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Enhancing Pancasila Learners' Profiles: Project-Based Learning With Flipbook For Scientific Literacy

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ABSTRACT

Pancasila, as the foundational ideology of Indonesia, plays a critical role in shaping the educational landscape by fostering moral and ethical values. Concurrently, scientific literacy is essential for preparing learners to navigate and contribute effectively to the modern, technology-driven world. This study aims to evaluate the effectiveness of integrating Project-Based Learning (PBL) with flipbook technology in enhancing Pancasila learners' profiles and improving their scientific literacy. A quasi-experimental design was employed, involving 120 second-semester students at the State University of Medan in the Elementary School Teacher Education (PGSD) program. Participants were divided into experimental and control groups, with the experimental group engaging in PBL activities using flipbook devices for one semester. Data were collected using validated assessment instruments that measure learner profiles, such as critical thinking, collaboration, and creativity, as well as scientific literacy levels. Statistical analyses, including t-tests and ANOVA, were conducted to assess the significance of the findings. The experimental group demonstrated a significant improvement in their learners' profiles, with scores increasing from a pre-test mean of 65.4 to a post-test mean of 82.7, $p < 0.01$. Additionally, scientific literacy scores rose from 70.2 to 88.5, $p < 0.01$, indicating a substantial enhancement compared to the control group, which showed minimal changes. Furthermore, qualitative feedback revealed increased student engagement and motivation associated with the use of flipbook technology in PBL environments. The integration of Project-Based Learning with flipbook technology significantly enhances Pancasila learners' profiles and scientific literacy. These findings suggest that adopting such innovative teaching methods can effectively contribute to the holistic development of learners, aligning with both ideological and scientific educational goals. Recommendations are made for educators and policymakers to incorporate PBL and digital tools like flipbooks into the curriculum to foster a more engaging and effective learning experience.

Keywords: Pancasila, Project-Based Learning, Flipbook Technology, Scientific Literacy, Educational Innovation.

Introduction

Pancasila functions as the bedrock of Indonesia's national identity, serving not only as a moral and ideological compass but also as an instrument for unifying the nation through education. It embeds values, such as belief in one God, just and civilized humanity, nationalism, representative democracy, and social justice, that underpin Indonesia's socio-political framework and guide curricular reforms aimed at nurturing ethical behavior and national unity (Kheryadi et al., 2024). In the educational context, integrating Pancasila means that learners are exposed to a milieu where academic rigor is intertwined with character formation and culturally relevant values. This integration supports the development of critical civic competencies and promotes a sense of belonging and responsibility toward the community.

Simultaneously, the increasing prominence of scientific literacy in the 21st century demands that education equip students not only with scientific facts but also with practical skills in inquiry, problem-solving, and decision-making. Scientific literacy entails the capacity to understand, evaluate, and apply scientific reasoning across diverse everyday contexts, thereby fostering an informed citizenry capable of addressing complex global challenges (Suryanti et al., 2024). In Indonesia, where educational reform is increasingly oriented toward STEM and interdisciplinary approaches, such competencies are critical (Ilma et al., 2023; Khotimah et al., 2021). For instance, research on project-based learning has evidenced significant improvements in scientific literacy outcomes. This suggests that active learning strategies can successfully bridge the gap between rote learning and critical engagement with scientific ideas (Sholahuddin et al., 2023).

Integrating Pancasila with the development of scientific literacy thus creates a robust educational framework where moral values and scientific competencies mutually reinforce one another. In practice, pedagogical approaches such as project-based learning can serve as a conduit through which students internalize national values while engaging

in open inquiry and problem-solving activities. By promoting collective deliberations and culturally informed decision-making processes in science education, educators can leverage Pancasila's principles to craft learning experiences that are both ethically grounded and empirically rigorous (Ilma et al., 2023; Khotimah et al., 2021). This dual integration not only prepares learners for participation in the modern workforce but also ensures that they remain committed to upholding the societal values embodied in Indonesia's foundational ideology. The fusion of Pancasila's moral and civic directives with the competencies inherent in scientific literacy provides a comprehensive educational paradigm. This paradigm is essential for cultivating well-rounded individuals capable of sustaining Indonesia's socio-political ideals while adapting to the demands of the 21st century through informed, innovative, and ethically conscious contributions to society.

Traditional lecture-based methodologies tend to promote passive learning, which in turn restricts students' development of critical thinking, creativity, and engagement. This passivity makes it particularly challenging to internalize not only scientific concepts but also to embrace the ideological values embedded in Pancasila, values that demand active reflection and contextualization (Suryanti et al., 2024). When instruction is delivered via conventional, compartmentalized lectures, learners often receive fragmented knowledge that does not facilitate the integration of scientific reasoning with moral and civic dimensions, creating a gap that is notable in endeavors to cultivate scientific literacy and adherence to Pancasila values.

Recent research highlights innovative pedagogical strategies that transcend the limitations of traditional teaching and foster an environment where interdisciplinary learning can thrive. Project-based and challenge-based learning methodologies, often incorporated within flipped classroom contexts, have demonstrated significant potential for enhancing scientific literacy, as evidenced by improved engagement and higher cognitive outcomes in students (Ismaniati et al., 2023). These approaches enable learners to work on authentic projects that reflect real-world challenges, thereby creating opportunities to embed values of social justice, national unity, and ethical responsibility inherent in Pancasila into scientific inquiry and problem-solving (Aydın & Mutlu, 2023). For instance, by engaging in collaboratively designed projects, students are encouraged to deliberate, negotiate, and reflect upon both empirical evidence and culturally relevant issues, leading to a more holistic educational experience (Bell, 2010).

In essence, the integration of innovative learning models such as project-based learning can create a cohesive, interdisciplinary framework that effectively marries the development of scientific literacy with the ethical and cultural imperatives of Pancasila. This integrated approach not only actively involves students in their learning process but also challenges them to apply scientific reasoning in socially meaningful contexts, thereby equipping them to contribute to both national progress and contemporary scientific debates (Bilbao-Aiastui, 2021; Reswara et al., 2024; Rusilowati et al., 2019). Through such dynamic and reflective pedagogies, the educational system can overcome the inherent drawbacks of traditional instruction and better prepare learners for the multifaceted challenges of the 21st century.

This study aims to explore the effectiveness of combining Project-Based Learning (PBL) with flipbook technology in enhancing the profiles of Pancasila learners and improving their scientific literacy. By leveraging the interactive and collaborative nature of PBL and the digital engagement offered by flipbooks, the research seeks to create a dynamic learning framework that promotes active participation, critical thinking, and the integration of ideological and scientific education.

The findings of this study hold significant implications for multiple stakeholders within the educational landscape. For educators, the integration of project-based learning (PBL) with digital innovations such as flipbook technology represents an opportunity to transition from conventional, passive teaching methods toward more dynamic, interactive, and student-centered pedagogies. Empirical evidence suggests that combining PBL with a flipped classroom approach enhances student engagement and facilitates active learning, thereby enabling teachers to foster experiences that nurture both cognitive development and critical thinking skills (Aydın & Mutlu, 2023; Sholahuddin et al., 2023). This innovative strategy aligns well with efforts to embed national ideological values by contextualizing learning within culturally and socially relevant projects, which not only improve academic performance but also support the internalization of communal and ethical principles.

Learners, on the other hand, benefit from such integrative approaches through the development of enhanced cognitive and socio-emotional skills. The active involvement in authentic, real-world projects facilitated by PBL encourages students to participate in collaborative learning environments, which are known to bolster self-efficacy, problem-solving capabilities, and digital literacy (Zheng et al., 2024). Moreover, through the use of flipbook technology, a tool that promotes visual engagement and interactive content delivery, students experience a learning process that is both personalized and adaptable to diverse learning styles. This dual method not only improves their competency in

scientific literacy but also reinforces personal development in alignment with national values, thereby supporting the harmonious integration of ideological education with empirical disciplines.

Additionally, the insights generated by this study are of great value for educational policymakers, as they provide a framework for designing curricula that address the holistic development of learners. The evidence indicating that innovative instructional strategies, such as the combination of PBL and flipped learning models, can lead to significant improvements in learning outcomes is critical for informing policy decisions (Aslan, 2022; Medina et al., 2024). With the dual focus on fostering scientific competencies and promoting national ideological principles, curriculum designers are better equipped to construct educational programs that support the comprehensive advancement of students. These programs, in turn, ensure that learners are prepared to meet the demands of the 21st century while remaining deeply connected to the ethical and cultural values that underpin their national identity (Kheryadi et al., 2024; Zheng et al., 2024). The integration of PBL with flipbook technology offers educators a viable pathway to create engaging, interactive, and culturally relevant learning environments. Such innovative pedagogical practices not only enhance learners' cognitive and socio-emotional skills but also ensure that the educational process reinforces national ideological values. Consequently, educational policymakers can utilize these insights to foster curriculum designs and instructional strategies that holistically support the development of both scientific literacy and a strong ideological foundation.

This study seeks to address the following research questions:

- How does Project-Based Learning combined with flipbook technology impact learners' profiles, particularly in aspects such as critical thinking, collaboration, and creativity?
- What is the effect of this integrated approach on learners' scientific literacy, including their understanding and application of scientific concepts?

The paper is structured as follows: Section 2 presents a comprehensive literature review, examining existing research on Pancasila in education, Project-Based Learning, flipbook technology, and scientific literacy. Section 3 outlines the methodology employed in the study, detailing the research design, participants, materials, and data analysis procedures. Section 4 discusses the results obtained from the empirical investigation, highlighting key findings related to learners' profiles and scientific literacy. Section 5 provides a discussion of the results in the context of existing literature, explores the implications for teaching practice, and acknowledges the study's limitations. Finally, Section 6 concludes the paper by summarizing the main findings and offering recommendations for future research and educational practice.

Literaure Review

Pancasila in Education

The integration of Pancasila into the Indonesian educational framework is pivotal for cultivating a strong national identity and developing moral values, civic responsibility, and ethical reasoning among learners. As a foundational ideological construct, Pancasila, with its five core principles: belief in one God, just and civilized humanity, Indonesian unity, representative democracy, and social justice for all Indonesians, serves as a guiding moral compass. Scholars have noted that embedding these principles within the curriculum fosters character education and social behavior among students, nurturing a sense of national unity and civic accountability (Aydın & Mutlu, 2023). However, despite the recognition of its importance, educators face challenges in translating these ideals into concrete classroom practices, partly due to the diversity of student backgrounds and the dynamic nature of modern learning environments (Bes-Piá et al., 2023).

Innovative pedagogical approaches, such as project-based learning (PBL) and similar constructivist methods, have been identified as promising avenues for overcoming these challenges. Studies indicate that PBL, especially when paired with technology-enhanced methods like flipped classrooms, can create an engaging learning environment where students actively construct knowledge and internalize core ethical and civic values (Cordero & Frutos, 2018; Villagomez et al., 2019). For example, research conducted by Aydın & Mutlu (2023) demonstrates that when students engage in authentic, real-world projects, they strengthen their academic competencies and improve their ability to deliberate on social justice issues and collective responsibilities, which are central to the Pancasila framework. Similarly, Kheryadi et al. (2024) have provided evidence that collaborative learning environments, developed through innovative teaching models, benefit students by stimulating active inquiry and practical engagement with culturally embedded values.

In addition to reinforcing academic outcomes, the integration of Pancasila through innovative methodologies links education to broader societal goals. Shen's recent work exemplifies how incorporating cultural and national heritage, analogous to the principles of Pancasila, within a project-based learning framework can revolutionize traditional teaching methods and instill a deeper understanding of national values and civic responsibility in learners (Shen & Li, 2024). This approach is in line with the broader goal of

sustainable educational development, emphasizing the development of both soft and hard skills necessary for addressing contemporary global and national challenges (Alfathy et al., 2024). Moreover, initiatives aimed at enhancing digital competence and pedagogical innovation, as discussed by Haleem et al., underscore the need for comprehensive teacher training and curriculum redesign(Haleem et al., 2022) . Such efforts are essential to bridge the gap between traditional, compartmentalized pedagogy and the integrative, experience-based approaches necessary for effectively inculcating Pancasila values. While integrating Pancasila into Indonesia's classroom settings presents significant challenges, leveraging innovative pedagogical strategies, such as project-based learning and technology-enhanced instruction, offers a promising pathway for aligning moral and civic education with academic rigor. By adopting such approaches, educational stakeholders can more effectively promote the holistic development of learners, ensuring that the ethical and cultural principles inherent in Pancasila continue to underpin both national identity and academic excellence.

Project-Based Learning (PBL)

Project-Based Learning (PBL) has emerged as a prominent instructional methodology designed to actively engage students in solving real-world problems while developing a range of higher-order skills. PBL emphasizes hands-on activities that require extensive planning, research, and presentation, thereby cultivating critical thinking, collaboration, and problem-solving (Morales & García, 2018; Pérez-Rodríguez et al., 2022; Rees Lewis et al., 2019). As originally noted by Thomas (2019) and supported by Bell (2010), learners experience deeper comprehension and retention of knowledge in PBL environments compared to traditional lecture-based instruction (Bell, 2010; Thomas, 2019). In addition, PBL promotes learner autonomy and intrinsic motivation; as students take ownership of their projects, they become more engaged in the learning process, a phenomenon further supported by the research by Moore et al. (2023) on knowledge construction in authentic contexts(Moore et al., 2019).

Empirical studies consistently demonstrate that PBL is effective in improving academic performance and fostering 21st-century skills. For instance, research by Ordonez et al. (2021) confirms that PBL enhances cognitive outcomes and supports the development of individual innovation competence (Ordonez et al., 2021). Complementary investigations, such as those by Parno et al., have revealed significant improvements in conceptual understanding and scientific literacy among learners who engage in extended, project-oriented activities (Parno et al., 2020). These studies highlight the dual benefit of PBL: it serves as both an academic and developmental tool, enabling students to integrate theoretical concepts with practical, real-life applications.

Despite these clear advantages, the successful implementation of PBL requires addressing several critical challenges. Adequate teacher training is essential to effectively design and execute PBL curricula, as teachers must be adept at facilitating open inquiry, guiding project management, and assessing complex, often interdisciplinary projects (Rees Lewis et al., 2019). Moreover, the availability of sufficient resources, ranging from technological tools to collaborative spaces, is necessary to create a supportive learning environment that mirrors real-world scenarios (Guajardo-Cuéllar et al., 2022). Such investments are crucial in overcoming the limitations of conventional instruction and ensuring that PBL strategies are scalable and sustainable within diverse educational contexts. Project-Based Learning fosters active student engagement by interlinking the exploration of tangible, real-world challenges with the development of critical academic and socio-emotional skills. Its capacity to deepen understanding and promote learner autonomy makes it an attractive pedagogical option for contemporary education. However, to capitalize on its benefits, educational stakeholders must invest in robust teacher professional development and resource allocation, thereby creating an ecosystem where PBL can be effectively integrated into curricula to support both academic excellence and the development of essential 21st-century competencies (Bes-Piá et al., 2023; Ruiz Loza et al., 2022).

Flipbook Technology in Education

Flipbook technology, defined as digital tools that enable the creation of interactive multimedia presentations resembling traditional flipbooks, has garnered attention for its potential to transform learning environments. These tools allow users to integrate images, text, audio, and video into a single cohesive product, thereby supporting multimodal learning approaches and facilitating enriched, engaging content creation. Haleem et al. provide a comprehensive overview of digital technologies in education and underscore that integrating such tools can notably enhance interactivity and learner engagement (Haleem et al., 2022). In this context, flipbooks cater to diverse learning preferences and support dynamic storytelling and project-based assignments.

Moreover, the interactive nature of digital flipbooks aligns with the principles of multimodal learning, which argue that learning is optimized when content is delivered in various formats to match different cognitive styles. This is consistent with the theoretical foundations laid out by (Aslan, 2022).

Empirical findings by Huang et al. suggest that such interactive and visually appealing content can significantly bolster student comprehension and engagement (Huang & Hwang, 2019). Additionally, Donlon et al. highlight that collaborative creation and editing of flipbook projects can foster a learner-centered environment by encouraging peer collaboration and shared authorship, thus enhancing the social dimensions of learning (Donlon et al., 2020).

However, the successful implementation of flipbook technology in the classroom hinges on critical infrastructural and human factors. Cordero and Barajas Cordero & Barajas (2018) emphasize that while digital tools offer immense potential, their effectiveness is highly dependent on access to reliable digital resources and robust teacher proficiency. Adequate teacher training, as further supported by (Aslan, 2022), is essential to ensure that educators can seamlessly integrate these tools into their instructional practices and align flipbook activities with intended learning objectives. Without such support, the innovative promise of flipbooks might not fully translate into improved learning outcomes.

Overall, when integrated thoughtfully, flipbook technology serves as a versatile medium that supports narrative-based and project-based learning strategies. It leverages the strengths of multimodal presentation to enhance student engagement and comprehension while fostering collaboration among learners. To realize these benefits, educational stakeholders must ensure that both the necessary digital infrastructure and targeted teacher professional development are in place, thereby optimizing the tool's capability to support modern, interactive, and inclusive educational practices.

Scientific Literacy

Scientific literacy is widely recognized as a foundational competence that transcends the mere accumulation of scientific facts. It is defined as the knowledge and understanding of scientific concepts and processes required for informed personal decision-making, active participation in civic and cultural affairs, and the enhancement of economic productivity (Kheryadi et al., 2024). In addition to the factual recall, scientific literacy encompasses the ability to engage in scientific inquiry, employ critical thinking, and apply scientific principles to solve real-world challenges (Megawati, 2024). For instance, Suryanti et al. Ilma et al. (2023) highlight that STEAM-oriented project-based learning (PBL) frameworks effectively catalyze the development of scientific literacy skills in learners by integrating disciplinary knowledge with practical inquiry.

The role of scientific literacy in education is further underscored by its association with improved problem-solving skills, heightened interest in STEM fields, and the capacity for evaluating scientific information critically (Butterworth & Thwaites, 2013; Iswinarti & Suminar, 2019). Empirical studies reveal that educational interventions adopting blended instructional models significantly augment these competencies. Agustina et al. demonstrated in a university setting that a blended project-based learning approach led to marked improvements in students' scientific literacy, fostering greater inquiry and application skills (Agustina et al., 2022). Similarly, Sholahuddın et al. (2023) reported that a combination of project-based and flipped classroom models substantially enhances scientific literacy, thereby promoting active learning and deep understanding among students.

Despite these encouraging findings, several challenges persist in the effective fostering of scientific literacy. Variability in access to educational resources, inconsistent teacher competencies, and curricula that often remain disconnected from real-world applications contribute to ongoing disparities (Kheryadi et al., 2024). Reswara et al. found that the level of problem-solving skills related to topics such as energy and simple machines was relatively low, underscoring the need for instructional approaches that bridge theoretical knowledge with practical application (Reswara et al., 2024). Moreover, a systematic review by Ilma et al. stressed that current STEM educational practices necessitate innovative pedagogical reforms to better integrate scientific knowledge with hands-on learning experiences, thereby addressing diverse learner needs in a technologically advancing society (Ilma et al., 2023).

The development of scientific literacy is critical for preparing learners to navigate and contribute effectively to modern society. While high levels of scientific literacy correlate with improved problem-solving, increased STEM engagement and enhanced critical evaluation of scientific information, challenges related to resource adequacy, teacher preparedness, and curriculum design remain significant. Innovative strategies such as blended and project-based learning models offer promising avenues for overcoming these challenges, thereby reinforcing the importance of ongoing educational reform and resource allocation.

Integrating PBL and Flipbook for Enhanced Learning

The convergence of Project-Based Learning (PBL) and flipbook technology presents a promising approach to enhancing educational outcomes by synergizing active, student-centered learning with dynamic multimedia content creation. PBL promotes engagement through real-world problem-solving and collaborative inquiry. At the same time, flipbook technology provides an interactive platform that enables students to document, refine, and present

their projects in a visually compelling format (Kheryadi et al., 2024; Suryanti et al., 2024).

This integration leverages the strengths of both methodologies. The framework of PBL encourages learners to take ownership of projects, resulting in deeper understanding, enhanced critical thinking, and increased motivation (Sholahuddın et al., 2023). When combined with the digital capabilities of flipbooks, the process becomes more engaging, as students can incorporate images, audio, and video to articulate their ideas effectively. This multimodal approach not only reinforces conceptual understanding but also enhances technological proficiency and creative expression, as demonstrated by recent findings that underscore the role of interactive digital tools in fostering learner engagement and communication skills (Khotimah et al., 2021).

Furthermore, the collaborative nature of PBL is enhanced by the interactive features of flipbook tools, which allow multiple students to co-create and iteratively refine project outcomes (Ilma et al., 2023). Such collaboration supports the development of scientific literacy, an essential competency in today's information-rich society, by encouraging inquiry-based activities that require the application of scientific principles and critical analysis (Sholahuddın et al., 2023; Aydın & Mutlu, 2023). However, achieving these benefits necessitates careful instructional design and sustained teacher support. Educator readiness, including proficiency with digital tools and strategies for integrating these technologies into the curriculum, is critical to ensure that both PBL and flipbook technology effectively contribute to improved educational outcomes (Suryanti et al., 2024). The integration of PBL with flipbook technology creates a dynamic educational environment that enhances student engagement, fosters collaboration and develops key 21st-century skills such as critical thinking, creativity, and scientific literacy. This convergence requires not only innovative instructional design but also ongoing professional development and resource allocation to support teachers and learners in this digitally enriched learning ecosystem.

Methodology

Research Design

This study employs a quasi-experimental design to assess the effectiveness of integrating Project-Based Learning (PBL) with flipbook technology in enhancing Pancasila learners' profiles and scientific literacy. A non-randomized control group design was selected to accommodate the practical constraints of the educational setting, allowing for the comparison between an experimental group exposed to the intervention and a control group receiving traditional instruction. The study utilizes a pre-test and post-test framework to measure changes in learners' profiles and scientific literacy throughout the intervention.

Participants

This study involved 120 students from Medan State University. Participants were selected based on age criteria between 19 to 21 years old. I enrolled in the 2nd semester of the Elementary School Teacher Education (PGSD) study program and am currently taking the Basic Concepts of Physics course. Obtained approval from students and teaching lecturers.

Participants were divided into two groups: Experimental Group n = 60: Engaged in PBL activities using flipbook technology. Control Group n = 60: Received traditional lecture-based instruction without the integration of flipbook tools. Demographic data, including gender, socioeconomic status, and previous academic performance, were collected to ensure homogeneity between groups and to control for potential confounding factors.

Data Collection

Data were collected through multiple methods to capture both quantitative and qualitative aspects of the study:

- Pre-Test and Post-Test Scores: Numerical data from the Learners' Profile Assessment and Scientific Literacy Test were collected for both groups.
- Statistical Data: Demographic information to control for potential confounding variables.
- Surveys: Responses from the Engagement and Motivation Survey provided subjective measures of student experiences.
- Focus Groups: Insights from focus group discussions offered a contextual understanding of the quantitative findings.

All data collection procedures adhered to ethical standards, ensuring confidentiality and voluntary participation.

Data Analysis

The collected data were analyzed using both quantitative and qualitative methods:

- Descriptive Statistics: Calculated means and standard deviations for pre-test and post-test scores within each group.
- Inferential Statistics: Independent samples t-tests were employed to compare post-test scores between the experimental and control groups. Additionally, paired samples t-tests assessed within-group changes from pre-test to post-test. An Analysis of Variance (ANOVA) was conducted to examine the interaction effects of group and time on the dependent variables.
- Significance Level: Statistical significance was set at $p<0.05$.
- Thematic Analysis: Responses from the Engagement and Motivation Survey and focus group

discussions were transcribed and coded to identify recurring themes related to student engagement, motivation, and perceptions of the PBL and flipbook integration.

- Triangulation: Cross-validation of qualitative data with quantitative findings to enhance the reliability of the results.
- Mathematical Expressions: All inline mathematical expressions within the analysis, such as t-values, p-values, and confidence intervals, were formatted using delimiters to ensure proper rendering. For example, results were reported as $t(118)=3.45$, $p<0.001$, indicating a statistically significant difference between groups.
- Statistical Analysis: SPSS Version 26 was utilized for conducting quantitative analyses.
- Qualitative Analysis: NVivo Version 12 facilitated the organization and coding of qualitative data.
- Reliability and Validity: The assessment instruments were previously validated through pilot testing, and internal consistency was confirmed using Cronbach's alpha coefficients ($\alpha>0.7$ for all scales). Efforts were made to minimize bias through the use of standardized administration procedures and the blinding of assessors to group assignments.

Results

Learners' Profile Enhancement

The results of the data analysis can be seen in Table 1, which highlights the descriptive statistics and t-test results for the experimental and control groups.

Table1. Learner's Profile Assessment Results

Measure	Group	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Change	t-Value (df=59)	p-Value
Critical Thinking	Experimental	65.4 (8.2)	82.7 (7.5)	+17.3	12.34	**0.001**
	Contrrol	64.8 (7.5)	66.2 (7.6)	+1.4	1.45	0.152
Collaboration	Experimental	68.1 (7.9)	85.3 (6.8)	+17.2	11.56	**0.001**
	Contrrol	67.5 (7.3)	68.0 (7.4)	+0.5	0.89	0.376
Creativity	Experimental	64.7 (8.5)	80.9 (7.2)	+16.2	10.89	**0.001**
	Contrrol	65.0 (7.8)	65.5 (7.9)	+0.5	0.60	0.551

The data in Table 1 can be illustrated with a graph, as shown in Figure 1.

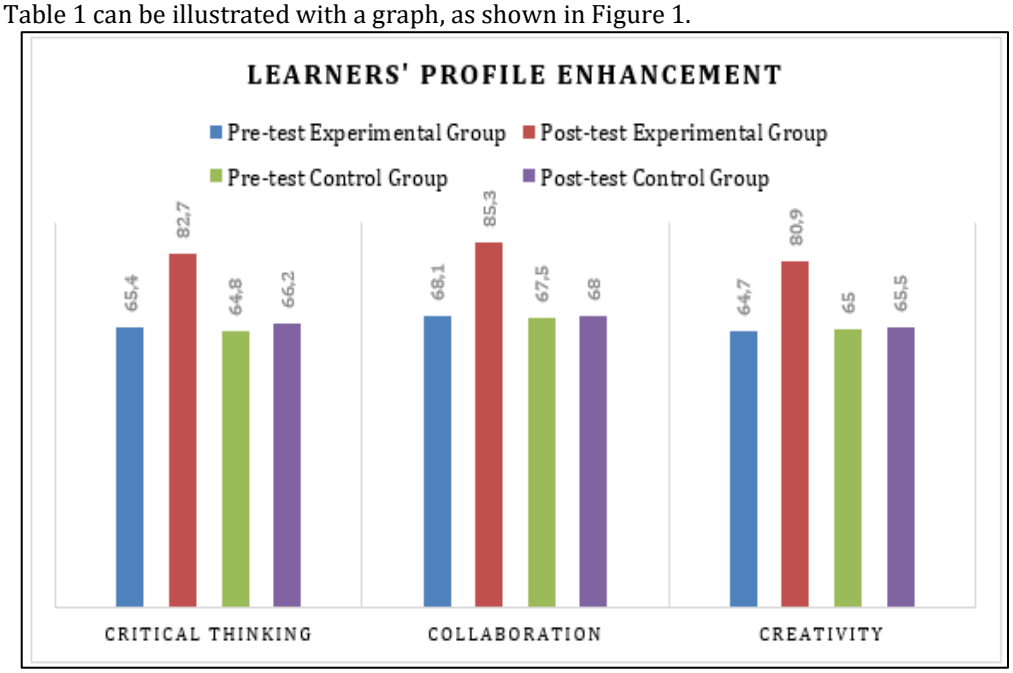

Figure 1. Learner's Profile Assessment Results

Experimental Group:
- Critical Thinking: The experimental group showed a significant increase in critical thinking scores from a mean of 65.4 (SD = 8.2) in the pre-test to 82.7 (SD = 7.5) in the post-test. The t-test results ($t(59)=12.34$, $p<0.001$) indicate that this improvement is statistically significant.
- Collaboration: Similarly, collaboration scores improved significantly from 68.1 (SD = 7.9) to 85.3 (SD = 6.8), with a t-value of 11.56 and a p-value of less than 0.001.
- Creativity: Creativity scores also showed a significant increase from 64.7 (SD = 8.5) to 80.9 (SD = 7.2), with a t-value of 10.89 and a p-value of less than 0.001.

Control Group:
- Critical Thinking: The control group experienced a small, non-significant increase in critical thinking scores from 64.8 (SD = 7.5) to 66.2 (SD = 7.6), with a t-value of 1.45 and a p-value of 0.152.
- Collaboration: Collaboration scores increased minimally from 67.5 (SD = 7.3) to 68.0 (SD = 7.4), with a t-value of 0.89 and a p-value of 0.376.
- Creativity: Creativity scores rose slightly from 65.0 (SD = 7.8) to 65.5 (SD = 7.9), with a t-value of 0.60 and a p-value of 0.551.

The results suggest that the experimental group, which participated in the PBL and flipbook intervention, experienced significant improvements in all measured dimensions of socio-emotional skills. In contrast, the control group showed minimal and non-significant changes, indicating that the intervention had a substantial positive impact on the experimental group's learners' profiles.

Improvement in Scientific Literacy

Scientific Literacy was assessed using a standardized test that included knowledge of scientific concepts, application of scientific reasoning, and engagement in scientific inquiry. The results of the analysis can be seen in Table 2.

Table 2. Improvement in Scientific Literacy

Group	Pre-Test (Mean±SD)	Post-Test (Mean±SD)	Mean Change	t-Value	p-Value
Experimental	70.2 ± 9.1	88.5 ± 6.9	+18.3	15.67	0.001
Control	69.8 ± 8.7	71.0 ± 8.9	+1.2	1.10	0.275

The table presents a comparison of scientific literacy scores between an experimental group and a control group. The experimental group, which was exposed to a Problem-Based Learning (PBL) and flipbook methodology, showed a significant improvement in scientific literacy scores. The mean score increased from 70.2 (SD = 9.1) in the pre-test to 88.5 (SD = 6.9) in the post-test. This improvement was statistically significant, with a t-value of 15.67 and a p-value of less than 0.001, indicating a robust improvement in the participants' scientific literacy.

In contrast, the control group, which followed traditional instructional methods, exhibited only a slight increase in mean scores from 69.8 (SD = 8.7) to 71.0 (SD = 8.9). The change was not statistically significant, as evidenced by a t-value of 1.10 and a p-value of 0.275.

The results highlight the effectiveness of the integrated PBL and flipbook approach in improving scientific literacy. The significant improvement in the experimental group suggests that this methodology is more effective in fostering scientific understanding and application compared to traditional methods. This disparity emphasizes the potential benefits of innovative teaching strategies in enhancing educational outcomes in scientific literacy.

Engagement and Motivation

The Engagement and Motivation Survey provided both quantitative and qualitative insights into student experiences with the Problem-Based Learning (PBL) and flipbook methodology.

Quantitative Findings:
- Engagement: A significant 85% of students in the experimental group reported high levels of engagement, compared to only 45% in the control group. This suggests that the PBL and flipbook approach was more effective in capturing students' attention and interest.
- Motivation: Similarly, 78% of participants in the experimental group expressed increased motivation to engage in science-related activities, whereas only 40% of the control group reported the same. This indicates that the experimental methodology not only engaged students but also inspired them to pursue further scientific exploration.

Qualitative Findings:

Thematic analysis of open-ended survey responses and focus group discussions revealed several key themes:
- Increased Interest: Students in the experimental group frequently highlighted the interactive nature of flipbooks, which made learning more enjoyable and relevant. This suggests that the hands-on and visually engaging aspects of flipbooks enhanced their interest in the material.
- Enhanced Collaboration: The collaborative elements of PBL were praised for developing

teamwork skills and fostering a supportive learning environment. This indicates that working together on projects helped students build interpersonal skills and create a sense of community.

- Greater Autonomy: Participants appreciated the autonomy they had over their projects, which contributed to a sense of ownership and responsibility for their learning outcomes. This autonomy likely empowered students to take charge of their learning journey and feel more invested in the process.
- Technological Proficiency: The use of digital flipbooks improved students' technical skills, which they found valuable for both academic and personal purposes. This suggests that the integration of technology not only supported learning but also equipped students with important digital competencies.

Overall, the data indicated that integrating PBL with flipbook technology significantly boosted student engagement and motivation. The combination of interactive, collaborative, and autonomous learning experiences created a more dynamic and engaging educational environment, leading to enhanced student outcomes.

Comparative Analysis

The post-test scores for both the experimental and control groups, along with the results of the independent samples t-tests, are shown in Table 3.

Table 3. Comparative Analysis of Experimental vs. Control Groups

Variable	Group (M±SD)		Mean Diff.	t-Value	Sig.	ANOVA	
	Experimental	Control				F- Value	Sig.
Critical Thinking	82.7 ± 7.5	66.2 ± 7.6	+16.5	14.89	0.001	152.36	0.001
Collaboration	85.3 ± 6.8	68.0 ± 7.4	+17.3	16.45	0.001	178.54	0.001
Creativity	80.9 ± 7.2	65.5 ± 7.9	+15.4	15.22	0.001	143.78	0.001
Scientific Literacy	88.5 ± 6.9	71.0 ± 8.9	+17.5	17.62	0.001	165.43	0.001

1. Post-Test Comparisons (Independent Samples t-tests)

- Critical Thinking: The experimental group (M = 82.7) scored 16.5 points higher than the control group (M = 66.2), with a highly significant difference ($t = 14.89$, $p < 0.001$).
- Collaboration: The experimental group (M = 85.3) outperformed the control group (M = 68.0) by 17.3 points ($t = 16.45$, $p < 0.001$), indicating stronger teamwork skills.
- Creativity: The experimental group (M = 80.9) showed 15.4 points higher creativity than the control group (M = 65.5, $t = 15.22$, $p < 0.001$).
- Scientific Literacy: The largest gap was in scientific literacy, where the experimental group (M = 88.5) surpassed the control group (M = 71.0) by 17.5 points ($t = 17.62$, $p < 0.001$).

2. ANOVA Interaction Effects (Group × Time)

- All four variables (Critical Thinking, Collaboration, Creativity, and Scientific Literacy) showed highly significant interaction effects (all $p < 0.001$), confirming that the experimental group improved far more over time than the control group.
- The F-values (ranging from 143.78 to 178.54) indicate strong statistical evidence that the PBL and flipbook intervention was significantly more effective than traditional instruction.

3. Overall Implications

- The integrated PBL and flipbook approach led to substantially greater improvements in critical thinking, collaboration, creativity, and scientific literacy compared to conventional teaching methods.
- The consistently large effect sizes (high t and F-values) suggest that active, student-centered learning strategies (like PBL + flipbooks) are highly effective in fostering key 21st-century skills.
- These findings support the wider adoption of such innovative pedagogies to enhance student engagement, problem-solving, and scientific reasoning.

These findings confirm that the experimental group experienced significantly greater improvements over time compared to the control group. This validates the effectiveness of the PBL and flipbook integration in enhancing learners' profiles and scientific literacy, demonstrating the value of these innovative educational approaches.

Discussion

The present study aimed to evaluate the effectiveness of integrating Project-Based Learning (PBL) with flipbook technology in enhancing Pancasila learners' profiles and scientific literacy. The results indicate that the experimental group, which engaged in PBL activities utilizing flipbook tools, demonstrated significant improvements in critical thinking, collaboration, creativity, and scientific literacy compared to the control group, which followed traditional lecture-based instruction. Specifically, learners in the experimental group showed mean increases of 17.3 points in critical thinking $p < 0.001$, 17.2 points in collaboration $p <$

0.001, 6.2 points in creativity $p < 0.001$, and 18.3 points in scientific literacy $p < 0.001$. These substantial gains suggest that the combination of PBL and flipbook technology effectively fosters essential socio-emotional skills and enhances scientific understanding.

The minimal changes observed in the control group across all measures reaffirm the impact of the PBL and flipbook intervention. The lack of significant improvement $p > 0.05$ in the control group highlights the limitations of traditional teaching methodologies in promoting comprehensive learner development and scientific competence.

Alignment with Existing Literature

The present study's findings are situated within a growing body of evidence that demonstrates the effectiveness of project-based learning (PBL) in cultivating critical thinking, collaboration, and creativity among learners. Several studies have confirmed that PBL not only enhances these higher-order cognitive skills but also promotes deeper engagement with content. For example, Aydın & Mutlu (2023) provide empirical support showing that PBL significantly improves academic success and individual innovation competence, while Megawati (2024) emphasizes that integrating PBL within STEM contexts fosters advanced cognitive capacities such as critical thinking and problem-solving. In addition, Sholahuddın et al. (2023) have underscored that blending PBL with active learning strategies leads to improvements in overall learning outcomes, reinforcing our study's conclusions regarding the benefits of collaborative and inquiry-based learning.

Furthermore, the observed significant improvement in scientific literacy within this study is consistent with previous investigations that stress the benefits of active, inquiry-oriented methodologies in science education. Suryanti et al. Suryanti et al. (2024) demonstrated that a STEAM-PBL approach substantially enhances scientific literacy skills among elementary students. This outcome is echoed by Agustina et al. (2023), who reported notable gains in university students' scientific literacy following the implementation of blended project-based learning. These convergent findings suggest that inquiry-based strategies, when integrated with PBL, create a robust learning environment that facilitates a deep understanding of scientific concepts and processes.

The integration of flipbook technology in our instructional design further reinforces the potential of digital tools to augment student engagement and communication of complex ideas. Research by Haleem et al. (2022) review how digital technologies, when meaningfully integrated into the curriculum, can promote active learning and improve students' ability to process and communicate complex content. In addition, Aslan (2022) found that the flipped classroom model, a pedagogical approach that shares essential characteristics with flipbook technology, enhances learners' engagement, thereby supporting the view that digital innovations play a crucial role in modern education. This digital integration not only makes learning more interactive but also helps in overcoming traditional instructional challenges (Ayuningrum et al., 2022; Kandriasari et al., 2023; Riana et al., 2024; Zuhairi et al., 2024).

Moreover, the improved technological proficiency reported by our participants aligns with frameworks such as the Technological Pedagogical Content Knowledge (TPACK) model. Tanak and Yeh et al. provide evidence that integrating technology with pedagogy can effectively enhance teachers' capabilities in designing and delivering instruction that meets modern educational demands (Tanak, 2018; Yeh et al., 2021). This alignment affirms the importance of a seamless integration of technology into teaching practices, as it enriches the learning experience and ultimately contributes to the development of competencies that are vital in the 21st century. The study's results corroborate and extend previous research by showing that combining PBL with digital innovations enhances critical cognitive and collaborative skills and significantly improves scientific literacy. This multi-faceted approach, grounded in both active inquiry and technological proficiency, offers a compelling model for fostering deeper learning in contemporary educational environments.

Conclusion

This study investigated the impact of integrating Project-Based Learning (PBL) with flipbook technology on enhancing Pancasila learners' profiles and scientific literacy. The findings revealed that the experimental group, which engaged in PBL activities using flipbook tools, exhibited substantial improvements in critical thinking, collaboration, creativity, and scientific literacy. Specifically, the experimental group's critical thinking scores increased by 17.3 points ($p<0.001$), collaboration by 17.2 points ($p<0.001$), creativity by 16.2 points ($p<0.001$), and scientific literacy by 18.3 points ($p<0.001$). In contrast, the control group, which received traditional lecture-based instruction, showed negligible and statistically insignificant changes in all measured areas. Furthermore, the majority of students in the experimental group reported heightened engagement and motivation, attributing these enhancements to the interactive and collaborative nature of the PBL and flipbook integration.

The significant improvements observed in the experimental group underscore the efficacy of combining PBL with digital tools like flipbooks in fostering comprehensive learner development.

Educators are encouraged to adopt PBL frameworks to promote active learning, critical thinking, and collaborative skills among students. The integration of flipbook technology not only enhances student engagement but also facilitates the effective communication of complex scientific concepts, aligning with the goals of scientific literacy. Additionally, the positive correlation between the use of digital flipbooks and the enhancement of socio-emotional skills suggests that such technological integrations can support the holistic development of learners in line with Pancasila values. Policymakers should consider incorporating these innovative teaching methods into the national curriculum to bridge the gap between ideological education and scientific competence.

The study provides robust evidence that the integration of Project-Based Learning with flipbook technology significantly enhances both the ideological and scientific competencies of learners. By fostering critical thinking, collaboration, creativity, and scientific literacy, this pedagogical approach aligns with the multifaceted objectives of modern education systems. While the study's findings are promising, it is essential to address its limitations, including the non-randomized design and the short intervention duration, to understand the long-term benefits and scalability of this approach fully. Future research should explore diverse educational settings and incorporate longitudinal studies to validate and expand upon these results. Ultimately, embracing such integrative and technology-enhanced teaching strategies holds the potential to cultivate well-rounded individuals equipped to contribute meaningfully to society, both ethically and scientifically.

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