Vol. 11, No. 2, 2025, pp. 158-164
DOI: https://doi.org/10.29210/1202525666

Contents lists available at Journal IICET

Jurnal EDUCATIO (Jurnal Pendidikan Indonesia)
ISSN: 2476-9886 (Print) ISSN: 2477-0302 (Electronic)

Journal homepage: https://jurnal.iicet.org/index.php/jppi

Designing a stem-based project learning module to foster creativity and collaboration in junior high school: an exploratory study in the p5 context

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Article Info

Article history:

Received May 02nd, 2025
Revised Jul 03rd, 2025
Accepted Dec 29th, 2025

Keyword:

Project-based learning,
Stem education,
Creativity,
Collaboration,
Pancasila student profile

ABSTRACT

This preliminary descriptive study aimed to assess junior high school students' creativity and collaboration as input for developing a STEM-integrated Project-Based Learning (PjBL-STEM) module aligned with the Pancasila Student Profile (P5) curriculum. A total of 64 students from classes 9B and 9C at SMPN 1 Cikidang participated. Creativity was measured using the Torrance Test of Creative Thinking (TTCT), covering fluency, flexibility, originality, and elaboration, while collaboration was observed using structured indicators of participation, mutual support, and group decision-making. Data were analyzed using descriptive statistics and categorized based on validated scoring rubrics. Results showed moderate creativity (average 64.3%) and low collaboration (average 14.4/25), indicating gaps in current instructional practices. These findings highlight the need for a contextually relevant learning module. The study supports the analysis phase of the ADDIE framework and contributes to the design of a PjBL-STEM module that fosters 21st-century skills through authentic, interdisciplinary, and student-centered learning aligned with national curriculum goals.

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Introduction

The Indonesian Ministry of Education, Culture, Research, and Technology has launched the Merdeka Curriculum, which places strong emphasis on character development and the mastery of 21st-century competencies through project-based learning initiatives known as the Profil Pelajar Pancasila (P5) (Azmi et al., 2023; Fauzan et al., 2023 ; Kartika, 2024; Sukma & Dewi, 2024). One of the thematic priorities within the P5 framework is "Engineering and Technology," which seeks to foster creativity and collaboration two critical skills for navigating a complex and rapidly changing global landscape (Comesaña-Comesaña et al., 2022; Conference et al., 2024; Forman et al., 2023; Gratani & Giannandrea, 2022; Membrillo-Hernández et al., 2023; Ryabets & Shchyrbul, 2023; Viegas et al., 2017). While the vision of P5 is progressive, its practical implementation in schools remains uneven and frequently encounters systemic and pedagogical barriers.

Field evidence suggests that many schools struggle to carry out P5 projects effectively, particularly under the Engineering and Technology theme. Preliminary observations from public junior secondary schools in rural West Java, for example, indicate that teachers often lack access to contextualized learning modules and have limited capacity in applying integrated STEM pedagogies. These constraints hinder the development of student

creativity and teamwork, which are core learning outcomes mandated by the P5 curriculum. At SMPN 1 Cikidang, a needs analysis revealed that while students' creative thinking abilities scored at a moderate level (M = 64.3%), their collaboration scores were significantly lower (M = 14.4%), indicating a substantial gap between intended competencies and actual performance.

Despite the growing body of research supporting the effectiveness of STEM-based Project-Based Learning (PjBL-STEM) in enhancing student engagement and critical skills (Agustin et al., 2022; Hendriyani et al., 2023; H. Lestari & Rahmawati, 2020; Rahmania, 2021; Wahdi Ginting et al., 2023; Widiawati et al., 2023; Winarni et al., 2022), its application within the P5 framework has received limited scholarly attention. Previous studies often focus on STEM implementation as a stand-alone innovation or in high school settings, leaving a gap in understanding how PjBL-STEM can be adapted to meet the thematic and character-building goals of the P5 framework, especially in lower-secondary schools. Moreover, few studies offer design-based interventions that respond directly to school-level data and teacher needs in the Indonesian context.

This research responds to that gap by initiating a research and development project aimed at designing a P5 learning module based on the PjBL-STEM approach. The objective of this study is to develop a contextualized instructional module aligned with the Engineering and Technology theme of P5 that effectively enhances students' creativity and collaboration. The initial phase involves analyzing students' baseline competencies and identifying instructional challenges within the school context to inform the module design process.

This study contributes to the advancement of contextual pedagogy by integrating character-based national curriculum goals with evidence-based STEM pedagogical models. By addressing real challenges faced by teachers and students in implementing the P5 framework, this research not only proposes a feasible instructional solution but also enriches the discourse on STEM integration in value-oriented education. The findings are expected to provide practical insights for educators, policymakers, and curriculum developers aiming to improve project-based learning implementation in Indonesian schools.

Method

This preliminary study employed a quantitative descriptive design as the initial phase of a broader research and development (R&D) initiative following the ADDIE instructional design model. The study was conducted at SMPN 1 Cikidang in February 2025, involving 64 students from classes 9B and 9C of the 2024/2025 academic year. Participants were selected purposively based on their active involvement in project-based learning activities. While purposive sampling was deemed suitable for this early-stage investigation, it is acknowledged that this approach limits generalizability; future phases of the study will incorporate more diverse and randomly selected samples to enhance external validity.

To assess students' creative thinking abilities, the Torrance Tests of Creative Thinking (TTCT) were used, focusing on fluency, flexibility, originality, and elaboration (Alabbasi et al. 2022; Arifa et al. 2023; Aryanti et al. 2021; Elena and Becerra 2024; Fatmawati, Jannah, and Sasmita 2022; Istikomah et al. 2024; Njonge 2023; Redó, Gutiérrez, and Cano 2021; Sa'idah, Budiyono, and Siswanto 2021; Samaniego et al. 2024; Syarifatul luthfia 2024). For collaboration, a structured rubric-based observation sheet was employed rather than a simple checklist. The rubric evaluated observable indicators such as active participation, mutual support, communication effectiveness, and timely task completion (Demetroulis et al., 2023; Fulk, 2023; Ilma et al., 2022; I. D. Lestari & Rachmawati, 2024; Suharti et al., 2024). Each indicator was scored on a 5-point Likert scale to minimize subjectivity and increase measurement precision.

Two trained observers conducted the classroom observations independently during team-based tasks. To reduce potential bias, inter-rater reliability was calculated using Cohen's Kappa, which yielded a coefficient of 0.81, indicating strong agreement. All instruments underwent expert validation and were piloted with a comparable student cohort prior to the main study. Reliability coefficients (Cronbach's Alpha) for the TTCT and collaboration rubric were 0.87 and 0.85, respectively.

Data collection was conducted during two project-based learning sessions: February 7 (class 9B) and February 14 (class 9C). While this short duration is a limitation, the sessions were integrated into authentic classroom practices to ensure ecological validity. To strengthen the interpretation of results, qualitative reflections from students and teachers were also collected through short open-ended questionnaires and post-activity discussions. These responses provided insights into students' learning experiences, challenges, and perceptions of the PjBL-STEM approach.

Quantitative data were analyzed using descriptive statistical methods, including means and percentages, to summarize students' performance before and after the intervention. To examine the effectiveness of the implemented activities, paired sample t-tests were conducted to identify significant differences between pretest

and posttest scores. These inferential tests were employed to ensure that any observed improvements were statistically significant and not due to random variation.

As this was a preliminary phase, no comparison group was included. However, a control group will be incorporated in subsequent experimental stages to examine the true effectiveness of the developed module. This study primarily served to identify student needs, instructional gaps, and contextual constraints, which are critical inputs for the next phases (Design and Development) of the ADDIE process.

Results and Discussions

The preliminary findings of this study reveal that the overall level of student creativity at SMPN 1 Cikidang is categorized as moderate, with a combined average score of 64.3% obtained from classes 9B and 9C. This categorization is based on scoring intervals adapted from the Torrance Test of Creative Thinking (TTCT) and aligned with relevant educational standards, wherein scores below 60% are classified as low, those between 60% and 79% as moderate, and scores of 80% or above as high. These results suggest that while students demonstrate a foundational level of creative thinking, there remains substantial potential for further development through targeted instructional interventions (Dogan, Maria Antonia Manassero, and Vázquez-Alonso 2020; Yan et al. 2022).

An analysis of the TTCT dimensions reveals significant variation in students' creative thinking performance (Table 1). The highest score was observed in fluency (70.2%), while the lowest was in originality (57.4%), indicating that although students can produce numerous ideas, these ideas tend to lack uniqueness. This gap indicates that students may not be adequately supported in taking intellectual risks or thinking beyond conventional boundaries, possibly due to traditional classroom environments that emphasize accuracy over creativity.

Table 1. Average Scores by TTCT Dimensions

TTCT Dimension	Average Score (%)	Category
Fluency	70.2	Moderate
Flexibility	64.7	Moderate
Originality	57.4	Low
Elaboration	64.9	Moderate

When analyzed by gender, female students outperformed male students with an average creativity score of 66.1%, compared to 62.4% for males. Although no inferential statistical test was conducted in this preliminary phase, this pattern aligns with previous research suggesting that female students often exhibit higher verbal expressiveness and reflective thinking in creative tasks (Cahyono, Rohman, and Fauzi 2021; Islam, Budiyono, and Siswanto 2021). Factors such as learning styles, classroom participation dynamics, and comfort levels in group settings may play a role and warrant deeper investigation in future studies.

In terms of collaboration, students scored 14.4 out of 30, placing them in the low category. Class 9B recorded a slightly higher mean (14.6) than class 9C (14.2), but both remain substantially below the expected benchmark. This score was derived from a structured rubric measuring four collaboration indicators: positive interdependence, promotive interaction, shared decision-making, and individual accountability. Among these, the weakest aspects were constructive communication and shared task responsibility.

Qualitative observations revealed frequent instances of group work being dominated by one or two students, while others remained passive. For example, observers noted situations where "group members remained silent during task division" or where "a student's suggestions were ignored by peers without discussion." Such behaviors indicate a lack of collaboration norms and insufficient practice in interpersonal skills necessary for effective teamwork core competencies expected in the Pancasila Student Profile.

Although both classes received instruction from the same teacher and followed an identical project-based learning approach, minor differences in student performance were observed. These disparities may be attributed to internal group dynamics or the established classroom culture unique to each class. Teacher observations prior to the study indicated that students in class 9B had more experience working collaboratively compared to those in 9C, which may account for the slight gap in achievement scores.

These findings highlight a significant gap between students' creative potential and their ability to collaborate effectively, indicating the necessity for instructional approaches that simultaneously nurture both skill sets. Despite the ongoing implementation of project-based learning in the observed classrooms, the absence of a structured and contextually relevant learning module limited the effectiveness of these efforts. In particular, the

lack of integration of the PjBL-STEM framework appears to constrain the holistic development of students' creativity and collaboration competencies.

Consistent with the findings of Hendriyani et al. (2023), Pramesti et al. (2022), Putri & Zulyusri (2022), D. R. Sari et al. (2023), I. K. Sari et al. (2024), and Yanti et al. (2023), STEM-integrated project-based learning has been shown to effectively foster both divergent thinking and peer interaction. These outcomes are particularly evident when learning is facilitated through scaffolded tasks and situated within authentic, real-world problem contexts. Nevertheless, the full potential of this approach is often underutilized in practice due to the lack of well-structured instructional design.

The findings of this study strongly justify the development of a PjBL-STEM module specifically tailored to the Engineering and Technology theme within the P5 initiative. Such a module should be intentionally designed to address the identified gaps in both creativity and collaboration. First, it is essential to structure clear and purposeful collaborative roles within student groups to ensure balanced participation and shared responsibility, thus minimizing passive engagement. Second, the module should embed explicit opportunities for students to engage in creative ideation and experimentation through open-ended tasks, problem-solving challenges, and real-world scenarios that stimulate divergent thinking. Third, to promote deeper interaction and mutual understanding, the inclusion of tools and prompts such as guiding questions, reflection sheets, or peer-assessment rubrics is necessary to foster reflective dialogue among students. Together, these elements would not only strengthen the learning process but also directly support the core values of the Pancasila Student Profile by nurturing creative, critical, and collaborative learners

In the short term, teachers can be supported through targeted professional development aimed at enhancing their ability to implement collaborative learning strategies effectively. This support may include the use of structured scaffolds, such as role cards, peer feedback protocols, or other cooperative learning tools. These interim measures are intended to bridge the gap while the complete instructional module is still under development.

This study's limitations namely its single-site setting, short data collection period, non-random sampling, and lack of control group affect both internal and external validity. As such, findings cannot be generalized across broader populations. Moreover, contextual factors such as teacher experience, classroom culture, and school infrastructure were not controlled, which may also have influenced outcomes. Future research should incorporate a quasi-experimental or longitudinal design, engage a more diverse sample, and integrate contextual variables to assess the module's broader applicability and impact.

Conclusions

This study provides preliminary insights into the current state of student creativity and collaboration within the context of the Pancasila Student Profile (P5) curriculum. The findings, derived from a descriptive analysis, indicate that students' creative thinking skills are at a moderate level (average score of 64.3%), while their collaborative abilities remain low (average score of 14.4). These results suggest that the existing instructional approaches may not yet fully support the development of these key 21st-century competencies, particularly when aligned with the demands of the Engineering and Technology theme in the P5 framework. However, given the non-experimental design, the limited sample, and the single-site context, these conclusions must be interpreted with caution. The study does not provide causal evidence regarding the effectiveness or limitations of current teaching strategies, nor does it claim generalizability across different educational settings. Rather, the findings serve as a diagnostic baseline that highlights areas in need of pedagogical enhancement, particularly in structuring group collaboration and stimulating creative ideation. Based on these early observations, the study proposes the development of a PjBL-STEM-based module, designed using the ADDIE framework, to better align classroom practices with the competency targets of the P5 curriculum. This module is intended to offer structured, contextualized, and student-centered learning experiences that integrate creativity and collaboration in meaningful ways. Further research is needed to develop, implement, and evaluate the proposed module in broader and more diverse contexts. Future studies should adopt experimental or quasi-experimental designs, involve larger and more heterogeneous samples, and incorporate both quantitative and qualitative data to rigorously assess the module's effectiveness. Only through such extended research efforts can stronger empirical claims be made and practical recommendations be offered to inform curriculum innovation and policy direction.

Acknowledgments

The author would like to express heartfelt appreciation to the first and second academic supervisors for their invaluable guidance, continuous encouragement, and constructive feedback throughout the research and writing

process. Sincere gratitude is also extended to the author's beloved family for their unwavering moral support, patience, and motivation during every stage of this study. Appreciation is also given to the teachers and students of SMPN 1 Cikidang for their enthusiastic participation and cooperation throughout the implementation phase. Special thanks are addressed to the Principal of SMPN 1 Cikidang for the permission, support, and facilitation that enabled the smooth conduct of this research

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