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Exploring Project-Based Learning within an Independent Curriculum: A Qualitative Inquiry into Technical Drawing Competence in Vocational Automotive Education

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ABSTRACT
Background: Vocational education is undergoing curriculum reform that emphasizes learner autonomy and competency-based learning, yet evidence on its implementation in technical drawing instruction remains limited.
Aims: This study examines the application of Project-Based Learning within the Independent Curriculum and its contribution to the development of technical drawing competence in vocational automotive education.
Methods: This study employed a qualitative descriptive approach. Data were collected through classroom observations, learning document analysis, and reflective inputs from teachers and grade X students in an automotive vocational program. The analysis focused on instructional design, learning processes, assessment practices, and observed competency development.
Result: The findings indicate that Project-Based Learning supports active engagement and contextual understanding in technical drawing instruction. Students demonstrated improved ability to interpret technical symbols, apply drawing standards, and relate drawings to automotive components. The learning process also encouraged collaboration and independent learning.
Conclusion: Project-Based Learning is a suitable pedagogical approach for implementing the Independent Curriculum in vocational automotive education, as it strengthens technical drawing competence while promoting learner-centered learning practices.

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Introduction

In the current educational landscape, vocational education is increasingly expected to respond to fast-moving technological and industrial changes (Matkin, 2022; Webb et al., 2021). This expectation places pressure on vocational institutions to ensure that learning outcomes are relevant and applicable. Graduates are no longer assessed solely on academic achievement but on their readiness to perform in real work environments (Alam & Parvin, 2021; Siddique et al., 2022). Such demands highlight the urgency of strengthening competency-oriented learning. Curriculum design therefore becomes a decisive factor in shaping vocational learning quality. When curricula fail to evolve, vocational education risks losing its relevance. This challenge has prompted many education systems to reconsider how learning is organized. As a result, curriculum reform has become a central concern in vocational education.

At the same time, educational discourse has shifted toward learning models that position students as active participants (Matthews et al., 2023; Naylor et al., 2021). This shift is driven by the recognition that passive learning limits skill development. Vocational education requires learning experiences that allow students to explore, practice, and reflect (Kumar et al., 2021; Schmid & Garrels, 2021). Teacher-centered instruction often restricts these opportunities. Consequently, learner autonomy has gained importance in curriculum planning. Flexible learning structures are believed to support deeper

engagement. The Independent Curriculum reflects this pedagogical orientation. Its adoption signals an effort to reshape classroom dynamics in vocational settings.

Another important aspect of vocational reform lies in the emphasis on competency-based education (M'mboga Akala, 2021). This approach prioritizes demonstrable skills over theoretical coverage. In vocational contexts, competence is closely tied to performance and task completion (Antonietti et al., 2022; Gagné et al., 2022). Learning activities must therefore simulate real occupational situations. The success of competency based learning depends on instructional execution rather than curriculum documents alone. Teachers act as key mediators between curriculum intentions and classroom practice. Their instructional decisions influence how competence is developed. For this reason, classroom-level analysis is essential.

Within automotive vocational education, technical drawing plays a crucial foundational role (Hermans et al., 2024; Lewis, 2025). It enables students to interpret designs, understand component relationships, and follow technical procedures. Without adequate technical drawing skills, students may struggle with advanced automotive tasks (Muoghalu & Ahmad, 2025; Relmasira et al., 2023). Despite its importance, technical drawing is often perceived as abstract and difficult. Students frequently face challenges in connecting symbols with physical components. This disconnect can reduce learning motivation and comprehension. Instructional strategies must therefore bridge theory and practice. Addressing this issue is vital for effective vocational training.

In response to such instructional challenges, active learning approaches have received growing attention (Doolittle et al., 2023; Tharwat & Schenck, 2023). Project-Based Learning is frequently associated with meaningful vocational learning. This model encourages students to engage in tasks that resemble real work situations (Elendu et al., 2024; Javaid et al., 2023). Through projects, students integrate knowledge, skills, and problem-solving abilities. Learning becomes more contextual and purposeful. Collaboration and responsibility are naturally embedded in the process. These characteristics align with vocational education goals. Consequently, Project-Based Learning offers a promising instructional alternative.

However, implementing Project-Based Learning within a reformed curriculum is not without challenges (Markula & Aksela, 2022; Martinez, 2022). Teachers must design projects that are both authentic and pedagogically sound. Learning objectives need to be clearly aligned with project outcomes (Børte & Lillejord, 2024; Miller et al., 2021). Assessment practices must capture both processes and results. Without careful planning, projects may become activities rather than learning tools. Instructional coherence is therefore essential. Understanding how teachers manage this complexity is important. Classroom-based inquiry can provide valuable insights.

Despite extensive discussion on curriculum reform, research often remains focused on policy perspectives (Tight, 2021; Wang et al., 2024). Studies that examine classroom implementation in detail are comparatively fewer. Technical drawing instruction, in particular, is rarely explored through qualitative inquiry (Costes-Onishi & Kwek, 2023; Hannigan & Raphael, 2020). This lack of attention limits understanding of instructional realities in vocational education. Classroom interactions, learning experiences, and instructional decisions remain underrepresented. Qualitative studies can reveal nuances that quantitative approaches may overlook. Such insights are critical for instructional improvement. Addressing this research gap is therefore necessary.

Finally, exploring instructional practices within the Independent Curriculum contributes to broader vocational education discourse (McGrath & Yamada, 2023). Technical drawing provides a relevant lens due to its dual theoretical and practical nature. Examining this competence allows for deeper understanding of curriculum enactment (Clemmons et al., 2022; Tran et al., 2025). Findings from this context may inform other vocational fields. They may also support teachers in refining instructional strategies. Furthermore, this type of research strengthens evidence-based curriculum development. For these reasons, investigating this topic remains timely and significant.

Existing studies indicate that Project-Based Learning has strong potential to support competency development and meaningful learning. Pham et al. (2025) highlight that the success of Project-Based Learning is closely linked to instructional coherence and contextual relevance rather than the project format alone. The importance of learner-centered instruction is reinforced by Olitsky (2025), who shows that active student involvement strengthens engagement and learning identity. From a broader educational perspective, Christopher & Pinias (2025) argue that effective STEM and STEAM education depends on the integration of theory with practical experience. Design oriented and interdisciplinary learning approaches are further discussed by Arango-Caro et al. (2025) , who demonstrate that project-based activities enhance students' understanding and learning motivation. In a similar vein, Nguyen et al. (2025) emphasize that pedagogical innovation, supported by digital transformation, plays a critical role in competency based education. Focusing on instructional planning, Ni'mah (2025) underlines the need for clear learning objectives and structured guidance in Project Based Learning design. Empirical evidence from classroom-based studies by Nurhakim et al. (2025) and Fauziyah et al. (2025) suggests that project-based activities contribute to creativity and problem solving skills. Meanwhile, a systematic review by Juandi et al. (2025) confirms the effectiveness of Project-Based Learning across learning contexts. Nevertheless, research that specifically examines technical drawing competence in vocational automotive education remains limited, indicating a clear gap that warrants further qualitative investigation.

The introduction of the Independent Curriculum places strong emphasis on flexibility, learner autonomy, and competency-based learning, yet its effectiveness depends largely on how it is realized in everyday classroom practice. In vocational education, this issue becomes particularly important because learning outcomes are expected to translate directly into technical skills and workplace readiness. Technical drawing in automotive programs is not only a foundational subject but also a gateway to understanding complex mechanical systems and procedures. Teaching this competence requires instructional approaches that move beyond explanation and repetition toward active engagement and application. Project-Based Learning is often associated with such an approach, as it allows students to learn through authentic tasks and problem-solving processes. However, the way this model is applied within the framework of a newly implemented curriculum remains underexplored. Investigating this relationship is therefore necessary to understand how curriculum intentions are transformed into meaningful learning experiences.

Existing literature has provided extensive discussions on Project-Based Learning, learner-centered pedagogy, and curriculum reform across various educational contexts. Nevertheless, much of this research tends to focus on general learning outcomes, STEM disciplines, or large scale policy analysis. Studies that closely examine classroom-level implementation in vocational education are still relatively limited, particularly those adopting qualitative perspectives. Moreover, research that specifically addresses technical drawing competence within vocational automotive education is scarce. As a result, there is limited insight into how Project Based Learning functions in subjects that demand technical accuracy, visual interpretation, and practical application. This gap indicates the need for focused qualitative inquiry that captures instructional practices, learning interactions, and competency development within authentic vocational settings.

In response to the identified gap, this study aims to explore how Project Based Learning is implemented within the Independent Curriculum in vocational automotive education. The study focuses on understanding how this pedagogical approach supports the development of technical drawing competence at the classroom level. By examining instructional planning, learning activities, and observed learning outcomes, the research seeks to provide empirical insights into the enactment of competency-based curricula. The findings are expected to contribute to ongoing discussions on vocational pedagogy and offer practical considerations for teachers and curriculum developers working in similar educational contexts.

Method

Research Design

This study adopted a qualitative descriptive research design to examine how Project-Based Learning is implemented within the Independent Curriculum in vocational automotive education, particularly in technical drawing instruction. A qualitative approach was considered appropriate because the study aimed to understand instructional processes rather than to measure learning outcomes numerically. The focus of the investigation was placed on how teaching strategies, classroom interactions, and learning activities support the development of technical drawing competence. By observing learning as it naturally occurred, the research was able to capture contextual factors that influence curriculum enactment. The overall methodological stages of the study are presented in Figure 1, which illustrates the research flow from the identification of the research focus to conclusion drawing.

Participant

The participants in this study were selected purposively based on their direct involvement in the learning process under investigation. They consisted of one vocational automotive teacher who taught technical drawing and Grade X students enrolled in the automotive program. This selection allowed the study to obtain in-depth information related to instructional planning, classroom implementation, and student learning experiences. All participants were involved in regular classroom activities during the study period, ensuring that the data reflected authentic instructional practices rather than simulated conditions. Their perspectives provided complementary insights into both teaching and learning processes.

Instrument

Data collection was conducted using several qualitative instruments to capture different dimensions of the learning process. Classroom observations were used to document instructional strategies, student participation, and the application of Project-Based Learning during technical drawing lessons. Document analysis focused on instructional plans, learning materials, student project work, and assessment records relevant to technical drawing competence. In addition, reflective notes were maintained throughout the data collection process to record contextual details and emerging observations. The combination of these instruments enabled the researcher to triangulate data sources and strengthen the trustworthiness of the findings.

Data Analysis

Data analysis was carried out through a systematic and iterative qualitative process. Initially, data from observations, documents, and reflective notes were organized and reviewed to obtain a comprehensive understanding of the instructional context. The data were then coded to identify recurring patterns related to instructional design, learning activities, student engagement, and competency development. These codes were further examined to develop themes that represented the implementation of Project-Based Learning within the Independent Curriculum. The analytical stages, including data organization, coding, interpretation, and conclusion drawing, are summarized in Figure 1, which provides a visual representation of the research process.

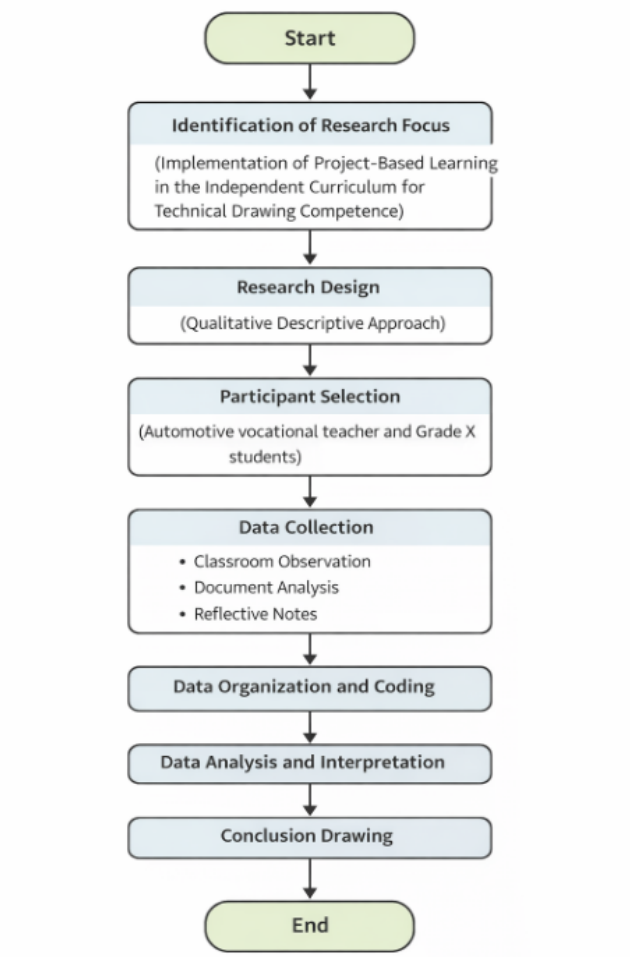

Figure 1. Research flowchart illustrating the stages of the qualitative study from research focus identification to conclusion drawing.

Results and Discussion

Results

This section presents the empirical findings derived from classroom observations, analysis of instructional documents, and reflective field notes. The results focus on how Project Based Learning was enacted within the Independent Curriculum and how this instructional approach contributed to the development of technical drawing competence in vocational automotive education.

Observation data indicate that the learning process followed a sequence of project-oriented stages that structured student activities throughout the lessons. Learning began with project planning, where students were encouraged to identify automotive components and define drawing objectives based on project requirements. During this stage, students actively engaged in discussions to clarify tasks and expectations. Document analysis of lesson plans and learning materials confirmed that these activities were aligned with competency indicators outlined in the curriculum. This alignment suggests that project tasks were intentionally designed to support competency development rather than mere task completion.

As learning progressed into the project execution stage, students were observed applying technical drawing principles while producing drawings related to real automotive components. Student worksheets and project outputs demonstrated consistent engagement and task persistence. Reflective notes showed that students gradually became more confident in applying drawing standards, dimensions, and symbols. The presentation stage further revealed students' ability to explain their work and justify technical decisions, indicating growing competence in interpreting and communicating technical drawings.

A comprehensive overview of how Project-Based Learning activities corresponded with observed technical drawing competencies is presented in Table 1. This table illustrates the relationship between learning phases, instructional activities, evidence collected during the study, and the competencies that emerged during the learning process.

Table 1. Implementation of Project-Based Learning and Observed Technical Drawing Competence

Learning Phase	Project-Based Learning Activities	Evidence from Observation and Learning Documents	Observed Technical Drawing Competence
Project Planning	Students identified automotive components and drawing objectives as project tasks	Lesson plans and classroom discussions showed active negotiation of task requirements	Understanding of technical symbols and drawing purposes
Project Execution	Students produced technical drawings based on real automotive components	Student worksheets and project outputs indicated sustained engagement and task completion	Application of drawing standards and dimensional accuracy
Project Presentation	Students explained and presented completed technical drawings	Observation notes recorded increased clarity and confidence during presentations	Interpretation and communication of technical drawings
Reflection	Students reviewed project outcomes and identified areas for improvement	Reflective notes showed independent evaluation and corrective reasoning	Integration of conceptual understanding and practical drawing skills

Further analysis revealed several recurring patterns that characterized the learning process. Students tended to show stronger engagement when project tasks were explicitly connected to real-world automotive contexts. Collaborative interaction was most visible during project execution, while individual responsibility became more apparent during reflective activities. Across all stages, the teacher's role shifted toward facilitation, guiding students through inquiry and problem solving rather than delivering direct explanations.

To capture these patterns concisely, the main findings of the study are summarized in Table 2. This table synthesizes the key aspects of student learning and instructional dynamics observed during the implementation of Project-Based Learning.

Table 2. Summary of Key Findings on Technical Drawing Competence Development

Aspect	Key Findings
Learning engagement	Students demonstrated higher participation and sustained focus during project-based tasks
Technical understanding	Improved ability to interpret technical symbols and apply drawing standards
Learning autonomy	Students showed increasing independence in completing drawing tasks and evaluating results
Collaborative skills	Group discussions and peer feedback supported problem-solving processes
Instructional role	The teacher primarily functioned as a facilitator rather than a sole knowledge source

Overall, the results indicate that Project Based Learning provided a structured yet flexible learning environment that supported active participation, contextual understanding, and gradual competence development. Through project-oriented activities, students were able to connect conceptual knowledge with practical application, reflecting the intended learning orientation of the Independent Curriculum.

Discussion

The results of this study indicate that Project-Based Learning can function as a practical mechanism for translating the principles of the Independent Curriculum into classroom practice in vocational automotive education. The structured sequence of project activities observed in this study reflects a deliberate effort to align instructional design with competency-oriented learning goals. This finding resonates with the argument of Pham, et all (2025), who emphasize that the effectiveness of Project-Based Learning lies in the coherence between learning activities and targeted competencies. In the present study, projects were not implemented as isolated tasks but as interconnected learning stages. This coherence allowed students to engage meaningfully with technical drawing content. As a result, curriculum intentions were reflected in observable classroom practices. Such alignment underscores the role of instructional design in curriculum enactment.

Student engagement emerged as a consistent pattern throughout the learning process. Observations showed that students were more actively involved during project execution and increasingly responsible during reflection activities. This pattern supports the findings of Olitsky (2025), who notes that learner-centered instruction encourages students to develop a stronger sense of learning ownership. In this study, students were positioned as problem solvers rather than recipients of instruction. Engagement was particularly evident when tasks required direct interaction with real automotive components. These conditions appeared to sustain students' attention and effort. The findings suggest that Project-Based Learning creates an environment conducive to active participation in vocational contexts.

The development of technical drawing competence was closely linked to the authenticity of the learning tasks. Students demonstrated improved ability to interpret symbols, apply drawing standards, and communicate technical information through their project work. This observation aligns with Christopher and Pinias (2025), who argue that meaningful learning in STEM and STEAM education depends on the integration of theory and practice. In the present study, technical drawing tasks were embedded in realistic automotive scenarios. This approach helped students connect abstract conventions with concrete applications. Such contextualization appears essential for mastering vocational technical skills. The findings therefore reinforce the pedagogical value of authentic learning experiences.

Although the primary focus of the study was technical drawing, the learning process also fostered broader competencies such as collaboration and problem-solving. Students frequently engaged in discussion and peer feedback during project activities. This outcome is consistent with the findings of Arango-Caro, Langewisch, Ying, Branton, and Callis-Duehl (2025), who report that design-oriented project learning enhances student understanding and motivation. In this study, students were required to justify their design decisions, indicating engagement in higher-order thinking. These interactions extended learning beyond procedural accuracy. They also contributed to the development of transferable skills relevant to vocational practice.

A notable shift in the teacher's instructional role was observed during the implementation of Project-Based Learning. Rather than providing continuous direct instruction, the teacher guided students through questioning, feedback, and facilitation. This instructional pattern reflects the perspective of Nguyen, Le, and Doan (2025), who highlight pedagogical innovation as a central element of competency-based education. In the present study, facilitative teaching supported student autonomy while maintaining instructional direction. This balance allowed students to explore solutions independently without losing focus on learning objectives. The findings suggest that the teacher's role is critical in sustaining effective Project-Based Learning.

The structured nature of the projects also contributed to instructional clarity and learning effectiveness. Projects were designed with clear objectives, defined stages, and observable outcomes. This finding supports the argument of Ni'mah (2025), who emphasizes that Project-Based Learning requires structured guidance to remain pedagogically meaningful. In this study, structure prevented projects from becoming unfocused activities. Instead, it provided a framework within which students could explore and apply technical drawing concepts. Such structure appears particularly important in

vocational subjects that demand precision and accuracy. The results highlight the importance of careful project planning.

Creativity and problem-solving emerged as secondary yet meaningful outcomes of the learning process. Students collaborated to resolve drawing challenges and refine their work during project execution. These observations are consistent with the findings of Nurhakimi, Gita, Waris, and Dafik (2025), who report that project-based activities foster creativity through active problem-solving. Similarly, Fauziyah, Gita, Emyus, and Marsidi (2025) emphasize that contextual design tasks enhance students' creative engagement. Although creativity was not the central focus of this study, its presence suggests additional educational benefits. This reinforces the multifunctional value of Project-Based Learning in vocational education.

The findings of this study also align with research conducted in Indonesian educational contexts. Juandi, et all (2025) demonstrate that Project-Based Learning can improve learning outcomes when effectively integrated into instructional practice. While their study focuses on mathematics education, the present research extends this insight to vocational technical drawing. The consistency across disciplines suggests that Project-Based Learning is adaptable when aligned with competency objectives. This cross-context relevance strengthens the applicability of the approach. It also supports its use within vocational curricula.

Despite the positive outcomes observed, the findings should be interpreted within the qualitative scope of the study. The research prioritizes depth of understanding rather than statistical generalization. However, this depth provides valuable insights into instructional processes that are often overlooked in large-scale studies. By focusing on classroom interactions and learning activities, the study reveals how competencies develop in practice. Such process-oriented insights complement quantitative findings. This perspective enhances the contribution of the study to vocational education research.

Overall, the discussion suggests that Project-Based Learning effectively supports the development of technical drawing competence when implemented through structured, contextual, and learner-centered instruction. The integration of real-world automotive contexts enabled students to connect theoretical knowledge with practical application. By providing classroom-level evidence, this study extends existing literature on Project-Based Learning and curriculum implementation. It also addresses a gap in research on vocational automotive education. In doing so, the study contributes to broader discussions on competency-based learning and curriculum enactment.

Implications

The results of this study imply that the implementation of Project-Based Learning can play a strategic role in strengthening competency-oriented instruction within the Independent Curriculum. The learning process observed in this study suggests that technical competencies, such as technical drawing, develop more effectively when students are engaged in structured projects that reflect real vocational tasks. For teachers, this finding highlights the importance of shifting instructional focus from content transmission toward learning facilitation and guided inquiry. Instructional planning therefore needs to emphasize coherence between project activities, competency targets, and assessment practices. At the institutional level, the findings suggest that vocational curricula should be supported by pedagogical strategies that encourage learner autonomy while maintaining instructional clarity. These implications indicate that Project-Based Learning is not merely an instructional alternative but a practical means of aligning curriculum intentions with classroom realities.

Limitations

Several limitations should be considered when interpreting the findings of this study. The research was conducted within a specific vocational automotive context, which may limit the extent to which the findings can be transferred to other vocational disciplines. The qualitative descriptive approach adopted in this study focused on capturing learning processes and instructional dynamics rather than measuring learning outcomes quantitatively. Consequently, the study does not provide numerical evidence of competency improvement, but instead offers process-oriented insights. In

addition, the reliance on observation and document analysis may reflect the perspectives of the researcher and participants within a limited time frame. These constraints suggest that the findings represent a contextual understanding rather than generalizable conclusions.

Suggestions

Future research may build upon the findings of this study in several ways. Studies conducted across different vocational programs could provide comparative insights into how Project-Based Learning supports various technical competencies. Researchers may also consider employing mixed-method approaches to examine both learning processes and measurable outcomes. Longitudinal studies could further explore how sustained implementation of Project-Based Learning influences competency development over time. In addition, research focusing on teacher professional development may offer valuable insights into instructional readiness and long-term sustainability. Such future investigations would deepen understanding of how competency-based curricula can be effectively enacted in vocational education.

Conclusion

The findings of this study suggest that Project-Based Learning offers a practical instructional pathway for realizing the objectives of the Independent Curriculum in vocational automotive education. By organizing learning activities into clearly defined project stages, students were provided with opportunities to engage actively with technical drawing tasks that reflect real vocational practices. The learning process supported not only the development of technical drawing competence but also encouraged learner autonomy and meaningful participation. Classroom observations and document analysis indicate that instructional effectiveness was closely related to the teacher's ability to facilitate learning rather than deliver content directly. Although the study was limited to a specific instructional context, it provides valuable insight into how competency-oriented curricula can be enacted through project-based instruction. Overall, this research contributes to vocational education discourse by illustrating how structured and contextual learning experiences can strengthen the integration of theory and practice.

Author Contributions Statement

Ridwan was responsible for conceptualizing the study, designing the research framework, and conducting data collection through classroom observation and document analysis. Ridwan also led the interpretation of findings and drafted the initial manuscript. Riyan Saputra contributed to data organization, supported the analysis process, and assisted in refining the theoretical and methodological sections. Both authors collaboratively reviewed, revised, and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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