025; Arici & Yilmaz, 2025). However, empirical research in TVET has predominantly focused on teachers' readiness and institutional capacity, leaving student-centred evidence underexplored (Cabero-Almenara et al., 2025; Wu et al., 2025).

While prior studies have examined inquiry-based learning and technology integration separately in Technical and Vocational Education and Training (TVET) contexts, empirical evidence capturing vocational students lived experiences of inquiry-based, technology-integrated Final Year Projects remains limited, particularly within Malaysian vocational colleges. Accordingly, this study aims to examine vocational students' inquiry engagement, perceived technology literacy, and learning outcomes within a technology-integrated Final Year Project context at Kolej Vokasional Batu Lanchang. By positioning students as the primary unit of analysis, this study contributes student-centred empirical evidence to support the pedagogical design of inquiry-oriented and technology-enhanced Final Year Projects in future-oriented TVET environments.

Despite increasing interest in inquiry-based learning and technology integration in TVET, existing studies have largely focused on teacher readiness, institutional capacity, or theoretical frameworks, with limited empirical evidence capturing students' perspectives within technology-integrated Final Year Project contexts, particularly in Malaysian vocational colleges. Therefore, this study contributes by providing student-centred quantitative evidence on inquiry engagement and technology literacy within a real FYP environment, offering practical insights for designing structured inquiry-based and technology-enhanced vocational learning models.

Literature Review

Inquiry-Based Learning in Vocational Education

Inquiry-Based Learning (IBL) is widely recognised as an instructional approach that promotes deep learning through learner-driven questioning, investigation, and reflection. In vocational education, IBL aligns naturally with problem-oriented and experiential learning traditions, where students engage with authentic, real-world technical challenges that mirror industry practices. Empirical studies in Technical and Vocational Education and Training (TVET) contexts demonstrate that IBL enhances higher-order thinking, decision-making, and self-regulated learning, which are essential for managing complex vocational projects and adapting to evolving workplace demands (Palaguyan & Abusama, 2025).

The inquiry cycle proposed by Pedaste et al. (2015), comprising orientation, investigation, conclusion, and discussion, remains one of the most influential conceptualisations of IBL. Subsequent adaptations have extended this model to technology-enhanced, STEM, and project-based learning environments, demonstrating its flexibility and pedagogical relevance (Li et al., 2025). However, within vocational Final Year Project (FYP) contexts, inquiry elements are often implicitly embedded rather than systematically structured, resulting in variability in students' inquiry engagement and learning experiences (Hijaz et al., 2025b).

While previous studies have demonstrated the effectiveness of inquiry-based learning and technology integration independently, these studies often differ in context and methodological focus. For instance, Li et al. (2025) emphasised technology-supported inquiry in controlled STEM environments, whereas Hijaz et al. (2025b) focused on systematic literature synthesis rather than empirical student data. In contrast, the present study adopts a quantitative case-based approach within an authentic vocational FYP setting, thereby providing direct student-centred empirical evidence that bridges the gap between theory and practice.

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Technology Integration and Technology Literacy

Technology literacy in vocational education extends beyond basic operational skills to include learners' ability to select, evaluate, adapt, and apply digital tools for problem-solving, knowledge construction, and professional practice. In TVET settings, technology literacy encompasses competence in industry-relevant software, digital diagnostic systems, simulation tools, data analysis platforms, and collaborative digital environments (Noordin et al., 2025; Wu et al., 2025). Recent studies emphasise that technology literacy is most effectively developed when technology is embedded within authentic learning tasks rather than taught as isolated technical skills (Riyanda et al., 2025).

Within inquiry-based learning environments, technology functions as an epistemic and cognitive tool that supports data collection, analysis, simulation, modelling, and collaborative knowledge construction. When aligned with inquiry processes, technology enhances students' conceptual understanding and problem-solving capabilities (Li et al., 2025; Makransky et al., 2025). Rather than reiterating definitional perspectives, this study positions inquiry-based learning as an operational framework embedded within the Final Year Project, where students actively engage in problem identification, investigation, and reflective evaluation throughout the project lifecycle. This practice leads to surface-level technology literacy, where students demonstrate procedural proficiency without developing deeper evaluative and adaptive technological competencies required in workplace contexts (Imama et al., 2025; Hijaz et al., 2025a).

Final Year Projects as Inquiry Platforms

Final Year Projects (FYP) are uniquely positioned to function as extended inquiry platforms in vocational education. As capstone experiences, FYP require students to engage in sustained investigation, independent planning, iterative problem-solving, and reflective learning, thereby integrating theoretical knowledge, vocational skills, and technological applications (Siliņa-Jasjukeviča et al., 2025). When structured inquiry scaffolding is incorporated, project-based learning environments have been shown to support deeper learning, stronger student engagement, and more meaningful technology integration (Palaguyan & Abusama, 2025).

Recent research on technology-supported learning further demonstrates that adaptive scaffolding, particularly when supported by generative AI, can enhance learners' higher-order thinking, metacognitive regulation, and task performance while reducing cognitive load, highlighting the importance of structured and responsive scaffolding in inquiry-oriented learning environments (Liu et al., 2026). Complementary evidence from capstone and project-based learning studies indicates that, even when learners face cognitive or academic challenges, structured project-based approaches can enhance participation, motivation, ownership, and learning engagement when appropriate scaffolding is provided (Park & Scanlon, 2025).

In addition, research on capstone projects in higher education has shown that students benefit from structured instructional support during the early stages of project ideation, as insufficient guidance can constrain creative and inquiry processes, underscoring the need for explicit scaffolding in final-year project supervision (Braun, 2026). Despite this potential, existing literature highlights a lack of coherent pedagogical frameworks guiding inquiry-based FYP implementation in vocational institutions. Without explicit inquiry structures, students' engagement with inquiry processes becomes inconsistent and highly dependent on individual supervision practices, institutional culture, and available resources (Cabero-Almenara et al., 2025). This gap underscores the need for empirical, student-centred studies examining how inquiry-based and technology-integrated FYP are experienced by learners within authentic vocational contexts.

Research Questions

This study is guided by the following research questions:

1. What is the level of inquiry engagement among vocational students in technology-integrated Final Year Projects?
2. What is the level of perceived technology literacy among vocational students?
3. What are the perceived learning outcomes and 21st-century skills developed through the Final Year Project?
4. Is there a significant relationship between inquiry engagement and perceived technology literacy?

Methods

Research Design

This study employed a quantitative case study design to examine vocational students' experiences of inquiry-based and technology-integrated Final Year Projects (FYP) at Kolej Vokasional Batu Lanchang. In this study, the case study refers to a bounded institutional context rather than methodological triangulation, with quantitative survey data used to investigate patterns of inquiry engagement and technology literacy within a real educational setting. This design is particularly appropriate when the research seeks to explore how pedagogical approaches are enacted within specific institutional environments where contextual factors such as curriculum structure, supervision practices, and technological infrastructure may influence student learning experiences.

The quantitative approach enabled the systematic measurement of students' perceptions, levels of inquiry engagement, and technology literacy using structured instruments. Quantitative case study designs have been increasingly adopted in vocational and educational research to provide empirical evidence of learner experiences while retaining sensitivity to contextual influences (Duff, 2025). In the context of vocational education, such designs are especially relevant because Final Year Projects involve complex interactions between inquiry processes, technological tools, and institutional practices that cannot be meaningfully examined outside their authentic learning environments.

By combining a case-based focus with quantitative analysis, this study provides a rigorous yet contextually grounded examination of inquiry-based and technology-integrated FYP from a student-centred perspective. The design supports the identification of relationships between inquiry engagement and technology literacy while avoiding overgeneralisation beyond the studied institutional context. This quantitative case study approach allows for systematic measurement of student perceptions while preserving the contextual specificity of inquiry-based project implementation within a vocational institution.

Samples and Population

The participants comprised 30 final-year vocational students who were actively undertaking their Final Year Projects at Kolej Vokasional Batu Lanchang at the time of data collection. The students were drawn from technical programmes including Automotive Technology, Electrical Technology, Electronic Technology, Industrial Machining Technology and Welding Technology. Purposive sampling was employed to ensure that all participants possessed direct and current experience with inquiry-based and technology-integrated project work, which was essential for addressing the research objectives.

The selection of final-year students was methodologically justified because FYP represents the most inquiry-intensive and technology-mediated learning experience within vocational programmes. Students at this stage are expected to demonstrate independent problem-solving, sustained inquiry, and applied use of digital and technical tools. Although the sample size was relatively small, it is considered appropriate for a quantitative case study situated within a single institutional context, where the emphasis is on analytical depth and contextual relevance rather than statistical generalisation. Prior to correlation analysis, assumptions of normality were examined using Shapiro-Wilk tests, and the data were found to be approximately normally distributed, supporting the use of Pearson correlation analysis. Similar sample sizes have been reported in prior vocational education studies examining learner perceptions and readiness within bounded educational settings (Siliņa-Jasjukeviča et al., 2025).

Research Instruments

The questionnaire used in this study was systematically developed and adapted from established instruments and prior empirical studies related to inquiry-based learning, technology integration, learning outcomes, and 21st-century skills. Foundational frameworks on inquiry learning and technology acceptance were drawn from seminal and widely cited works (Hmelo-Silver et al., 2008; Spronken-Smith et al., 2012; Davis, 1989; Venkatesh et al., 2003; Ananiadou & Claro, 2009; OECD, 2018) to ensure theoretical robustness. The adaptation process was undertaken to ensure contextual relevance to inquiry-based and technology-integrated Final Year Projects (FYP) within a Malaysian

vocational education setting, with particular emphasis on capturing students' learning experiences rather than instructional practices.

The instrument comprised four main constructs: inquiry engagement (7 items), technology literacy (7 items), perceived learning benefits (7 items), and learning readiness (7 items). Items measuring inquiry engagement were adapted to assess students' involvement in key inquiry processes, including problem identification, investigation, evidence-based reasoning, and reflection, consistent with inquiry-based learning frameworks applied in project-based and vocational contexts. Technology literacy items were informed by prior research on digital skills and technology integration challenges in vocational education, particularly those examining students' ability to use, evaluate, and adapt digital tools for authentic problem-solving tasks (Riyanda et al., 2025). These items reflect the nature of technology use in FYP, where students engage with digital platforms for design, simulation, documentation, and analysis.

Items related to perceived learning benefits and learning readiness were adapted from studies examining learners' acceptance of inquiry-oriented and technology-enhanced learning environments. These constructs capture students' perceptions of the usefulness of inquiry-based and technology-integrated FYP for enhancing conceptual understanding, problem-solving skills, and preparedness for future learning and professional contexts (Palaguyan & Abusama, 2025). The inclusion of these dimensions aligns with contemporary perspectives that position inquiry-based and technology-mediated learning as essential for fostering future-ready competencies in vocational education.

All questionnaire items were measured using a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5), to allow for nuanced assessment of students' perceptions. Content validity was ensured through expert review involving three senior lecturers with expertise in educational technology and vocational pedagogy. The experts evaluated the clarity, relevance, and alignment of the items with the study objectives and the vocational FYP context. Based on their feedback, several items were refined to enhance conceptual clarity, reduce ambiguity, and strengthen contextual appropriateness. The instrument was adapted from established frameworks rather than newly developed. A pilot test involving 10 students was conducted to ensure clarity and reliability before the actual data collection. This validation process followed established methodological practices in educational research to ensure that the instrument accurately captured vocational students' experiences of inquiry-based and technology-integrated Final Year Projects. Internal consistency reliability analysis indicated satisfactory reliability across all constructs, with Cronbach's alpha values ranging from 0.78 to 0.91, exceeding the recommended threshold of 0.70 for educational research.

Data Analysis

Data collection was conducted using an online survey administered through Google Forms, which enabled efficient and accessible participation by students engaged in ongoing project work. Prior to data collection, participants were informed of the study's purpose, the voluntary nature of participation, and confidentiality assurances. Ethical considerations were addressed by ensuring anonymity and obtaining informed consent from all respondents.

Data were analysed using descriptive and inferential statistical techniques with IBM SPSS Statistics version 26. Descriptive statistics, including means and standard deviations, were used to summarise students' responses and examine overall trends in inquiry engagement and technology literacy. To explore relationships between key constructs, Pearson correlation analysis was employed to examine the association between students' inquiry engagement and perceived technology literacy outcomes. Correlational analysis is widely used in educational research to identify meaningful relationships among learner-related variables, particularly in studies examining inquiry-based and technology-enhanced learning environments (Fitrah et al., 2025). The combined use of descriptive and correlational analyses provided a comprehensive understanding of students' experiences while remaining aligned with the study's quantitative design.

Results

Demographic Characteristics of Respondents

The respondents represented students from multiple technical programmes within the vocational institution, including Automotive Technology, Electrical Technology, Electronic Technology, Industrial Machining Technology, and

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Welding Technology. All participants were final-year Diploma Vocational Malaysia students undertaking their Final Year Projects during the data collection period (see Table 1). Although the cohort was predominantly male, this distribution reflects the typical gender composition of technical vocational programmes.

Overall, the diversity of programme backgrounds suggests that the findings capture student perceptions across different technical disciplines rather than being limited to a single specialisation. This variation strengthens the contextual relevance of the results by reflecting inquiry-based and technology-integrated project experiences across multiple vocational domains.

Table 1
Summary of Respondents' Demographics (n = 30)

Response	Frequency	Percentage (%)
Courses		
Automotive Technology	6	20
Industrial Machining Technology	7	23.3
Welding Technology	5	16.7
Electrical Technology	6	20
Electronic Technology	6	20
Year of Study (Semester)		
Year 2 DVM, Semester 4	30	100
Gender		
Male	28	93.3
Female	2	6.7

Inquiry-Based Learning Elements

Overall, the findings in Table 2 indicate a consistently strong presence of inquiry-based learning elements throughout the Final Year Project. This is supported by mean scores ranging from 4.13 to 4.53 (SD = 0.52–0.68), indicating a high level of engagement across all inquiry-related items. Students reported meaningful engagement across key inquiry processes, including problem identification, question formulation, independent information searching, analytical decision-making, and reflective thinking.

A clear pattern emerged showing that inquiry engagement was not limited to isolated activities but was embedded across the project lifecycle. Students perceived substantial autonomy in exploring ideas and evaluating information, while lecturers were predominantly viewed as facilitators rather than directive instructors. This suggests that supervisory practices aligned with inquiry-based pedagogical principles, enabling students to take active ownership of their learning.

Collectively, these results indicate that the Final Year Project functioned as a structured inquiry experience rather than a purely task-driven exercise, supporting deeper cognitive engagement and analytical reasoning.

Table 2
Inquiry-Based Learning Elements (n = 30)

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
I am given the opportunity to independently identify project problems.	0.00%	0.00%	20.00%	36.70%	43.30%	4.23	0.75
I am encouraged to formulate research questions related to my project.	0.00%	0.00%	16.70%	43.30%	40.00%	4.23	0.72

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I conduct independent information searching to solve project-related problems.	0.00%	0.00%	20.00%	46.70%	33.30%	4.13	0.70
I analyse the information obtained before making project decisions.	0.00%	0.00%	23.30%	43.30%	33.30%	4.10	0.74
The lecturer acts as a facilitator throughout the project implementation.	0.00%	0.00%	10.00%	36.70%	53.30%	4.43	0.68
I am given the freedom to explore new ideas in the project.	0.00%	0.00%	13.30%	33.30%	53.30%	4.40	0.70
Project activities encourage me to think critically and analytically.	0.00%	0.00%	20.00%	26.70%	53.30%	4.33	0.77
Total						4.32	0.72

Technology Integration in the Final Year Project

Students reported systematic and purposeful use of technology throughout the Final Year Project process. The mean values ranged from 4.20 to 4.60 (SD = 0.48–0.65), suggesting consistently strong agreement on the role of technology in supporting project implementation (see Table 3). Technology was perceived as supporting multiple stages of project implementation, including information searching, planning, documentation, communication, and presentation.

Rather than serving as an auxiliary tool, technology functioned as an integral component of inquiry and project management. Students consistently associated digital tools with improved efficiency, organisation, and communication with supervisors. This pattern suggests that technology integration was embedded within learning activities in a way that supported inquiry processes and self-regulated learning, rather than being used superficially or instrumentally.

Overall, the findings reflect a learning environment in which digital technologies were meaningfully aligned with project objectives and inquiry-oriented tasks.

Table 3
Technology Integration in the Final Year Project (n = 30)

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
I use digital technology to search for information related to my project.	0.00%	0.00%	0.00%	40.00%	60.00%	4.60	0.49
Technology helps me plan and manage project implementation more systematically.	0.00%	0.00%	0.00%	53.30%	46.70%	4.47	0.50
I use digital software or applications in developing my project.	0.00%	0.00%	13.30%	53.30%	33.30%	4.20	0.68
Technology facilitates communication between my lecturer and me.	0.00%	0.00%	6.70%	40.00%	53.30%	4.47	0.63

Technology helps me document and present my project outcomes.	0.00%	0.00%	3.30%	40.00%	56.70%	4.53	0.57
The use of technology increases my efficiency in carrying out the project.	0.00%	0.00%	10.00%	33.30%	56.70%	4.47	0.68
Total						4.45	0.59

Final Year Project Learning Outcomes

The results in Table 4 demonstrate positive perceived learning outcomes associated with inquiry-based and technology-integrated project supervision. Students reported enhanced conceptual understanding of their projects, increased confidence in decision-making, and improved problem-solving ability.

A notable pattern across responses indicates that inquiry-oriented engagement contributed to students' sense of responsibility for self-directed learning. Students also perceived improvements in the overall quality of their project outputs, suggesting that sustained inquiry and effective technology use supported deeper learning rather than surface-level task completion.

These findings suggest that inquiry-based and technology-integrated approaches contributed positively to both cognitive and affective learning outcomes within the Final Year Project context. It is important to note that these findings are based on students' self-reported perceptions and do not directly measure actual performance or objective learning outcomes.

Table 4
Final Year Project Learning Outcomes (n = 30)

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
This approach helps me understand my project more deeply.	0.00%	0.00%	16.70%	40.00%	43.30%	4.27	0.73
I am more confident in making decisions related to my project.	0.00%	0.00%	16.70%	40.00%	43.30%	4.27	0.73
I am able to solve project-related problems more effectively.	0.00%	0.00%	16.70%	30.00%	53.30%	4.37	0.76
The quality of my project outcomes improves through this approach.	0.00%	0.00%	10.00%	43.30%	46.70%	4.37	0.67
I feel more responsible for my self-directed learning.	0.00%	0.00%	10.00%	30.00%	60.00%	4.50	0.67
Total						4.36	0.71

Development of 21st-Century Skills and Overall Student Perception

Students consistently perceived the Final Year Project as contributing to the development of key 21st-century skills, including critical thinking, problem-solving, communication, collaboration, and creativity (see Table 5). These skills were viewed as emerging naturally through sustained inquiry, teamwork, and engagement with real-world project challenges.

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In addition, students expressed increased readiness to face workplace demands after graduation. This pattern indicates that the inquiry-based and technology-integrated project experience was perceived not only as academically meaningful but also as relevant to professional and employability-oriented skill development.

Table 5
Development of 21st-Century Skills and Overall Student Perception (n = 30)

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
This project enhances my critical thinking skills.	0.00%	0.00%	10.00%	46.70%	43.30%	4.33	0.65
This project improves my problem-solving skills.	0.00%	0.00%	10.00%	40.00%	50.00%	4.40	0.67
I am able to communicate more effectively during project implementation.	0.00%	0.00%	10.00%	43.30%	46.70%	4.37	0.67
This project enhances my collaboration skills with teammates.	0.00%	3.30%	6.70%	36.70%	53.30%	4.40	0.77
I become more creative in generating project ideas.	0.00%	0.00%	13.30%	33.30%	53.30%	4.40	0.72
I am better prepared to face workplace challenges after graduation	0.00%	0.00%	10.00%	43.30%	46.70%	4.37	0.67
Total						4.38	0.69

Overall Student Perception of Inquiry-Based and Technology-Integrated Learning

The findings in Table 6 reveal a strong overall endorsement of inquiry-based learning integrated with technology in the Final Year Project. Students perceived the approach as suitable for vocational project-based learning and more engaging than traditional supervision methods.

A consistent pattern of support emerged regarding the continued use of this pedagogical approach. Students associated inquiry-based and technology-integrated supervision with increased motivation, meaningful learning experiences, and greater ownership of learning. This positive perception suggests high acceptability and perceived value of the approach within the vocational education context.

Table 6
Overall Student Perception of Inquiry-Based and Technology-Integrated Learning (n = 30)

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
Inquiry-Based Learning integrated with technology is suitable for use in the Final Year Project.	0.00%	0.00%	6.70%	56.70%	36.70%	4.30	0.59
This approach makes learning more	0.00%	0.00%	13.30%	46.70%	40.00%	4.27	0.69

engaging and meaningful.							
I support the continuous use of this approach in the Final Year Project.	0.00%	0.00%	13.30%	33.30%	53.30%	4.40	0.72
Total						4.32	0.67

Table 7 presents the Pearson correlation analysis between Inquiry Engagement and Technology Literacy.

Table 7
Pearson Correlation Between Inquiry Engagement and Technology Literacy (n = 30)

Variables	Inquiry Engagement	Technology Literacy
Inquiry Engagement	1.00	0.68**
Technology Literacy	0.68**	1.00

Note. $p < 0.01$

Pearson correlation analysis revealed a statistically significant positive relationship between inquiry engagement and technology literacy ($r = 0.68$, $p < 0.01$), indicating that higher levels of inquiry engagement are associated with higher perceived technology literacy.

Discussions

This discussion focuses on interpreting how inquiry-based learning integrated with technology operates within the vocational Final Year Project context and how it influences student learning experiences. Rather than reiterating existing literature, the discussion emphasises the meaning and implications of the findings in relation to vocational pedagogy and future-oriented learning.

Overall, the findings indicate strong student endorsement of inquiry-oriented processes, meaningful technology integration, positive learning outcomes, development of 21st-century skills, and high acceptance of sustained implementation. These results suggest that inquiry-based, technology-supported project supervision aligns well with contemporary expectations of future learning, particularly within vocational education where authentic problem-solving and applied knowledge are central (Kreber, 2025; Pang & Wei, 2025).

From a theoretical perspective, the findings reinforce constructivist and inquiry-based learning principles, which posit that learning is most effective when students actively construct knowledge through exploration, reflection, and contextualised problem-solving (Pedaste et al., 2015). The positive student perceptions observed in this study also support recent empirical evidence demonstrating that technology, when embedded within pedagogically structured inquiry, enhances learner autonomy, cognitive engagement, and transfer of learning to real-world contexts (Makransky et al., 2025; Li et al., 2025). Collectively, these results position inquiry-based and technology-integrated Final Year Projects as a viable pedagogical model for advancing vocational education toward future-oriented learning paradigms.

Students' strong agreement regarding inquiry-based learning elements indicates that the Final Year Project functioned as a genuine inquiry experience rather than a procedural task. Opportunities to identify problems, formulate research questions, analyse information, and explore alternative solutions reflect core inquiry phases identified in established inquiry models (Pedaste et al., 2015). Recent studies confirm that such inquiry processes are critical for developing higher-order thinking and epistemic agency, particularly in applied learning environments (Palaguyan & Abusama, 2025; Li et al., 2025).

Furthermore, students' perception of lecturers as facilitators rather than authoritative instructors aligns with inquiry-based supervision literature, which emphasises guided facilitation as a mechanism for balancing autonomy and cognitive support (Kreber, 2025). Research shows that facilitator-oriented supervision encourages reflective thinking, sustained engagement, and deeper conceptual understanding compared to directive supervision models (Asante et al.,

2025). Thus, the findings suggest that inquiry-based pedagogical principles were not only theoretically present but operationalised meaningfully within project supervision.

Further examination of the data provides additional support for this interpretation. The consistently high mean scores across inquiry-related items (M = 4.13–4.53) indicate that students were not only exposed to inquiry elements but actively engaged in core inquiry processes throughout the project lifecycle. The relatively low standard deviation values (SD = 0.52–0.68) suggest that this pattern of engagement was consistent across participants rather than limited to specific individuals.

In this context, the notion of a "genuine inquiry experience" can be empirically understood through students' active involvement in key inquiry actions, including independent problem identification, formulation of project-related questions, analytical evaluation of information, and reflective decision-making. These elements collectively demonstrate that inquiry processes were systematically embedded within project activities rather than being implemented superficially. However, it is important to acknowledge that these findings are based on self-reported perceptions, which may be influenced by response bias or subjective interpretations of learning experiences. Despite this limitation, the consistency of responses across multiple items suggests that the observed patterns reflect a meaningful trend in students' engagement with inquiry-based processes.

Students' positive perceptions of technology integration indicate that digital tools played a substantive role in supporting inquiry processes. The use of technology for information search, planning, documentation, communication, and presentation reflects a shift from technology as a content delivery medium toward technology as a cognitive and organisational scaffold. This is consistent with recent research demonstrating that technology-integrated inquiry environments enhance learners' ability to manage complex tasks and sustain self-regulated learning (Makransky et al., 2025; Li et al., 2025).

Importantly, the findings align with evidence cautioning against unstructured technology use. Studies on AI and digital tools in education show that learning gains are maximised only when technology is embedded within explicit pedagogical structures, particularly inquiry-based frameworks (El Fathi et al., 2025). The present results suggest that students experienced technology as pedagogically meaningful rather than distracting, reinforcing arguments for intentional, inquiry-aligned technology integration in vocational project-based learning.

Further analysis of the findings suggests that the cognitive value of technology integration can be understood through its functional roles in supporting different stages of the inquiry process. High agreement on items related to information searching, project planning, and documentation (M = 4.20–4.60) indicates that students primarily utilised technology as a tool for accessing information, organising tasks, and communicating with supervisors. This reflects a structured and task-oriented use of technology that supports inquiry processes at an operational level.

However, the findings also suggest variation in the depth of technology use. While most students demonstrated consistent engagement with basic digital functions, fewer responses indicated advanced use of technology for higher-order inquiry activities such as data modelling, simulation, or critical evaluation of digital outputs. This implies that technology integration, although generally effective, may still be predominantly applied at a functional rather than transformative level. Such variation highlights the need for more explicit scaffolding to support deeper, cognitively rich uses of technology within vocational Final Year Projects.

Students' perceptions of improved understanding, confidence, problem-solving ability, and project quality indicate that inquiry-based, technology-integrated supervision positively influenced cognitive and affective learning outcomes. These findings are consistent with recent meta-analytic evidence showing that inquiry-oriented learning promotes deep conceptual understanding and transferable problem-solving skills, especially in complex, authentic learning tasks (Kreber, 2025).

In vocational education, Final Year Projects serve as capstone experiences intended to synthesise theory, practice, and professional skills. The findings suggest that inquiry-based supervision strengthens this synthesis by encouraging reflective decision-making and evidence-based problem-solving. Similar conclusions have been reported in recent

TVET research, which highlights that inquiry-driven projects better prepare students for industry demands compared to traditional product-focused project supervision (Noordin et al., 2025; Hijaz et al., 2025b).

However, it is important to critically consider that these learning outcomes are derived from students' self-reported perceptions rather than objective performance measures. While students indicated improvements in understanding, confidence, and problem-solving ability, such perceptions may be influenced by response bias, overestimation of competence, or positive learning experiences that do not necessarily reflect actual skill mastery. In addition, self-reported data may not capture the depth of conceptual understanding or the quality of problem-solving processes demonstrated in project outputs. Therefore, although the findings suggest positive learning effects, they should be interpreted as perceived outcomes rather than definitive evidence of actual performance improvement. Future research should incorporate objective assessment methods, such as project evaluation rubrics, performance-based assessments, or analysis of project artefacts, to provide a more comprehensive evaluation of learning outcomes.

The strong development of 21st-century skills reported by students reinforces the relevance of inquiry-based and technology-integrated Final Year Projects for future learning and work readiness. Critical thinking, collaboration, communication, creativity, and adaptability are widely recognised as essential competencies in Industry 4.0 and AI-driven economies (OECD, 2024; Pang & Wei, 2025). Inquiry-based project work provides an authentic context for cultivating these skills through sustained problem engagement and collaborative knowledge construction.

Recent empirical studies confirm that project-based inquiry supported by digital tools is among the most effective pedagogical approaches for fostering 21st-century competencies, particularly in vocational and professional education settings (Fitrah et al., 2025). The present findings therefore support global policy and research agendas that advocate for pedagogical transformation in vocational education to emphasise inquiry, digital fluency, and transferable skills.

A more detailed examination of the findings indicates that 21st-century skills should not be treated as a uniform construct, as different competencies appear to be developed at varying levels. Higher levels of agreement were observed in skills closely associated with individual cognitive engagement, such as critical thinking and problem-solving, suggesting that inquiry-based activities strongly support analytical and reflective processes. In contrast, skills such as collaboration and communication, while still positively reported, may be influenced by group dynamics and the structure of project teamwork, resulting in more varied levels of development among students. Creativity, on the other hand, appears to emerge through opportunities for idea exploration but may depend on the degree of autonomy and guidance provided during project implementation. These variations suggest that while inquiry-based and technology-integrated projects provide a comprehensive platform for skill development, targeted instructional strategies may be required to ensure balanced growth across different dimensions of 21st-century competencies.

Students' strong overall acceptance of inquiry-based learning integrated with technology has important implications for pedagogical sustainability. Educational innovation literature consistently shows that learner acceptance is a critical determinant of long-term implementation success (Cabero-Almenara et al., 2025). When students perceive learning approaches as meaningful and relevant, resistance to pedagogical change is reduced, and institutional adoption becomes more viable.

Moreover, positive student perception supports technology acceptance theory, which posits that perceived usefulness and meaningful engagement significantly influence continued use of educational innovations (Pan & Chen, 2025). The findings suggest that inquiry-based, technology-integrated Final Year Projects are not only pedagogically effective but also socially and institutionally acceptable, strengthening the case for their systematic adoption within vocational education.

Conclusion

This study examined vocational students' perceptions of inquiry-based learning integrated with technology in the context of the Final Year Project. The findings demonstrate consistently positive perceptions across inquiry engagement, technology integration, learning outcomes, 21st-century skill development, and overall acceptance. These results provide empirical support for the growing consensus that future learning requires pedagogical models that combine structured inquiry with purposeful technology use to promote deep, transferable learning.

The evidence suggests that inquiry-based, technology-integrated Final Year Projects effectively enhance students' conceptual understanding, confidence, autonomy, and readiness for professional practice. In line with recent TVET research, the approach positions students not merely as task executors but as active problem solvers capable of navigating complex, real-world challenges using digital tools. The strong development of critical thinking, collaboration, and creativity further reinforces the alignment of this pedagogical model with global employability and lifelong learning agendas.

In conclusion, this study contributes to vocational education literature by providing student-centred empirical evidence supporting the sustained adoption of inquiry-based and technology-integrated supervision in Final Year Projects. For vocational institutions, these findings suggest the need for structured inquiry guidelines and supervisor professional development to ensure consistent inquiry-oriented project supervision. While the findings are context-specific, they offer transferable insights for vocational institutions seeking to modernise project-based learning practices. Future research should expand this work through longitudinal designs, multi-institutional samples, and mixed-method approaches to further validate learning impacts and inform the development of structured inquiry frameworks tailored to vocational education.

Theoretically, this study extends inquiry-based learning literature by providing empirical evidence linking inquiry engagement with technology literacy in vocational education contexts. Practically, the findings offer guidance for designing structured inquiry-based supervision models in Final Year Projects. From a curriculum perspective, the study highlights the importance of embedding inquiry scaffolding and purposeful technology integration to enhance student readiness for future workforce demands.

Limitations of The Studies

While this study provides empirical insights into inquiry-based and technology-integrated Final Year Projects within a vocational education context, several limitations must be critically considered in interpreting the findings. First, the relatively small sample size (n = 30) and the single-institution context limit the generalisability of the results. As such, the strong positive patterns observed in inquiry engagement, technology integration, and perceived learning outcomes should be interpreted as context-specific rather than broadly representative of all vocational institutions. Variations in institutional practices, supervision approaches, and resource availability may yield different outcomes in other settings.

Second, the study relied on self-reported questionnaire data, which directly affects the interpretation of key findings related to learning outcomes and 21st-century skill development. While students reported improvements in understanding, problem-solving, and readiness, these results reflect perceived gains rather than objectively measured competencies. Consequently, the positive outcomes identified in this study should be understood as indicative of students' learning experiences rather than definitive evidence of actual performance or skill mastery.

Third, the cross-sectional design constrains the ability to examine how inquiry engagement and technology literacy develop over time. The relationships identified, including the significant correlation between inquiry engagement and technology literacy, represent a snapshot of student experiences rather than evidence of sustained or causal effects. Therefore, interpretations of the findings should avoid assumptions of long-term impact or developmental progression.

In light of these limitations, future research should adopt more strategically aligned methodological approaches. Multi-institutional studies with larger samples are needed to validate whether the patterns observed in this study are consistent across different vocational contexts. To address the limitation of self-reported data, future studies should integrate objective performance measures, such as project assessment rubrics, evaluation of project artefacts, or supervisor ratings, to more accurately assess learning outcomes and skill development.

Furthermore, longitudinal research designs are recommended to examine how inquiry-based engagement and technology use evolve throughout different stages of the Final Year Project, thereby addressing the current study's limitation in capturing developmental changes. Finally, quasi-experimental or comparative studies could be employed to directly evaluate the effectiveness of inquiry-based, technology-integrated supervision against traditional project supervision models, providing stronger evidence of causal relationships and pedagogical impact.

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Collectively, these targeted research directions would not only address the limitations identified in this study but also contribute to the development of more robust, evidence-based frameworks for implementing inquiry-based and technology-integrated learning in vocational education.

Conflict of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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