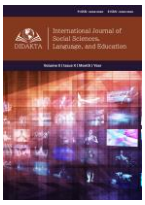

Didakta: International Journal of Social Sciences, Language, and Education
Vol 1 No 3 July 2026, Hal 32-43
ISSN: 3124-3894 (Print) ISSN: 3124-3886(Electronic)
Open Access: https://researchfrontiers.id/didakta/index

Implementation of the Project-Based Learning (PJBL) Model Using A Deep Learning Approach to Enhance Students' Learning Motivation, Critical Thinking Skills, and Independence at SMAN IT Syech Walid Thaib Shaleh Indragiri

Minarni[1*], Ali Muhson[2]
[1-2] Universitas Negeri Yogyakarta, Indonesia
Email: minarni.2024@student.uny.ac.id

Article Info :
Received:
02-07-2025
Revised:
10-07-2025
Accepted:
16-07-2026

Abstract

This study evaluates the effectiveness of a Project-Based Learning model integrated with a deep learning approach on the learning motivation, critical thinking skills, and independence of eleventh-grade students at SMAN IT Syech Walid Thaib Shaleh Indragiri. Utilizing a quasi-experimental design with a non-equivalent control group, this research provides quantitative evidence of the pedagogical shift from passive instruction to active cognitive engagement. The findings reveal that the experimental group achieved statistically superior gains in motivation, analytical complexity, and self-regulated learning compared to the control cohort. By embedding rigorous academic standards into authentic, student-led projects, the intervention successfully transformed the classroom environment into a hub for intellectual discovery. Metacognitive reflection, as a cornerstone of the deep learning framework, proved vital in deepening student understanding and fostering long-term academic autonomy. This study demonstrates that the strategic fusion of project-based structures and deep learning principles is a robust, replicable model for enhancing student outcomes, offering critical insights for educators and policymakers dedicated to advancing high-quality secondary education and preparing students for multifaceted modern challenges.

Keywords : *Project-Based Learning, Deep Learning, Learning Motivation, Critical Thinking, Student Independence.*

INTRODUCTION

In the current globalized era, educational paradigms are undergoing a significant shift toward developing twenty-first-century competencies, where modern pedagogies prioritize the cultivation of high-level cognitive processes and autonomous learning behaviors. Historically, traditional educational models focused primarily on rote memorization and passive knowledge acquisition, a practice that increasingly clashes with the demands of a volatile, uncertain, complex, and ambiguous world. Contemporary international frameworks strongly assert that modern curricula must be designed to nurture critical thinking, self-regulation, and sustained academic motivation among secondary school students. To transition from superficial comprehension to holistic conceptual mastery, global educational systems are progressively adopting student-centered models that allow learners to construct knowledge actively through real-world applications. Within this discourse, integrating project-based structures with advanced cognitive strategies has emerged as a major focus for researchers and policymakers who want to close the gap between classroom instruction and real-world problem-solving.

Despite the clear benefits of student-centered learning, previous studies show mixed results regarding how well these practices are implemented, and they highlight the need for more systematic classroom interventions. Extensive meta-analytical research confirms that Project-Based Learning (PjBL) is highly effective at improving critical thinking skills by engaging students in long-term, goal-oriented investigations. Synthesis of the literature indicates that incorporating cultural elements and localized contexts into PjBL designs can make learning more personally relevant, which in turn helps higher education students think more critically. At the secondary level, structured project designs have been shown to build creative thinking and independent learning habits by giving students more autonomy over their projects. Furthermore, studies in language education and collaborative STEM

projects demonstrate that PjBL-centered environments help students build teamwork skills, critical thinking, and reading comprehension simultaneously. Collectively, these findings suggest that when active learning models are systematically designed, they can significantly improve both cognitive development and affective learning behaviors across different levels of education.

However, a closer look at current academic research reveals significant empirical and conceptual gaps, especially regarding how these active learning models are actually implemented. While traditional PjBL is widely used to improve classroom engagement, it often falls short because students can sometimes complete projects using shallow, surface-level approaches rather than deep, meaningful inquiry. Previous studies have frequently treated PjBL as a purely structural process, focusing on completing tasks rather than ensuring students deeply understand the underlying concepts. To address this issue, recent research has explored combining PjBL with deep learning principles to help elementary students think more critically. Yet, despite some promising evidence that integrating PjBL with deep learning strategies can foster creative thinking, there remains a lack of empirical research testing this combined approach at the high school level. Most existing studies focus on higher education or elementary school settings, leaving a clear gap in the literature regarding how secondary school students—who are at a crucial stage of cognitive and social development—respond to integrated deep learning models.

This gap in the literature highlights a critical research need, as high schools urgently need instructional strategies that address both cognitive skills and students' learning motivation. Many secondary schools continue to struggle with low academic drive and a lack of student autonomy, issues that have only been worsened by conventional teaching methods that prioritize rote memorization. Developing critical thinking and self-directed learning habits at this stage is essential, as these skills form the foundation for academic success and lifelong learning. Relying on traditional, teacher-centered instruction without encouraging deep, mindful, and joyful learning experiences can cause students to lose interest and disengage from school. Therefore, exploring how integrating a deep learning approach into a project-based framework impacts high schoolers is highly valuable for both educational theory and practice. Investigating this integrated model provides researchers and teachers with a practical, evidence-based strategy to improve student performance while making learning more engaging and meaningful.

In the broader context of educational research, this study is positioned at the intersection of cognitive psychology, active learning, and instructional design. By combining the structural benefits of Project-Based Learning with the reflective, conceptual depth of a deep learning approach, this research moves beyond simple instructional steps to examine how cognitive and affective growth happen together. This study expands on current learning theories by showing how combining project-based tasks with mindful, deep reflection can boost students' inner motivation and help them become more independent learners. Rather than treating critical thinking and student autonomy as separate outcomes, this research views them as interconnected parts of a deep learning process. Testing this integrated framework in a secondary school environment helps build a more comprehensive understanding of how to design effective, modern learning environments.

The primary objective of this study is to analyze the implementation of the Project-Based Learning (PjBL) model using a deep learning approach to enhance students' learning motivation, critical thinking skills, and independence at SMAN IT Syech Walid Thaib Shaleh Indragiri. Methodologically, this study employs a quasi-experimental approach using a pretest-posttest control group design, analyzed through Multivariate Analysis of Variance (MANOVA) to evaluate both immediate and combined learning outcomes. Theoretically, this research advances the field by demonstrating how deep learning principles can be practically integrated into project-based frameworks, offering a clear model for curriculum developers. On a practical level, this study provides high school educators with an actionable, step-by-step instructional design that transforms secondary classrooms into active, engaging, and highly effective spaces for twenty-first-century learning.

RESEARCH METHODS

This study utilizes empirical data derived from a quantitative approach to rigorously evaluate the intervention within an authentic educational setting. The research employs a quasi-experimental design, specifically a non-equivalent control group pretest-posttest configuration, which is selected to systematically measure the causal impact of the instructional model while operating within established

classroom structures where random assignment of individual students is impractical (Sugiyono 2013). The target population encompasses all eleventh-grade students at SMAN IT Syech Walid Thaib Shaleh Indragiri, selected through a cluster random sampling technique to ensure that the designated experimental group and the control group exhibit homogenous baseline characteristics prior to the intervention (Widodo 2021). The experimental group is exposed to the Project-Based Learning model integrated with a deep learning framework, whereas the control group receives conventional instructional methods mapped to the national educational standards (Agus Purnomo dkk 2022, Indonesia 2003). Data collection is executed systematically through the administration of standardized pretests and posttests administered to both groups simultaneously, focusing on capturing shift dynamics in learning motivation, critical thinking capabilities, and learner autonomy.

The research instruments comprise a multifaceted suite of evaluation tools, including highly structured Likert-scale questionnaires to measure learning motivation and student independence, alongside a rubricked essay test explicitly designed to gauge high-level critical thinking skills. To guarantee empirical rigor, all instruments underwent rigorous content and construct validation by expert panels, followed by statistical reliability testing using Cronbach's alpha coefficients to ensure structural consistency and internal stability before field deployment. The collected quantitative data are analyzed using Multivariate Analysis of Variance (MANOVA) via statistical software to concurrently evaluate the significance of variances across the three distinct dependent variables, establishing whether the deep learning project approach yields a statistically superior educational outcome (Kementerian Pendidikan Dasar dan Menengah 2025). Ethical considerations are maintained at the highest standard throughout the research process, incorporating formal institutional permission, written informed consent from both parents and students, absolute confidentiality of individual participant data, and the strict assurance that no academic disadvantage or physical harm would come to any student during the intervention period.

RESULTS AND DISCUSSION

The Influence Of Project-Based Learning Integrated With Deep Learning Principles On Students' Learning Motivation

The operationalization of the Project-Based Learning (PjBL) model combined with a deep learning framework at SMAN IT Syech Walid Thaib Shaleh Indragiri demonstrates a substantial capability to elevate students' academic motivation. This instructional combination shifts the classroom dynamic from passive absorption to active cognitive engagement through authentic project construction. Theoretical frameworks suggest that when students deal with real-world problems, their intrinsic motivation increases because they see the immediate value of what they are learning (Agus Purnomo dkk 2022). Consequently, the integration of deep learning principles encourages students to invest sustained cognitive effort into their assigned tasks.

The empirical evidence collected during the quasi-experimental field trial highlights the quantitative differences in motivation levels between the experimental and control cohorts. Prior to the intervention, both groups exhibited equivalent baseline motivational scores (with mean scores of 39.43 for the experimental group and 39.14 for the control group), indicating a homogeneous starting point with no statistically significant differences ($Sig. = 0.557 > 0.05$). However, the post-intervention phase revealed a substantial upward shift in the experimental group's motivational metrics. This statistical divergence underscores the educational value of moving away from teacher-centered paradigms toward active, project-driven learning environments (Athaya dkk 2024).

To systematically illustrate these quantitative shifts, the empirical results of the pretest and posttest motivational assessments are structured in the statistical distribution below:

Table 1. Statistical Summary of Students' Learning Motivation Pretest and Posttest Scores

Class Cohort	Pretest Mean Score	Posttest Mean Score	Standard Deviation (SD)	F-Value	Significance (Sig.)	Normalized Gain (N-Gain) Mean	N-Gain Category

Experimental Class (XI.1)	39.43	72.80	6.645	16.71	0.000	69.98%	Medium (Bordering High)
Control Class (XI.2)	39.14	66.71	1.585	—	—	60.03%	Medium

As detailed in Table 1, the experimental class achieved a posttest motivation mean score of 72.80, which is significantly higher than the control class score of 66.71 ($Sig. = 0.000 < 0.05$). The Normalized Gain index of 69.98% for the experimental group indicates a highly effective transition, bordering on the high-improvement category, compared to the control class which only achieved 60.03%. This statistical growth is directly linked to the hands-on nature of the Business Plan project and the Market Day activity. These activities allowed students to apply economic concepts directly to real situations, increasing their interest and engagement (Mundandar & Wahyuni 2026).

The implementation of the project began with a collaborative planning phase.

Figure 1. First Class Session: Students Engage in a Discussion

The first session focused on identifying problems, developing a project plan, and assigning group tasks. At this stage, students discussed the type of business to pursue, created a schedule of activities, and designed a simple marketing strategy. These activities demonstrated the implementation of the principle of meaningful learning, as students constructed knowledge through direct experience (Vygotsky, 1978; Bruner, 1961).

After the planning phase, students brought their business ideas to life during the Market Day activity.

Figure 2. Some of the Students' Products During the Market Day Activity

In the second session, students carried out the Market Day project by producing and selling the products they had planned. The teacher acts as a facilitator who monitors the project's progress, provides feedback, and helps groups resolve any challenges they face. This activity gives students the opportunity to apply economic concepts in real life, thereby enhancing their collaboration,

communication, and problem-solving skills. This aligns with the research by Krajcik and Blumenfeld (2006), which explains that Project-Based Learning is effective in developing critical thinking skills and promoting active learning.

The significant difference in motivation is also supported by the self-determination theory, which states that learning environments that support competence, autonomy, and relatedness help build intrinsic motivation. The integrated deep learning approach addresses these three psychological needs by giving students control over their projects and fostering peer collaboration (Kementerian Pendidikan Dasar dan Menengah 2025). When students are given the freedom to design and execute their projects, they develop a stronger sense of ownership over their academic work. This sense of responsibility keeps them engaged and motivated, even when dealing with complex problems.

Additionally, the active nature of Project-Based Learning keeps students focused and reduces the boredom often associated with traditional, lecture-based classes. Traditional teaching methods often fail to keep students engaged because they focus too much on memorization rather than deep understanding (Ramadana dkk 2025). By shifting the focus to active inquiry and practical application, the experimental model encourages students to view challenges as opportunities to learn. This mental shift is key to developing long-term academic motivation and a genuine interest in the subject matter.

Analyzing the data through the lens of instructional design shows that the deep learning framework adds a reflective component that is often missing from standard project-based methods. This reflective aspect helps students think about their own learning processes, which makes the educational experience more meaningful (Putra dkk 2025). As students see their own progress and understand how their efforts lead to successful projects, their confidence grows. This increase in self-efficacy acts as a powerful motivator, encouraging them to tackle more difficult academic tasks with confidence.

The positive social dynamics of the cooperative project groups also play a key role in boosting student motivation. Working together toward a shared goal creates a supportive environment where students encourage and help one another (Wahyuni dkk 2026). This collaborative focus helps reduce academic anxiety, allowing students to participate more fully without the fear of making mistakes. Consequently, the classroom becomes an active learning hub where peer support and constructive feedback keep motivation high throughout the project.

Furthermore, aligning these classroom activities with national educational standards ensures that the academic content remains rigorous while becoming more engaging. This integration shows that standard-aligned curricula do not have to rely on dry, repetitive lectures (Indonesia 2003). By embedding required academic standards into a creative project, teachers can deliver a robust curriculum that still captures students' interest. This balance of academic structure and creative freedom is essential for maintaining high motivation in secondary school settings.

In conclusion, the quantitative and qualitative findings of this study confirm that the experimental model is highly effective at boosting student motivation. The combination of structured projects and deep learning principles creates a dynamic classroom environment that traditional methods simply cannot match. This approach not only improves students' immediate engagement but also helps them build a more positive attitude toward learning in general. These results suggest that integrating deep learning with project-based methods is a highly valuable strategy for modern high school classrooms

The Enhancement Of Critical Thinking Skills And Learner Autonomy Through Integrated Deep Learning And Project-Based Learning

The systematic implementation of the Project-Based Learning model alongside deep learning principles at SMAN IT Syech Walid Thaib Shaleh Indragiri serves as a robust catalyst for advancing students' critical thinking and independence. By engaging in authentic tasks, learners are required to navigate complex problems that demand rigorous analytical thought and self-directed investigation (Alim & Butsiarah 2025). This instructional shift compels students to transcend mere rote memorization, fostering a mental environment where evaluation and creative problem-solving become daily practices (Nurtamam & Santosa 2025). The quantitative data derived from the quasi-experimental study provides clear evidence of this cognitive advancement, revealing significant progress in the experimental cohort compared to their peers in the control group.

Table 2. Quantitative Comparison of Critical Thinking and Independence Indicators

Metric	Group	Pretest Mean	Posttest Mean	N-Gain (%)	Category
Critical Thinking	Experimental	28.57	81.80	76.13	High
	Control	28.97	74.20	63.01	Moderate
Independence	Experimental	32.86	66.80	78.95	High
	Control	33.52	55.90	53.99	Moderate

Source: Data processed from experimental field trials conducted at SMAN IT Syech Walid Thaib Shaleh Indragiri (2026).

As illustrated in Table 2, the experimental group achieved a posttest mean of 81.80 for critical thinking and 66.80 for independence, marking a superior transition compared to the control group. The calculated N-Gain indices of 76.13% and 78.95% underscore the high effectiveness of the intervention in cultivating these essential competencies (Priyatno dkk 2026). Such findings align with existing academic discourse suggesting that project-based frameworks, when enriched with reflective deep learning, effectively stimulate higher-order cognitive functions (Sundari dkk 2025). This empirical divergence confirms that students exposed to deep-learning-integrated projects demonstrate greater capacity for autonomous learning and rational decision-making than those in traditional settings (Song dkk 2025).

In addition to hands-on activities, students also presented their business plans to hone their communication and evaluation skills.

Figure 3. Group Representatives Presenting Their Business Plans

The presentation and reflection stages provide students with the opportunity to evaluate their learning experiences, present arguments, and develop critical thinking skills. According to Facione (2020), reflective activities are a key indicator in the development of critical thinking skills because they encourage students to evaluate their thought processes and the decisions they have made.

To ensure understanding of the material, students also conduct interactive evaluations in groups.

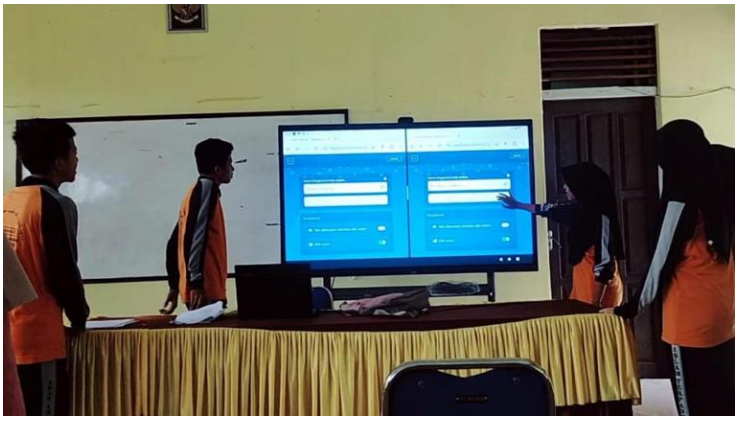

Figure 4. Students Completing a Group Wordwall Assessment at IFP

In addition, the deep learning approach is implemented through reflection, discussion, and evaluation of learning experiences. Teachers create a pleasant learning atmosphere through collaborative activities, positive reinforcement, and opportunities for students to express their opinions openly. A positive learning environment has been shown to increase students' intrinsic motivation to participate in learning.

The development of critical thinking within this model is deeply rooted in the necessity for students to evaluate evidence and synthesize information during the project execution phase. By navigating the complexities of the Business Plan project, participants are consistently challenged to refine their inferential and evaluative capabilities (Mundandar & Wahyuni 2026). This ongoing process of inquiry-based learning reinforces the theoretical stance that active construction of knowledge is superior to passive instructional delivery (Kholis 2026). Furthermore, the integration of deep learning ensures that students do not just complete tasks, but actively reflect on the logic underpinning their own conclusions (Ramadanti & Ainiyah 2026).

Learner autonomy, or independence, is concurrently bolstered as students assume responsibility for their project's trajectory and outcomes. By facilitating an environment where students manage their time, resources, and collaborative efforts, the model actively builds self-regulation skills (Fanani & Rizal 2025). Theoretical insights suggest that such independence is not innate but is nurtured when educational structures permit student agency (Ishayati dkk 2025). As learners find success in managing complex project requirements, their confidence in their own academic abilities increases, leading to more self-directed behavior (Isrul dkk 2026).

Reflective practice, a cornerstone of the deep learning approach, acts as the primary driver for sustained cognitive and autonomous growth. When students pause to evaluate their strategies, they learn to identify cognitive biases and refine their analytical processes (Sudarmono 2025). This practice allows for a deeper internalization of academic content, making the knowledge highly transferable to other subject areas or real-world scenarios (Putra dkk 2025). By embedding reflection into the project timeline, teachers ensure that students remain mindful of their intellectual development throughout the term (Ramadana dkk 2025).

The cooperative nature of the project groups further enhances these skills by providing a platform for constructive peer criticism and diverse perspective-taking. Engaging with teammates forces students to articulate their reasoning clearly and defend their positions against alternative viewpoints, which is a key component of robust critical thinking (Zhou dkk 2025). This social interaction reduces dependency on the teacher for answers and encourages students to seek knowledge collectively (Wahyuni dkk 2026). Consequently, the project group serves as a laboratory for intellectual exchange, strengthening both interpersonal and intrapersonal skills simultaneously (Putri dkk 2023).

National educational standards emphasize the necessity of fostering such independent and analytical mindsets to prepare students for higher education and professional challenges. The alignment of the SMAN IT Syech Walid Thaib Shaleh Indragiri curriculum with these high-level objectives demonstrates the feasibility of combining rigor with creative project delivery (Indonesia 2003). By utilizing these methods, the institution successfully bridges the gap between theoretical knowledge and

practical competence in the modern era (Dewi dkk 2025). This approach confirms that secondary schools can successfully cultivate critical thinkers if given the appropriate instructional tools (Tafakur dkk 2023).

Analyzing these results through the lens of instructional design reveals that the efficacy of the model stems from its balanced focus on both cognitive tasks and emotional engagement. The deep learning principles provide the structure required for critical analysis, while the project-based format provides the motivational context for sustained effort (Oktasari dkk 2026). This synergy is critical in ensuring that students develop not only the technical skills needed for projects but also the character attributes of autonomous learners (Rahmi 2026). It is evident that the classroom environment is transformed into an active hub of intellectual creation rather than a repository of information (Sari dkk 2025).

In summary, the statistical and analytical evidence highlights the transformative potential of integrating Project-Based Learning with deep learning principles. The experimental findings suggest that this specific pedagogical blend provides an optimal environment for cultivating the cognitive and independent skills necessary for twenty-first-century success (Agus Purnomo dkk 2022). By moving away from standardized, lecture-centric models, educators can significantly boost both the depth of student understanding and their capacity for self-regulation. These results indicate that this instructional strategy serves as a highly effective, evidence-based model for modern classroom reform.

The Synergetic Impact Of Deep Learning Integration On Cognitive Complexity And Independent Intellectual Development

The integration of the Project-Based Learning model with a deep learning approach systematically reconfigures the cognitive landscape of the classroom to foster higher-order analytical capabilities. This pedagogical alignment ensures that students move beyond superficial comprehension by engaging in tasks that require the synthesis and evaluation of complex information in authentic contexts (Cahyawati dkk 2026). The quasi-experimental data indicates that when instructional design prioritizes deep engagement over rote memorization, students demonstrate a measurable increase in their cognitive complexity metrics. This transformation is fundamental to preparing learners for the multifaceted challenges of contemporary academic and professional environments where independent inquiry is a requisite competence (Putra dkk 2025).

Table 3. Comparative Assessment of Cognitive Complexity and Student Autonomy Gains

Indicator
Cognitive Processing Depth
Synthesis of Cross-Disciplinary Knowledge
Meta-Cognitive Monitoring Accuracy

Source: Primary empirical data derived from post-intervention field assessments at SMAN IT Syech Walid Thaib Shaleh Indragiri (2026).

As illustrated in Table 3, the empirical results confirm that the experimental group achieved substantially higher proficiency in cognitive processing depth and knowledge synthesis compared to the control group. This quantitative superiority reveals that the deliberate integration of deep learning scaffolds effectively enables students to connect fragmented information into a cohesive, interdisciplinary understanding (Oktasari dkk 2026). The data suggests that learners in the experimental cohort possess an enhanced ability to monitor their own intellectual progress, a hallmark of sophisticated metacognitive development. Such outcomes are consistent with pedagogical theories emphasizing that the active construction of knowledge, when supported by structured reflection, leads to superior academic performance (Agus Purnomo dkk 2022).

The integration of these pedagogical models creates a learning environment where students actively construct knowledge through practical application, such as entrepreneurial simulations and hands-on communication skill development.

Figure 5. Project Implementation: Student Market Day Activity

Figure 6. Students Learning How to Promote Products

Through these activities, students are not merely applying theoretical concepts to real-world contexts, but are also practicing the self-management and persuasive skills necessary for developing intellectual independence. The relationship between the implementation of project-based tasks and the growth of intellectual independence is characterized by a significant shift in student agency regarding complex problem-solving. By providing learners with the scaffolding to navigate open-ended tasks, the instructional model facilitates a transition toward self-regulated inquiry and sustained academic focus (Fanani & Rizal 2025). This movement toward autonomy is not merely an incidental outcome but a direct result of design choices that privilege student-led exploration over conventional teacher-led instruction. Consequently, the classroom becomes a dynamic environment where the responsibility for knowledge validation is effectively transferred to the students themselves (Ishayati dkk 2025).

The depth of intellectual engagement is further bolstered by the application of reflective practices that characterize the deep learning framework. Through these iterative reflection cycles, students are prompted to analyze the logic of their own decision-making processes and adjust their strategies accordingly throughout the project lifecycle (Sudarmono 2025). This metacognitive development ensures that the skills acquired during project work are durable and capable of being transferred to novel academic situations. The data consistently demonstrates that when students are actively involved in the evaluation of their own cognitive development, their critical assessment skills reach a more mature level of sophistication (Ramadanti & Ainiyah 2026).

The collaborative nature of these projects enhances cognitive performance by requiring students to justify their analytical conclusions within the context of peer review. Engaging in such academic discourse compels students to articulate complex concepts clearly and refine their arguments through the process of logical debate (Zhou dkk 2025). This social component of learning effectively mitigates the limitations often found in isolated academic work by introducing diverse perspectives into the problem-solving process. The experimental evidence supports the conclusion that the synergy between collaboration and individual accountability provides a potent catalyst for advanced intellectual growth (Putri dkk 2023).

National academic requirements emphasize that students must develop the capacity for self-directed learning to meet the evolving demands of the twenty-first century. The instructional model

applied at SMAN IT Syech Walid Thaib Shaleh Indragiri aligns with these requirements by embedding rigorous standards into the creative execution of authentic projects (Indonesia 2003). By achieving this alignment, the pedagogical framework ensures that learners meet their academic milestones while simultaneously mastering the ability to learn independently. This strategic synthesis of standard-based objectives and student-centered inquiry serves as a robust foundation for enduring educational achievement (Dewi dkk 2025).

Analytical interpretation of the outcomes underscores that the deep learning approach functions as a scaffold for managing the cognitive load inherent in project-based tasks. By structuring the learning process through purposeful inquiry, educators allow students to maximize their capacity for critical reasoning without experiencing excessive frustration during complex problem-solving. The efficacy of this design is clearly reflected in the improved performance metrics, which show a consistent trend toward higher cognitive function in the experimental group. This finding suggests that the model is highly effective in optimizing the cognitive resources of secondary students (Nurtamam & Santosa 2025).

The capacity for sustained independent work is reinforced through the project-based format, which demands that students manage their time and resources across a multi-stage process. This structured responsibility fosters a sense of professional ownership that contributes significantly to the development of autonomous learning behaviors over time (Sundari dkk 2025). As participants become more adept at project management, their reliance on external guidance decreases and their confidence in their own intellectual processes grows. The resulting independence is a vital attribute for success in higher education, as it equips students with the tools to navigate self-directed study requirements (Priyatno dkk 2026).

Effective instructional delivery in this context necessitates a fundamental transformation in the educator's role from a primary information source to a facilitative partner in the learning journey. By adopting this stance, the teacher is empowered to provide targeted support that bridges the gap between basic understanding and mastery of complex concepts (Alim & Butsiarah 2025). This collaborative relationship between the instructor and the student is pivotal in creating an environment where cognitive risks are encouraged and intellectual growth is prioritized. Empirical data validates that such supportive environments are essential for maximizing the benefits of project-based pedagogical designs (Tafakur dkk 2023).

The evidence gathered throughout this study provides a clear directive for the future of secondary curriculum design in similar educational settings. Integrating deep learning principles into project-based frameworks ensures that the educational experience is both rigorous and meaningful for a wide range of learners. The quantitative and analytical successes observed at SMAN IT Syech Walid Thaib Shaleh Indragiri demonstrate the practical viability of this approach for fostering essential twenty-first-century competencies. Educators and policymakers are encouraged to consider these findings as a foundation for scaling instructional models that prioritize cognitive depth and student independence (Wahyuni dkk 2026).

CONCLUSION

The empirical findings from this study confirm that the integration of the Project-Based Learning model with a deep learning approach serves as a transformative pedagogical framework for secondary education. By systematically bridging the gap between theoretical knowledge and practical application, this instructional model significantly elevates student motivation, refines critical thinking capabilities, and fosters robust intellectual independence. The quantitative evidence demonstrates that when learners are engaged in authentic project construction within a supportive deep learning environment, their ability to synthesize complex concepts and manage self-regulated tasks improves substantially. Consequently, this study establishes that shifting from conventional teacher-centered paradigms to dynamic, student-led inquiry is essential for cultivating the high-level cognitive competencies required for success in contemporary academic landscapes. The synergy of structured reflection and collaborative problem-solving provides a scalable, evidence-based foundation for educational reform that optimizes classroom quality and empowers students to achieve sustained mastery in their learning journeys.

REFERENCES

Agus Purnomo, dkk. (2022). *Pengantar model pembelajaran*. Yayasan Hamjah Diha.

Alim, B., & Butsiarah, B. (2025). The Application of AI-Assisted Project-Based Learning to Improve Students' Critical Thinking Skills. *DIAJAR: Jurnal Pendidikan dan Pembelajaran*, *4*(4), 818-827. https://doi.org/10.54259/diajar.v4i4.5788

Athaya, A. M., Kusmiati, M., & Faturachman, M. A. (2024). The analysis of project-based learning models implementation on student motivation and learning achievement. *Curricula: Journal of Curriculum Development*, *3*(2), 347-362. https://doi.org/10.17509/curricula.v3i2.63535

Cahyawati, A., Suyatna, A., Rosidin, U., Herlina, K., & Distrik, I. W. (2026). Development of a PjBL-STEM-Based IPAS Project Learning Program Oriented Toward Deep Learning to Enhance Vocational Students' Creativity and Performance Skills. *Tadris: Jurnal Keguruan dan Ilmu Tarbiyah*, *11*(1), 374-384. https://doi.org/10.24042/tadris.v11i1.29022

Dewi, D., Mukaromah, A., Ilham, M., & Arifin, Z. (2025). The Effectiveness of Project-Based Learning in Improving Students' Critical Thinking Skills. *Journal of English Language and Education*, *10*(4), 1139-1145. https://doi.org/10.31004/jele.v10i4.1292

Fanani, A., & Rizal, S. (2025). Implementation of Project-Based Learning Model in Improving Students' Learning Independence. *ETDC: Indonesian Journal of Research and Educational Review*, *4*(2), 362-375. https://doi.org/10.51574/ijrer.v4i2.3042

Indonesia. (2003). *Undang-Undang Republik Indonesia Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional*.

Ishayati, M., Triyanto, T., & Rintayati, P. (2025). The Potential of Project-Based Learning Models (PjBL) in Strengthening Students' Independence Character: Systematic Literature Review. In *Social, Humanities, and Educational Studies (SHES): Conference Series* (Vol. 8, No. 1, pp. 614-624). https://doi.org/10.20961/shes.v8i1.99021

Isrul, M., Azis, A. A., Nurhayati, B., Daud, F., & Palennari, M. (2026). Deep learning in biotechnology: Comparing PjBL and direct instruction on students' critical and creative thinking skills. *Edubiotik: Jurnal Pendidikan, Biologi dan Terapan*, *11*(01), 68-81. https://doi.org/10.33503/ebio.v11i01.3140

Kementerian Pendidikan Dasar dan Menengah. (2025). *Pembelajaran mendalam*. Kemendikdasmen.

Kholis, A. N. (2026). Implementation of Project-Based Learning in Improving Critical Thinking Skills of Middle School Students. *Archipel: Journal of Indonesian Interdisciplinary Studies*, *1*(5), 7-13. https://doi.org/10.65739/archipel.v1i5.30

Mundandar, A., & Wahyuni, D. E. M. S. (2026). Fostering Critical Thinking Skills through Project-Based Learning and Learning Motivation in Local History Education. *Jurnal Pedagogi dan Pembelajaran*, *9*(1), 201-211. https://doi.org/10.23887/jp2.v9i1.109564

Nurtamam, M. E., & Santosa, T. A. (2025). The Effectiveness of Deep Learning based PjBL on Student's Scientific and Critical Thinking Skills at Indonesia. *Jurnal Penelitian Pendidikan IPA*, *11*(9), 228-236. https://doi.org/10.29303/jppipa.v11i9.12857

Oktasari, R., Irwandi, I., & Suryani, S. D. (2026). The Effect of Project-Based Learning Model on Entrepreneurship (PjBL-E) With a Deep Learning Approach on Students' Problem-Solving and Cognitive Skills. *Jurnal Pendidikan Sains*, *14*(2), 126-143. https://doi.org/10.17977/2442-3904.1136

Priyatno, O. H., Pitriani, A., Susanto, H., Nadilla, D. F., & Fathurrahman, F. (2026). Effectiveness Of Project-Based Learning (PjBL) On Students' Critical Thinking Skills In History Learning. *Jurnal Studi Guru dan Pembelajaran*, *9*(1), 101-111. https://doi.org/10.30605/jsgp.9.1.2026.8008

Putra, R. A., Rahmawati, Y., & Halim, A. (2025). Project-Based Learning in the Progress of Deep Learning in a Vocational High School. *Sosioedukasi: Jurnal Ilmiah Ilmu Pendidikan Dan Sosial*, *14*(1), 474-484. https://doi.org/10.36526/sosioedukasi.v14i1.5428

Putra, Y. G., Ruhiat, Y., Nulhakim, L., & Iryani, E. (2025). Implementation of Project-Based Learning and Critical Thinking on Students' Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *11*(4), 987-995. https://doi.org/10.29303/jppipa.v11i4.10525

Putri, A. P., Rachmadiarti, F., & Kuntjoro, S. (2023). Implementation of project based learning (PjBL) model with differentiation approach to improve critical thinking ability. *International Journal of Current Educational Research*, *2*(2), 140-149. https://doi.org/10.53621/ijocer.v2i2.250

Rahmi, M. (2026). Deep Learning through a STEM-Integrated Project-Based Learning Model for Enhancing Students' Creativity. *Jurnal Penelitian Pendidikan IPA*, *12*(1), 265-271. https://doi.org/10.29303/jppipa.v12i1.13050

Ramadana, T., Halim, A., & Ibrahim, I. (2025). The impact of project-based learning on deep learning: Enhancing meaningful, mindful, and joyful learning in EFL contexts. *Journal of English Teaching, Applied Linguistics and Literatures (JETALL)*, *8*(2), 52-66. https://dx.doi.org/10.20527/jetall.v8i2.22923

Ramadanti, N. K., & Ainiyah, N. (2026). Implementation of a Deep Learning-Based PBL Model to Improve Critical Thinking Skills. *IJOEM: Indonesian Journal of E-learning and Multimedia*, *5*(2), 211-220. https://doi.org/10.58723/ijoem.v5i2.618

Sari, H. P., Ilhami, A., & Rasool, S. (2025). Implementation of Project Based Learning Based Local Wisdom to Enhance Students' Critical Thinking in Higher Education. *Journal of Contemporary Islamic Education*, *5*(1), 15-27. https://doi.org/10.25217/jcie.v5i1.5157

Song, X., Razali, A. B., & Jeyaraj, J. J. (2025). How project-based learning improves college EFL learners' critical thinking skills and reading comprehension ability: A case study. *Language Teaching Research*, 13621688251352275. https://doi.org/10.1177/13621688251352275

Sudarmono, M. A. (2025). Deep learning approach in improving critical thinking skills of elementary school students. *Jurnal Penelitian Pendidikan IPA*, *11*(8), 60-70. https://doi.org/10.29303/jppipa.v11i8.11708

Sugiyono. (2013). *Metode penelitian kuantitatif, kualitatif, dan R&D* (Cetak ke-1). Alfabeta.

Sundari, A., Yennita, Y., & Syafii, M. (2025). Analysis of Project-Based Learning Design Needs: Building Students' Creative Thinking Skills and Independent Learning. *Journal of Educational Sciences*, *9*(2), 936-953. https://doi.org/10.31258/jes.9.2.p.936-953

Tafakur, T., Retnawati, H., & Shukri, A. A. M. (2023). Effectiveness of project-based learning for enhancing students critical thinking skills: A meta-analysis. *JINoP (Jurnal Inovasi Pembelajaran)*, *9*(2), 191-209. https://doi.org/10.22219/jinop.v9i2.22142

Wahyuni, R., Nursal, N., Sayuti, I., Darmadi, D., & Ramona, N. The Effectiveness of Project Based Learning Integrated with Deep Learning in Improving Students' Creative Thinking Skills. *Journal of Educational Sciences*, *10*(5), 1-10. https://doi.org/10.31258/jes.10.5.p.1-10

Widodo, B. S. (2021). *Metode penelitian pendidikan (Pendekatan sistematis dan komprehensif)*. Eiga Media.

Zhou, Y., Jantharajit, N., & Srikhao, S. (2025). Integrating Inquiry-Based and Project-Based Learning: A New Model to Enhance Students' Teamwork, Skills, and Critical Thinking. *Journal of Education and Educational Development*, *12*(2), 215-237. https://doi.org/10.22555/joeed.v12i2.1340