Technology Literacy, Inquiry-Based Learning, and Final Year Projects in Malaysian Vocational Education: A Systematic Literature Review

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Abstract
Technology literacy has become a core requirement for vocational graduates as industries continue to adopt digital, automated, and data-driven systems. In Malaysian vocational colleges, the Final Year Project (PTA) is intended to serve as an authentic platform for applying technical knowledge; however, its existing structure provides limited guidance on integrating inquiry processes that cultivate technology literacy. This systematic literature review synthesises 36 peer-reviewed studies published between 2021 and 2025 to examine how technology literacy is conceptualised, how Inquiry-Based Learning (IBL) supports its development, and how current PTA practices align with research-based recommendations. Guided by PRISMA procedures, studies were identified through Scopus, Web of Science, ERIC, and Google Scholar, and analysed thematically. Five themes emerged: pedagogical approaches and IBL models, development of technology literacy, assessment and measurement, challenges and barriers, and strategies and best practices. The review demonstrates that IBL significantly enhances students' digital competence, inquiry reasoning, and reflective technological understanding. However, gaps remain in PTA documentation, assessment coherence, and institutional readiness for IBL implementation. The findings offer evidence-based direction for strengthening inquiry-oriented project design and better aligning vocational education with the technological competencies required in IR4.0 environments.
Keywords: Technology Literacy, Inquiry-Based Learning, Final Year Project, Vocational Education, Systematic Literature Review, IR4.0 Competencies

Introduction

The rapid expansion of digital, automated, and data driven technologies has reshaped global industrial practices and created new expectations for workers who must operate confidently in technology rich environments. In this context, technology literacy has become a fundamental competency that enables individuals to understand technological concepts, interpret digital information, apply technological tools effectively, and make informed decisions in technology-based settings. These expectations are consistent with constructivist perspectives that emphasise learning through active engagement and interaction with the environment, including technological tools (Piaget, 1970; Vygotsky, 1978). The cognitive aspects of technology literacy, such as interpreting information and transforming experience into meaningful understanding, reflect Schunk's (2020) view of learning as a cognitive process that involves organising, evaluating, and applying knowledge.

In the Malaysian Technical and Vocational Education and Training system, the Final Year Project or Final Year Project is intended to integrate theoretical knowledge, practical skills, and workplace relevant competencies. The project courses known as PTA 1 and PTA 2 require students to identify real problems, propose solutions, document processes, and present outcomes in a professional manner (KPM BPLTV-PTA, 2023). Although the PTA structure outlines procedures and assessment components, it provides limited guidance on inquiry processes, reflective technological reasoning, or the use of digital tools throughout the investigative stages of the project. This situation often results in a focus on final products rather than the inquiry-based processes that cultivate deeper technological understanding.

A substantial body of research supports the use of Inquiry Based Learning to strengthen technology literacy. Inquiry Based Learning encourages learners to investigate problems, analyse evidence, construct explanations, and reflect on the quality of their reasoning. These processes are aligned with the explanation building and meaning making described by Hmelo Silver et al. (2007). Recent empirical studies also show that Inquiry Based Learning strengthens digital competence, analytical skill, and confidence in technological problem solving when supported with digital tools such as simulations, virtual environments, data platforms, and interactive applications (Amiron et al., 2019; Rafiq et al., 2023; Mohammad Hussain et al., 2023). These capabilities represent the multidimensional nature of technology literacy that includes technical, cognitive, and reflective components.

Despite these advantages, Malaysian PTA guidelines have not fully incorporated inquiry- oriented processes or technology supported investigation. The guidelines encourage innovation and the use of technology in final project artefacts, but they do not specify how students should engage with digital tools during inquiry, analysis, or reflection. This is inconsistent with research recommendations that highlight the importance of iterative explanation building (Hmelo Silver et al., 2007), learner generated inquiry (Wuxue, 2023), and technology acceptance factors such as perceived usefulness and perceived ease of use that influence technological engagement (Davis, 1989). Without these components, many students complete their projects without developing the depth of technological reasoning needed for contemporary vocational work.

These gaps make it necessary to examine the existing literature systematically in order to understand how technology literacy is conceptualised, how Inquiry Based Learning

supports its development, and how vocational projects align with established pedagogical models. A systematic literature review guided by the PRISMA approach is appropriate for identifying patterns, synthesising evidence, and highlighting gaps in current practice. This review consolidates contemporary research to provide clear direction for improving inquiry-oriented project design and ensuring that the vocational curriculum prepares learners for the demands of increasingly digital and automated industries.

Problem Statement

The rapid digitalisation of contemporary industries has created an urgent need for graduates who possess strong technology literacy. Technology literacy extends beyond the ability to operate digital tools. It requires learners to analyse technological information, interpret data, evaluate digital processes, and make responsible decisions within technology mediated environments. Although Malaysia recognises the importance of technology literacy within national education goals, its integration into vocational pedagogy remains inconsistent and insufficiently articulated. When learners do not receive structured opportunities to develop these cognitive and reflective abilities, they may enter the workforce with technical competence but without the deeper analytical skills required in modern industrial settings.

In Malaysian vocational colleges, the Final Year Project or Final Year Project is intended to function as a comprehensive platform where students apply knowledge, demonstrate professional skill, and engage in authentic problem-solving tasks. However, an analysis of the PTA 1 and PTA 2 guidelines shows that these documents emphasise procedural documentation, design development, and final product presentation (KPM BPLTV-PTA, 2023). They provide limited guidance on inquiry processes or the purposeful integration of digital tools during problem identification, investigation, analysis, or reflective evaluation. This approach may result in project work that focuses on the creation of a technological artefact without engaging students in the deeper investigative processes required to build meaningful technological understanding.

Research consistently shows that Inquiry Based Learning is one of the most effective approaches for developing technology literacy. Inquiry Based Learning requires learners to explore authentic problems, gather information, analyse evidence, test ideas, and justify decisions through reasoned argumentation (Hmelo Silver et al., 2007). When digital tools such as simulation software, virtual environments, or data platforms are integrated into inquiry tasks, learners develop stronger analytical reasoning and greater technological competence (Rafiq et al., 2023; Mohammad Hussain et al., 2023). These cognitive and reflective processes align closely with constructivist theories that emphasise active knowledge construction (Piaget, 1970; Vygotsky, 1978) and the transformation of experience into meaningful understanding (Schunk, 2020).

Despite these findings, Malaysian PTA guidelines do not embed inquiry cycles or technology supported engagement within the project structure. The absence of explicit expectations for inquiry may cause substantial variation in instructional practice across institutions and reduce opportunities for learners to apply digital tools during investigation and reasoning. This gap reflects a misalignment between research-based recommendations and current project implementation. As a result, many vocational students may complete

their projects without developing the level of technological literacy required in technology intensive industries.

This situation demonstrates a significant structural gap within Malaysian vocational education. Although industry requires graduates who possess strong analytical and technological competence, the pedagogical and assessment structures intended to develop these competencies do not fully support inquiry-oriented learning. There is therefore a clear need for a systematic review of contemporary research to clarify how technology literacy is conceptualised, how Inquiry Based Learning strengthens its development, and how existing project structures can be improved to produce technologically capable graduates who are ready for the demands of an increasingly digital workforce.

Objectives and Review Questions
A systematic literature review requires clear objectives to guide the search strategy, screening procedures, and synthesis of findings. The purpose of this review is to consolidate contemporary research related to technology literacy, Inquiry Based Learning, and the implementation of Final Year Projects in vocational education. These three domains are interconnected, yet existing studies often examine them separately, which results in fragmented understanding of how technology literacy is developed within authentic project environments. Establishing explicit objectives is therefore necessary to ensure that the review remains focused on the constructs that are most relevant to the development of technological competence in vocational contexts.

The first objective of this review is to examine how technology literacy is conceptualised within recent studies. Technology literacy is increasingly viewed as a multidimensional competency that includes technical skill, cognitive process, reflective judgement, and responsible engagement with digital tools. Understanding how scholars define and position this competency is important for determining how it should be developed within vocational programmes.

The second objective is to investigate how Inquiry Based Learning contributes to the development of technology literacy. Inquiry Based Learning encourages learners to build understanding through investigation, evidence based reasoning, and reflective consideration of their decisions. These processes align closely with the cognitive and reflective aspects of technology literacy described in recent research. Identifying empirical evidence that supports the relationship between inquiry and technological competence is therefore essential.

The third objective is to analyse the extent to which Malaysian Final Year Project guidelines support inquiry oriented and technology supported learning. Although the PTA framework aims to strengthen project-based learning, it does not provide detailed direction on how learners should engage with inquiry processes or digital tools throughout the project lifecycle. Reviewing the alignment between PTA requirements and research based pedagogical approaches can clarify gaps and guide necessary improvements in curriculum design.

Based on these objectives, the following research questions guide this systematic review:

i. How is technology literacy conceptualised in recent vocational education literature.
ii. How does Inquiry Based Learning contribute to the development of technology literacy.
iii. To what extent do Malaysian Final Year Project guidelines support inquiry oriented and technology supported learning.

Methodology

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta Analyses guidelines. The PRISMA approach was selected because it provides clear and transparent procedures for identifying, screening, and synthesising research evidence. This method supports a rigorous and replicable analysis of literature related to technology literacy, Inquiry Based Learning, and Final Year Projects in vocational education. The review process consisted of three major stages, namely identification, screening, and eligibility, followed by a quality appraisal stage.

Identification

The identification stage involved determining appropriate keywords and selecting suitable databases. The review used the PICo strategy to identify core concepts related to the population, the phenomenon of interest, and the context. Based on this approach, four core areas were selected, namely Inquiry Based Learning, Final Year Projects, vocational students, and technology literacy. Additional related terms were added through thesaurus checks, analysis of keywords in earlier studies, and expert consultation. This process ensured the inclusion of a wide range of relevant documents.

Four academic databases were selected for the search, namely Scopus, Web of Science, ERIC, and Google Scholar. Two search techniques were applied. The first technique involved the use of advanced search functions in databases, which included phrase searching, Boolean operators, field codes, truncation, and wildcard functions. The second technique involved manual searching, which included snowballing and backward reference tracking to ensure that no relevant studies were overlooked.

Table 1
Inclusion and Exclusion Criteria

Criterion	Criterion	Criterion
Publication Type	Peer reviewed journal articles, empirical studies, conceptual papers	Theses, dissertations, conference abstracts, non-scholarly sources
Database Source	Scopus, Web of Science, ERIC, Google Scholar	Informal websites, non-indexed publications
Year Range	Studies published between 2021 and 2025	Publications before 2021
Language	English	Any non-English language
Context	Studies involving education, vocational learning, Inquiry Based Learning, technology literacy, or Final Year Projects	Studies unrelated to education or technology supported learning
Study Design	Quantitative, qualitative, mixed method, case studies, bibliometric reviews, and meta-analyses	Opinion pieces without academic basis or unsupported commentaries
Participants	Students, lecturers, vocational learners, or educational stakeholders	Studies focusing only on industrial processes without educational relevance

Table 1 summarises the criteria used to determine which articles were included or excluded at different stages of the screening process.

Search Strings

The search strings were developed based on combinations of core constructs related to Inquiry Based Learning, Final Year Projects, and technology literacy. The search string used in Scopus is presented in the table below. For other databases, the string was adjusted to match the functions available in each platform.

Table 2
Search Strings Used in the Systematic Review

Database	Database
Scopus	TITLE ABS KEY ("inquiry based learning" OR "problem based learning" OR "question driven learning" OR "discovery learning" OR "exploratory learning" OR "student centered inquiry" OR "research based learning" OR "experiential inquiry" OR "constructivist learning" OR "investigative approach" OR "guided inquiry" OR "open inquiry" OR "project oriented inquiry" OR "active learning strategies") AND TITLE ABS KEY ("final year project" OR "capstone project" OR "senior project" OR "undergraduate thesis" OR "graduation project" OR "exit project" OR "bachelor thesis" OR "industrial project" OR "design project" OR "major project work") AND TITLE ABS KEY ("technology literacy" OR "digital literacy" OR "ICT literacy" OR "computer literacy" OR "digital competence" OR "information literacy" OR "media literacy" OR "data literacy" OR "computational literacy" OR "twenty first century skills" OR "technological fluency")
Web of Science	Inquiry based learning AND technology literacy AND vocational education AND final year project
ERIC	Inquiry based learning AND digital competence AND vocational learning AND project work
Google Scholar	"Inquiry based learning" "technology literacy" "vocational students" "final year project" with manual snowballing

Screening

The screening stage involved the application of the inclusion and exclusion criteria. Articles retrieved from the initial search were screened based on title and abstract. Only studies published between 2021 and 2025 and written in English were retained. A total of 349 papers were identified during the initial search. After removing studies that did not meet the criteria, 70 articles were retained for the eligibility stage.

Eligibility

During the eligibility stage, full texts of the 70 retained articles were reviewed. Studies that did not focus on pedagogy, vocational learning, Inquiry Based Learning, project-based assessment, or technology literacy were removed. A total of 36 articles were found to be relevant and aligned with the objectives of this review. These articles provided empirical or conceptual insights into the relationship between Inquiry Based Learning, technology literacy, and Final Year Projects.

Quality Appraisal

The 36 included articles were evaluated using a quality appraisal framework adapted from previous systematic reviews. The framework assessed six criteria, namely clarity of

purpose, usefulness of the work, clarity of methodology, definition of concepts, comparison with existing work, and articulation of limitations. Each criterion was scored using three options: Yes, Partly, or No. All 36 articles achieved a minimum score of 3.0, which indicated acceptable scholarly quality.
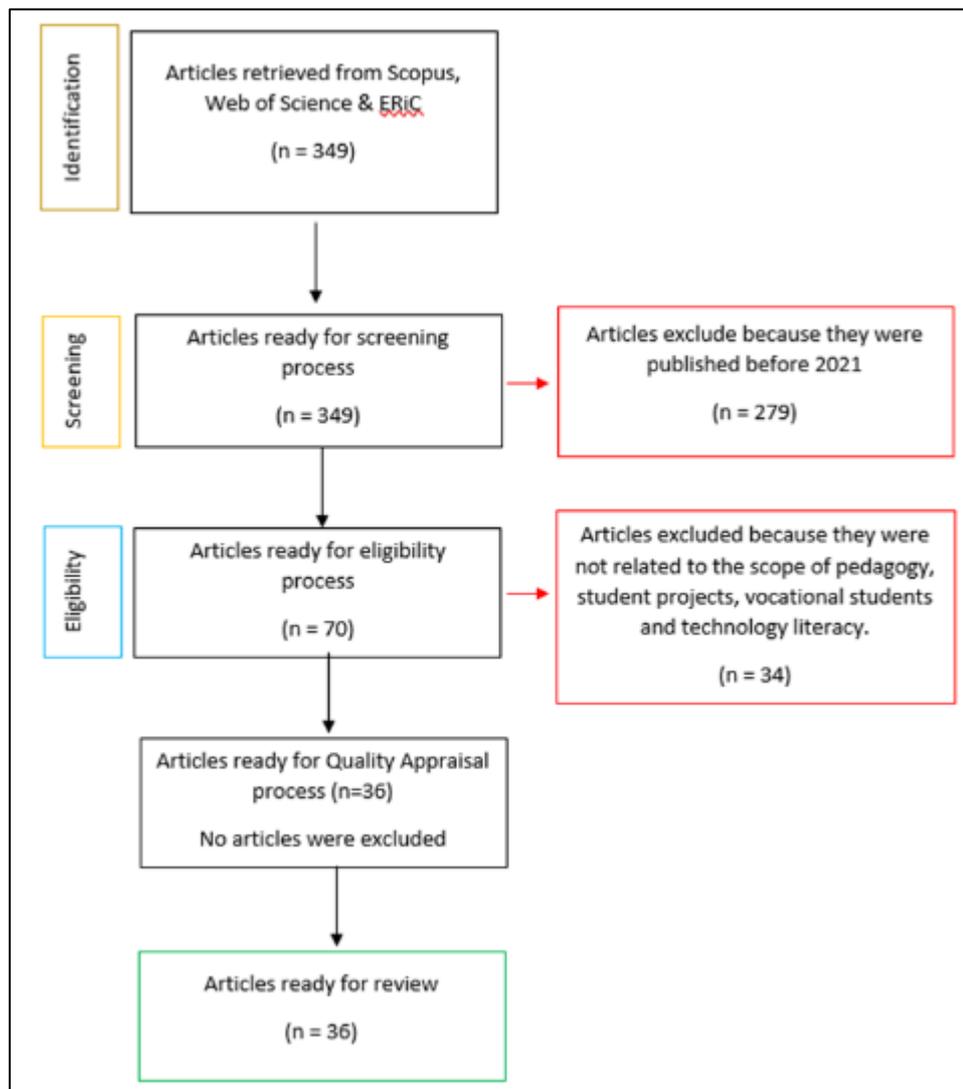

Figure 1: PRISMA Flow Diagram for the Systematic Review Process

Findings

The thematic synthesis of the thirty six selected studies revealed five major themes that explain how Inquiry Based Learning contributes to the development of technology literacy and how these findings relate to the structure of Final Year Projects in Malaysian vocational education. These themes reflect convergent and divergent patterns across studies in relation to pedagogical approaches, digital competence, assessment practices, implementation challenges, and strategies for improvement. The themes were derived through iterative coding and comparison of concepts and findings across the included studies.

Theme 1: Pedagogical Approaches and Models of Inquiry Based Learning
        The first theme concerns the wide range of Inquiry Based Learning approaches used in vocational and project-based contexts. Studies demonstrate that Inquiry Based Learning

can take many forms, including guided inquiry, open inquiry, discovery learning, and project-oriented inquiry. Guided inquiry appears most common in vocational and STEM settings because it provides structured support while still encouraging investigation and reasoning (Rafiq et al., 2023; Mutiaraningrum et al., 2024). Conceptual works emphasise constructivist and experiential foundations, where learners build understanding by interacting with problems, tools, and peers (Luckin, 2025; Bödding et al., 2023). Many studies conclude that Inquiry Based Learning becomes more effective when adapted to real project conditions and supported with digital tools that promote exploration and reflection.

Theme 2: Development of Technology Literacy through Inquiry Based Learning

The second theme is the most prominent across all studies. Many researchers report that Inquiry Based Learning promotes the development of technology literacy by strengthening digital proficiency, analytical ability, and reflective thinking. Studies from China, Turkey, Malaysia, and Indonesia show improvements in learners' ability to use digital tools, interpret technological information, solve problems, and collaborate in digital spaces (Meng & Jumaat, 2024; Mohammad Hussain et al., 2023; Cigdem & Ozkan, 2022). Inquiry tasks supported with simulations, virtual reality, digital mapping, and online platforms help learners apply technology purposefully and creatively, which aligns closely with the multidimensional conception of technology literacy. The process of asking questions, gathering data, analysing information, and evaluating technological options allows students to build deeper technological understanding.

Theme 3: Assessment and Measurement of Learning Outcomes

The third theme concerns the assessment and measurement strategies used to evaluate Inquiry Based Learning and technology literacy. Many studies emphasise the importance of authentic and performance-based assessment, where learners demonstrate their understanding through project artefacts, digital products, or inquiry reports (Abdul Rabu et al., 2023; Huba & Bist´ak, 2021). Several studies employed rubrics, competency frameworks, or instrument validation techniques such as content validity index calculations to measure learning outcomes (Suhaini et al., 2021). Other studies highlight the value of self-assessment, peer assessment, and concept mapping for capturing reflective and analytical dimensions of learning. These findings indicate that traditional knowledge-based assessments are insufficient for evaluating technological competence and inquiry processes, and that performance based and formative approaches are more suitable for Inquiry Based Learning.

The fourth theme concerns the challenges associated with applying Inquiry Based Learning in vocational education. Many studies report institutional constraints that include limited time, insufficient resources, and rigid curriculum structures (Ng & Tsang, 2022; Meng & Jumaat, 2024) Learners also face challenges such as uneven digital readiness, low motivation, or difficulty managing complex inquiry tasks. Lecturers experience barriers that include high workload, lack of training, and uncertainty about how to assess inquiry processes effectively. Studies from developing countries highlight systemic challenges such as inconsistent infrastructure, insufficient policy support, and limited collaboration between educational institutions and industry (Calister et al., 2023; Gaba et al., 2021). These findings indicate that Inquiry Based Learning requires significant pedagogical support, institutional commitment, and technological readiness to be implemented successfully.

Theme 5: Strategies and Best Practices for Strengthening Inquiry Based Learning and Technology Literacy

The fifth theme concerns recommended strategies and best practices that support the effective use of Inquiry Based Learning to enhance technology literacy. Several studies emphasise the importance of strong supervision and mentoring, especially when learners engage in open or semi structured inquiry (Chakerian & Ramakrishnan, 2025; Luo, Chano, Chen, 2024). Industry collaboration also emerges as a critical component, as it provides authentic problems and access to digital tools relevant to vocational contexts (Nurulwahida et al., 2024; Mutiaraningrum et al., 2024). Many studies propose blended or hybrid inquiry approaches, where digital platforms support collaboration, feedback, and reflection (Wuxue, 2023; Nong et al., 2022). Conceptual and policy-oriented papers stress the need for updated curriculum frameworks that emphasise inquiry, reflective practice, and digital competence as essential components of vocational education.

Table 3 presents the thirty-six studies synthesised in this review. The table includes the study source, country, participants, research design, theme contribution, and core findings. The themes correspond to the thematic structure presented in Section 5.

Theme Abbreviations
T1 = Pedagogical Approaches and Inquiry Based Learning Models
T2 = Development of Technology Literacy
T3 = Assessment and Measurement
T4 = Challenges and Barriers
T5 = Strategies and Best Practices

Table 3
Systematic Literature Review Table of Findings (n = 36)

Study ID	Country	Participants	Design/Method	Theme(s)	Key Findings
Scopus 1 (2024) (Jessica, Emmerson, & Richard, 2024)	Malaysia	120 students	Experimental	T1, T2, T3	Guided Inquiry Based Learning improved science engagement and digital competence.
Scopus 2 (2023) (Rafiq, Triyono, & Djatmiko, 2023)	Indonesia	120 students	Quasi experiment	T1, T2	Inquiry tasks enhanced reasoning and creativity.
Scopus 3 (2023) (Korakis & Dossis, 2023)	Greece	Not stated	Curriculum analysis	T1, T4	Identified gaps in curriculum structure for inquiry processes.
Scopus 4 (2022) (Lupión-Cobos, Girón-Gambero, & García-Ruiz, 2022)	Spain	85 students	Case study	T2, T3	Digital tools in inquiry supported problem solving.
Scopus 5 (2021) (Huba & Bist´ak, 2021)	Slovakia	Not stated	Descriptive	T2, T4	Institutional challenges affected inquiry implementation.

Scopus 6 (2023) (Mohammad Hussain, Ahmat Zainuri, Mohd Zulkifli, & Abdul Rahman, 2023)	Malaysia	64 students	Quasi experiment	T2, T3	Virtual reality and simulations improved digital proficiency.
Scopus 7 (2025) (Arifin, Sukarmin, Saputro, & Kamari, 2025)	Indonesia	Not stated	Meta analysis	T3, T5	Meta analysis confirmed positive effects of inquiry on academic performance.
Scopus 8 (2024) (Meng & Jumaat, 2024)	China	160 students	Quasi experiment	T2, T3	Digital inquiry improved interpretation and reasoning.
Scopus 9 (2025) (Wang, Wang, Xu, & Si-Jie, 2025)	China	37 students	Meta analysis	T2, T3, T5	Concept mapping improved higher order thinking.
Scopus 10 (2025) (Luckin, 2025)	United Kingdom	Not stated	Conceptual	T1, T5	Proposed inquiry models for project based learning.
Scopus 11 (2025) (Chakerian & Ramakrishnan, 2025)	United States	Not stated	Position paper	T1, T5	Provided future directions for inquiry in digital contexts.
ERIC 1 (2023) (Elena & Raitskaya, 2023)	Global	Not stated	Bibliometric	T1, T5	Mapped global trends in Inquiry Based Learning.
ERIC 2 (2024) (Nurulwahida, et al., 2024)	Malaysia	52 participants	Mixed method	T1, T5	Industry partnership strengthened inquiry engagement.
ERIC 3 (2023) (Calister, Attah, & Eze, 2023)	Nigeria	240 students	Descriptive	T2, T4	Identified digital readiness challenges.
ERIC 4 (2023) (Gottfried, et al., 2023)	United States	Not stated	Regression	T3, T4	Found significant predictors of student inquiry performance.
ERIC 5 (2021) (Gaba, Bhushan, & Kant Rao, 2021)	India	312 students	Survey	T2, T4	Reported limited digital access and competency issues.
ERIC 6 (2021) (Suhaini, Ahmad, & Mohd Bohari, 2021)	Malaysia	6 experts	Instrument validation	T3	Validated technology literacy constructs.

ERIC 7 (2021) (Bekbayeva, Galiyev, Albytova, & Zhazykbayeva, 2021)	Kazakhstan	60 students	Experimental	T2, T3	Inquiry activities increased digital skills.
ERIC 8 (2021) (Madimabe & Omodan, 2021)	South Africa	95 participants	Mixed method	T2, T4	Infrastructural and pedagogical barriers identified.
ERIC 9 (2022) (Cigdem & Ozkan, 2022)	Turkey	430 students	Survey	T2, T3	High readiness for technology supported inquiry tasks.
ERIC 10 (2022) (Rafiq, Triyono, & Djatmiko, 2022)	Indonesia	64 students	Experiment	T2	Virtual reality strengthened technology use in inquiry.
ERIC 11 (2023) (Onat & Bertiz, 2023)	Turkey	120 students	Experiment	T3, T4	Scaffolding improved inquiry assessment outcomes.
ERIC 12 (2023) (Wuxue, 2023)	China	150 students	Quasi experiment	T2, T3	Blended inquiry improved student learning.
ERIC 13 (2023) (Ozkale & Erdogan, 2023)	Indonesia	45 students	Case study	T1, T2	Spreadsheet based inquiry improved reasoning.
ERIC 14 (2024) (Sam, 2024)	South Africa	No direct/primary participants.	qualitative thematic analysis and cross-study comparisons.	T3, T4	Traditional assessment is not aligned with inquiry learning processes. Authentic measures are required.
ERIC 15 (2024) (Luo, Chano, & Chen, 2024)	China	110 students	Model development	T1, T5	Proposed a framework for inquiry in vocational education.
ERIC 16 (2024) (Mutiaraningrum, Fitriati, Yuliasri, & Saleh, 2024)	Indonesia	80 students	Mixed method	T2, T5	Reflection journals improved digital and analytical skills.
WoS 1 (2023) (Bödding, Bentler, & Maier, 2023)	Germany	Not stated	Conceptual	T1, T5	Introduced augmented reality supported inquiry frameworks.
WoS 2 (2022) (Ng & Tsang, 2022)	United Kingdom	35 students	Case study	T1, T2	Three-dimensional printing facilitated constructivist inquiry.

WoS 3 (2023) (Barragán-Pulido, Barragán-Pulido, Alonso-Hernández, & Castro-Sánchez, 2023)	Spain	200 students	Systematic review	T1, T2	Gamification supported inquiry based learning.
WoS 4 (2023) (Abdul Rabu, Mohamad, Awwad, Asmak Ismail, & Yeen, 2023)	Malaysia	180 students	Quasi experiment	T1, T2, T3	BLOSSOMS videos improved literacy and engagement.
WoS 5 (2023) (Mohammad Hussain, Ahmat Zainuri, Mohd Zulkifli, & Abdul Rahman, 2023)	Malaysia	64 students	Quasi experiment	T2, T3	Technology enhanced inquiry improved digital literacy.
WoS 6 (2023) (Razali, et al., 2023)	Malaysia	12 experts	Delphi	T1, T5	Identified future competencies for digital inquiry.
WoS 7 (2023) (Tikhonova & Raitskaya, 2023)	Global	Not stated	Bibliometric	T1, T5	Identified global patterns in technology supported inquiry.
WoS 8 (2022) (Nong, et al., 2022)	China	200 students	Quasi experiment	T2, T3	Short learning videos supported inquiry processes.
WoS 9 (2022) (Abd Karim & Mustapha, 2022)	Malaysia	372 students	Survey	T2, T4	Identified digital challenges in vocational education.

Discussion

The findings of this review highlight several important insights regarding the development of technology literacy through Inquiry Based Learning in vocational education. The five themes demonstrate clear patterns in how inquiry processes promote technological competence, how assessment practices influence learning outcomes, and how structural and institutional limitations affect learners and lecturers. These findings create meaningful connections to the issues identified in the problem statement and illustrate significant implications for the improvement of Final Year Projects within Malaysian vocational colleges.

The first theme confirms that Inquiry Based Learning provides a strong pedagogical foundation for developing technological understanding. Inquiry Based Learning models, whether guided, open, or project oriented, position learners as active constructors of knowledge who make meaning through investigation. This is consistent with the work of Piaget (1970) and Vygotsky (1978), who emphasise learning through interaction and social engagement. Modern studies reinforce these principles by showing that Inquiry Based Learning encourages deeper engagement with problems, promotes the use of digital tools for exploration, and enables learners to develop cognitive and reflective skills that are central to technology literacy. This alignment between theory and contemporary empirical findings

indicates that Inquiry Based Learning is pedagogically suitable for vocational projects that aim to strengthen higher level technological reasoning.

The second theme demonstrates that Inquiry Based Learning contributes directly to the development of technology literacy. Studies across multiple contexts show improvements in digital proficiency, problem solving skill, and analytical thinking when inquiry tasks integrate technological tools such as simulations, virtual environments, interactive software, and data-based platforms. These findings reflect the multidimensional nature of technology literacy, which includes technical skill, cognitive processing, and reflective judgement. This outcome aligns with Schunk's (2020) view of learning as a process of transforming information into organised and meaningful understanding. When learners are encouraged to ask questions, gather evidence, interpret data, and evaluate solutions, they develop technological competence that is relevant and transferable to authentic industrial environments.

The third theme shows that effective assessment plays an essential role in capturing inquiry and technological learning outcomes. Studies emphasise the need for performance-based assessment, digital artefacts, rubrics, and formative evaluation to accurately measure learners' reasoning and digital engagement. Traditional paper-based tests are insufficient for assessing the cognitive and reflective elements of inquiry. Instruments such as rubrics, validation methods, concept mapping, and reflective journals provide a more complete picture of learner understanding. This has direct implications for the PTA structure, which currently lacks clear guidelines for assessing inquiry processes and relies heavily on final product evaluation. Without refined assessment strategies, lecturers may overlook critical indicators of student learning and technological competence.

The fourth theme highlights the persistent challenges in implementing Inquiry Based Learning. These include limited time, insufficient infrastructure, uneven digital readiness among learners, and a lack of lecturer training in inquiry centered pedagogy. These barriers are consistent with previous research on technology supported learning, where institutional readiness and technological infrastructure influence the quality of student engagement. Davis (1989) notes that perceived usefulness and perceived ease of use are important predictors of technology acceptance. When learners or lecturers lack confidence in digital tools or face infrastructure limitations, their engagement with inquiry tasks may be reduced. These challenges explain why many vocational students do not fully develop technology literacy despite working on technology-based projects.

The fifth theme offers clear strategies and best practices for strengthening inquiry processes and technological competence. Strong supervision, industry collaboration, and reflective practice are frequently recommended as effective components of Inquiry Based Learning. Digital platforms and hybrid approaches also support sustained engagement and provide flexibility for feedback, collaboration, and data interpretation. These strategies reveal opportunities for improving the PTA structure by incorporating supervised inquiry cycles, integrating reflective activities, and expanding the use of digital tools throughout the project timeline. Studies that propose inquiry frameworks or competency models also provide direction for strengthening curriculum design and aligning project work with the technological demands of contemporary workplaces.

Taken together, these findings reveal a significant misalignment between global research on Inquiry Based Learning and the existing PTA guidelines in Malaysian vocational colleges. Although the PTA structure encourages innovation and the use of technology in final project artefacts, it does not provide explicit guidance on inquiry processes, iterative investigation, or technology supported analysis. As a result, learners may complete project tasks without fully engaging in the cognitive and reflective activities necessary for developing technology literacy. This gap suggests that PTA guidelines require revision to incorporate structured inquiry processes, clear assessment frameworks, and explicit expectations for digital engagement. Such changes would enhance the relevance of vocational projects and ensure that learners develop technological competence that is aligned with industry needs.

Implications

The findings of this review carry important implications for policy development, curriculum design, teaching practice, and assessment strategies within Malaysian vocational education. Strengthening technology literacy requires a coherent and systematic approach that integrates inquiry processes, reflective technological reasoning, and purposeful engagement with digital tools. The five themes identified in this review provide guidance for institutions seeking to align project-based learning with contemporary technological and industrial demands.

Implications for Policy

The findings indicate the need for clearer national level guidance on how Inquiry Based Learning should be embedded within vocational programmes. At present, the PTA guidelines emphasise procedural tasks and final artefacts but do not articulate inquiry processes that support the development of technology literacy. Policy makers should consider updating project-based learning requirements to include inquiry cycles, reflective tasks, and mandatory digital engagement. Supportive policies can encourage schools to invest in digital infrastructure, facilitate industry partnerships, and provide training for lecturers in inquiry-oriented pedagogy. Policy alignment with research-based practices will strengthen the relevance of vocational education and ensure that graduates possess competencies required by technology intensive industries.

Implications for Curriculum Design

The curriculum must integrate inquiry processes more explicitly across the project timeline. The review shows that technology literacy develops through iterative investigation, evidence-based reasoning, and reflection. These processes can be embedded in PTA 1 and PTA 2 through structured stages such as problem framing, data collection, digital experimentation, analysis, and evidence-based justification. Curriculum designers should ensure that course outcomes, learning activities, and instructional materials reflect the multidimensional nature of technology literacy. Inquiry Based Learning should not only inform teaching practice but also be reflected in course outcomes and assessment rubrics. Stronger alignment will help ensure that curriculum aims, instructional strategies, and assessment practices support the development of technological understanding in a coherent manner.

Implications for Teaching Practice

Lecturers play an essential role in guiding learners through inquiry processes. The findings indicate that strong supervision, timely feedback, and structured scaffolding are necessary for

learners to engage meaningfully in inquiry tasks. Lecturer training should therefore focus on strategies for facilitating investigation, supporting technological exploration, and providing constructive feedback during data analysis and interpretation. Lecturers should also model reflective thinking and technological reasoning by demonstrating how digital tools can be used to explore problems and develop solutions. Collaborative learning environments can further enhance inquiry engagement by allowing learners to share ideas, compare findings, and learn from contrasting perspectives.

Implications for Assessment
Assessment practices need to reflect the cognitive and reflective nature of Inquiry Based Learning. Traditional paper-based assessments are insufficient for evaluating technological competence. Instead, performance-based assessment, reflective journals, digital artefacts, and concept mapping can better capture the depth of learner understanding. Rubrics should measure inquiry processes such as problem framing, data interpretation, evaluation of technological options, and justification of decisions. These assessment strategies should be integrated into PTA evaluation to ensure that inquiry processes receive equal emphasis as the final project output. Incorporating digital tools in assessment tasks will further reinforce the importance of technology literacy as a core competency for vocational learners.

Limitations
Although this review provides valuable insights into the relationship between Inquiry Based Learning, technology literacy, and Final Year Projects in vocational education, several limitations should be acknowledged. These limitations relate to the scope of the review, the selection of studies, and the interpretive nature of thematic synthesis.

The first limitation concerns the inclusion criteria. The review focused only on studies published between 2021 and 2025 and written in English. This decision ensured the inclusion of current and accessible research but may have excluded relevant studies published in other languages or in earlier years. As a result, some perspectives from non-English speaking regions or earlier foundational work may not be represented.

The second limitation relates to database selection. Although four major databases were used, including Scopus, Web of Science, ERIC, and Google Scholar, it is possible that some relevant studies were not captured due to differences in indexing practices across databases. Google Scholar was included to address this issue, yet the variability of its search algorithms means that some sources may have been overlooked.

The third limitation concerns the nature of thematic synthesis. The themes generated in this review reflect patterns identified across heterogeneous studies that vary in methodology, context, and research design. While this variation enriches the analysis, it also requires careful interpretation, as not all findings are directly comparable. The synthesis therefore represents an interpretive integration of diverse evidence rather than a standardised statistical generalisation.

The final limitation concerns the absence of empirical validation within the context of Malaysian Final Year Projects. Although the review identifies clear gaps and provides evidence informed recommendations, the alignment between Inquiry Based Learning and the PTA

structure has not been tested directly in local practice. Future studies involving pilot implementation, lecturer feedback, and student performance data would provide stronger evidence to validate the recommendations proposed in this review.

Despite these limitations, the review offers a comprehensive and rigorous analysis of relevant literature and provides a strong basis for improving vocational project design and strengthening technology literacy within Malaysian vocational education.

Conclusion

This systematic review examined how technology literacy is conceptualised, how Inquiry Based Learning supports the development of technological competence, and how these insights relate to the structure of Final Year Projects in Malaysian vocational education. The findings show that Inquiry Based Learning provides a strong pedagogical foundation for developing the cognitive, technical, and reflective skills that define technology literacy. Studies consistently demonstrate that learners who engage in inquiry tasks that incorporate digital tools develop deeper understanding, stronger analytical ability, and greater confidence in applying technology to solve authentic problems.

The thematic synthesis also highlights significant gaps within current project-based practices in Malaysian vocational colleges. The Final Year Project structure focuses on procedural documentation and final artefacts but does not explicitly guide learners through inquiry processes or technology supported investigation. This misalignment limits opportunities for learners to engage in the type of evidence-based reasoning that strengthens technology literacy. Furthermore, the absence of clear assessment strategies for inquiry means that important aspects of technological understanding may not be measured or supported effectively.

The review also identifies structural and institutional challenges that affect the implementation of Inquiry Based Learning, including limited resources, uneven digital readiness, and insufficient pedagogical training for lecturers. Addressing these concerns will require coordinated action at the policy, curriculum, teaching, and assessment levels. The review provides evidence informed recommendations for strengthening project guidelines, embedding inquiry cycles, integrating digital tools, and redesigning assessment practices to better capture the depth of student learning.

Overall, this review contributes to a clearer understanding of how technology literacy can be developed systematically within vocational education. It offers a foundation for improving the design and implementation of Final Year Projects so that they become more aligned with the technological expectations of contemporary industries. By integrating inquiry processes, reflective digital engagement, and performance-based assessment, vocational institutions can ensure that graduates are better prepared for the demands of an increasingly digital and automated workforce.

Theoretical and Contextual Contributions

This study contributes to theory by clarifying the multidimensional nature of technology literacy and by positioning Inquiry Based Learning as an evidence based pedagogical mechanism that develops the cognitive, technical, and reflective competencies

required in digital learning environments. The synthesis enriches existing knowledge by demonstrating how inquiry processes interact with technological engagement to support higher order thinking, reasoning, and problem solving. These elements are central to constructivist learning theory. The insights generated from this review advance conceptual understanding by showing that technology literacy extends beyond the ability to operate tools. It involves a deeper process of inquiry driven cognitive activity that shapes how learners interpret, analyse, and apply technological information.

From a contextual perspective, this review provides the first consolidated analysis that connects Inquiry Based Learning with the structure of Malaysia's Final Year Project in vocational colleges. The findings reveal gaps between national policy intentions and current classroom implementation, and they offer timely direction for strengthening curriculum reform within Malaysian technical and vocational education. The contextual contribution of this review lies in identifying the structural, pedagogical, and assessment related adjustments needed to align Final Year Project practices with international research trends. These contributions support the development of more coherent project-based learning environments and provide guidance for policy makers, curriculum designers, and vocational educators who aim to enhance technological competence among vocational graduates.

Acknowledgment

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