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IMPLEMENTATION OF INTEGRATED PJBL-STEM AND SEL TO ENHANCE STUDENTS CREATIVE THINKING SKILLS

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ABSTRACT

The ability to think creatively is a necessary skill for students as a basis for thinking, with indicators of fluency, flexibility, originality, and elaboration. Therefore, a learning design is needed as a solution to train students abilities in generating many ideas smoothly, providing unique ideas, and relating their learning experiences as 21st century competencies. This study aims to describe the implementation process of PjBL-STEM integrated with SEL using a mini-planetarium product and analyze its impact on improving students creative thinking skills during the learning process. The learning process was implemented through several stages orientation,planningand designing,project creation,testing and presentation, and evaluation. This research is a case study with a single case design, which consists of determining and defining questions, determining research design and instruments, determining techniques and collecting research data, and making a final report. Data collection techniques were conducted through interviews, observations, and student questionnaires. The research instruments used were interview guidelines, learning implementation observation sheets, and student reflection questionnaires. Data analysis techniques were carried out by applying qualitative descriptive analysis and percentage calculation. The findings indicate that integrating PjBL-STEM with SEL through the mini-planetarium project effectively enhanced students creative thinking, with the strongest gains observed in fluency (89%) and flexibility (81%), while originality (74%) and elaboration (71%) showed good progress but require further reinforcement. Results on the implementation process are still under analysis and will provide important insights for refining instructional design and future classroom applications.

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1. INTRODUCTION

Science continues to evolve and advance rapidly in the 21st century. To adapt to these changes, it is necessary to design learning approaches that can facilitate students in improving their 4C skills (communication, collaboration, creative thinking, and critical thinking) for their future (Thornhill-Miller et al., 2023). The implementation of the *Merdeka Curiculum* aims to prepare a generation that is adaptive to the challenges of the times and to nurture students to become independent, intelligent, and character-driven individuals in accordance with the ProfilPelajar

Pancasila. *Merdeka Curiculum* emphasizes 21st century learning using the Project-Based Learning (PjBL) model to achieve various competency aspects, including creative thinking skills (Indarta et al., 2022). These skills need to be trained early as higher-order thinking abilities to help students face the dynamics of global development through a series of scientific activities in the learning process.

Scientific activities that encourage students to produce products based on their ideas can sharpen their creative thinking skills (Mamahit et al., 2020). An individual's creative behavior is influenced by motivational factors and the learning environment, indicated by indicators such as fluency, flexibility, originality, and elaboration (National & Gifted, 2002). These skills are essential as they enhance the ability to solve real-world problems(Simanjuntak et al., 2021). Creativity can be fostered through project-based learning, as students become more active in constructing their understanding through a series of designed procedures (Biazus & Mahtari, 2022). PjBL has a positive trend in the learning process because it improves students thinking abilities in facing problems and contributes to better learning outcomes (Nurhidayah et al., 2021). Additionally, PjBL is effective in helping students solve problems creatively, flexibly, and originally (Maros et al., 2023). Integrating PjBL-STEM trains students to connect existing knowledge to solve problems using engineering and technology, making this method recommended for science subjects (Susanti et al., 2021).

PjBL with a STEM approach can increase learning interest, provide meaningful learning experiences, offer challenges and motivation, and train students to think creatively (Ilafi et al., 2024). PjBL can boost students capacity for creative thinking, and the STEM approach enhances their creativity skills (Purba et al., 2024). The distinctive syntax of the PjBL model by the George Lucas Educational Foundation includes defining challenging essential questions, planning the project, scheduling activities, monitoring implementation, assessing project outcomes, and evaluating. Project-based learning can improve students cognitive and emotional competencies in the science learning process at school (Lozano et al., 2022). Social Emotional Learning (SEL) supports students in developing self-awareness, self-control, and interpersonal skills that are essential for success in school and life. It includes skills such as recognizing and managing emotions, understanding others perspectives, and making responsible decisions (Greenberg, 2023). PjBL integrated with SEL shows positive development for student learning (Rahmawati & Hidayah, 2024). Students with strong social-emotional skills are better able to improve their creative thinking abilities (Yenti et al., 2022).

Although previous studies have shown that PjBL and STEM approaches can enhance students creative thinking skills, most research has examined these approaches separately and rarely integrated them with SEL in a unified instructional model. Moreover, studies focusing on astronomy topics, particularly the solar system, and using tangible products as project outcomes are still limited. This study offers novelty by uniquely integrating PjBL-STEM with SEL through the design of a mini-planetarium project, which not only engages students in interdisciplinary problem-solving but also embeds SEL principles to foster collaboration, confidence, and emotional safety. By assessing all four dimensions of creative thinkingfluency, flexibility, originality, and elaborationthis research provides new empirical evidence and a practical model that addresses the gap in literature on combined PjBL-STEM-SEL frameworks for creativity development.

In the science subject for 7th-grade junior high school students in the second semester, the topics include the solar system, natural phenomena caused by celestial bodies, and climate changes due to natural events (Hardanie et al., 2023). Understanding the complex structure of the solar system, which cannot be directly observed, such as the arrangement of planets and other celestial bodies, is crucial in science learning (Prasetyo & Arbi, 2024). Learning abstract topics like the solar system requires appropriate strategies to support students in understanding and visualizing them (Amirahma & Setyasto, 2024). Based on the study by Masalah et *al*. (2024), PjBL-STEM significantly enhances students creative thinking abilities. Based on interviews with a science teacher and observations in class VII-F of SMP Negeri 2 Pakis with 33 students, the challenge encountered is the students still relatively low creative thinking skills. Therefore, this study aims to describe the implementation process of PjBL-STEM integrated with SEL through a mini planetarium product and analyze its impact on improving studentscreative thinking skills in class.

2. METHOD

The methodology used in this study is a qualitative approach through a case study using a single case design (Sugiyono, 2023). The research subjects consisted of one science teacher and 33 students from class VII-F of SMP Negeri 2 Pakis. The objective was to describe the implementation process of PjBL-STEM integrated with SEL using a mini planetarium product and to analyze its impact on improving students creative thinking skills during the learning process. The qualitative data were collected through interviews, classroom observations, and student reflections. Data collection techniques included interviews, observations, and student reflection questionnaires. The instruments used were interview guidelines, observation sheets for learning implementation, and student reflection sheets. Data analysis was conducted using qualitative descriptive analysis based on the Miles and Huberman model (1992), which includes data reduction, data presentation, and drawing conclusions. The data from interviews, observations, and student reflection journals were analyzed in depth to identify patterns related to students creative thinking skills after being exposed to the PjBL-STEM integrated with SEL on the solar system topic. The case study research flow is illustrated in Figure 1 (Sugiyono, 2023).

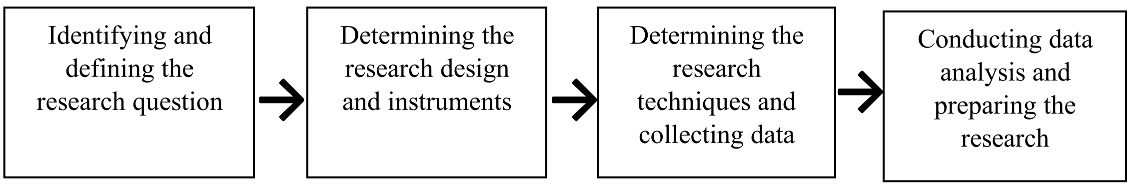

Figure 1. Case Study Research Flow

The Figure 1 initial stage of this research was to define the research question through interviews with the science teacher of class VII-F and observations of the learning activities, aiming to identify and observe existing problems. The subjects at this stage were the science teacher and 33 students in class VII-F of SMP Negeri 2 Pakis. Prior to this stage, a research consent request had been submitted. The qualitative data obtained included interview results from the teacher and observations of student behavior. Data collection techniques included interviews with the science teacher and classroom observations during the learning process. The instruments used were interview guidelines and observation sheets for the learning process. The data analysis technique applied was qualitative descriptive analysis. The second stage was to determine the research design and instruments. The research design used was a single case design, as it focused on a single issue students low creative thinking skills. This was evident in their inability to generate many ideas when presented with questions and problems by the teacher. Additionally, students struggled to provide out-of-the-box ideas and were limited in developing ideas from different perspectives. Therefore, a PjBL-STEM approach integrated with SEL was implemented to enhance students creative thinking skills on the solar system topic by producing a project-based product known as the “Mini Planetarium”. The indicators of creative thinking skills are presented in Table 1.

Table 1. Indicators of Creative Thinking Skills

Indicator	Category
Fluency	Ability to generate many ideas
Flexibility	Ability to think from multiple perspectives
Originality	Uniqueness of ideas
Elaboration	Development of ideas from various experiences

Table 1 third stage was to determine the data collection techniques. Data were collected through observation and questionnaires. The instruments used were observation sheets for learning implementation and student reflection questionnaires. Data analysis in this stage used qualitative descriptive analysis and percentage calculation to evaluate the impact of the PjBL-STEM integrated with SEL on students creative thinking using the mini planetarium project. A Likert scale was used in the student reflection questionnaire after the learning process. The Likert scale interpretation is shown in Table 2.

Table 2. Likert Scale Interpretation

Skor	Description
4	Very Good
3	Good
2	Fair
1	Poor

To calculate the percentage from these scores, Equation 1 is used:

$$P = \frac{\sum x_i}{\sum x} \times 100\% \tag{1}$$

When, P is Percentage, $\sum x_i$ is Obtained Score, $\sum x$ isMaximum Score.

The percentage results from the questionnaire scores were then interpreted using the creative thinking indicator scale shown in Table 3.

Table 3. Interpretation of Creative Thinking Indicator Percentages

Percentage (%)	Category

0 – 25	Poor
26 – 50	Fair
51 – 75	Good
76 – 100	Very Good

TheTable 3 final stage of the research was analyzing the data obtained from observations and student reflection questionnaires and compiling the final report. The techniques used included data reduction, presentation of results, and drawing conclusions from the research findings.

3. RESULTS AND DISCUSSION

This case study identified a key issue: students creative thinking skills were still relatively low. The initial phase of this research involved interviews with the teacher and observations of classroom activities. Analysis of the interview data indicated the need for a learning design that could enhance students' creative thinking skills through concrete visualization, especially on abstract topics such as the solar system. Conceptually, students had not fully understood or mastered the solar system material. During learning activities involving discussions on problems related to the solar system, students had not yet demonstrated flexibility in thinking, expressed their ideas clearly, or elaborated on their understanding according to the given context. This was due to insufficient practice in creative thinking skills. According to Kiraga (2023), creative thinking skills are essential for students as they positively influence learning outcomes and enhance their ability to solve problems from various perspectives.

The second phase involved determining the research design and instruments. The learning design implemented used a PjBL-STEM model integrated with SEL to improve students creative thinking skills. The implementation was conducted in one cycle over two meetings. This phase used observation techniques and student reflection questionnaires. The instruments used included observation sheets and post-treatment reflection questionnaires. The student worksheets used during learning were aligned with the PjBL syntax interpreted into the following activities. "Let's Think" to defining essential questions for the project; "Let's Design" for planning the design of the product; "Let's Schedule" to arranging a project timeline; "Let's Work" for executing the project based on the design; "Let's Answer" to evaluating the project outcomes; "Let's Reflect" to reflecting on the learning experience.

PjBL is a project-based learning method that can boost student motivation and thereby enhance their creative thinking skills (Fadhil et al., 2021). The PjBL-STEM model integrated with SEL actively engages students in solving challenging problems through projects. This process encourages students to apply interdisciplinary STEM knowledge to design solutions, while also training higher-order thinking skills such as analysis, synthesis, and evaluation. During the stages of designing, creating, and revising their projects, students are driven to think creatively, explore various ideas from multiple perspectives, and make decisions based on scientific understanding. SEL integration further supports creative thinking by equipping students with the emotional and social skills needed throughout the learning process. Self-awareness and emotional regulation help students manage challenges, while relationship skills foster collaboration and openness to new ideas. An emotionally safe learning environment also empowers students to take risks and generate novel solutions.

PjBL combined with STEM components has an interrelated relationship. PjBL-STEM is especially suitable for science learning where students create products as solutions to problems. This approach has a positive impact on students' creative and innovative thinking in science. It is student-centered and enhances understanding through real application in projects (Shodiq & Setyono, 2025). Problemsolving in science is crucial for developing comprehension and learning through projects, which ultimately boosts creative thinking skills. These skills relate to students freedom to explore and complete STEM-based projects (Widiyatmoko & Darmawan, 2023). The relationship between PjBL syntax, STEM aspects, and SEL components used in the student learning process is presented in Table 4.

Table 4. Relationship Between PjBL Syntax, STEM Aspects, and SEL Components

PjBL Syntax	STEM Aspects	SEL Components	Creative Thinking Indicators
Defining Essential Questions	Science & Mathematics	Self-awareness & Relationship skills	Originality
Designing the Project Plan	Engineering & Technology	Responsible decision-making & Self-management	Fluency & Ability
Scheduling the Project	Mathematics	Self-management & Social awareness	Flexibility
Monitoring Project Progress	Engineering & Science	Social awareness, Relationship skills, Decision-making	Elaboration
Testing Results	Science & Technology	Self-management & Relationship skills	Originality & Flexibility
Evaluating the Experience	Science, Math, Engineering	Social awareness & Responsible decision-making	Elaboration

This Table 4 illustrates the integration of PjBL syntax with STEM domains, SEL components, and creative thinking indicators in a structured manner. Each stage of the PjBL process is aligned with relevant STEM aspects, allowing students to apply scientific, mathematical, and technological knowledge in an authentic context. Simultaneously, the stages are designed to foster SEL competencies such as self-awareness, responsible decision-making, self-management, and social awareness, which are essential for effective collaboration and personal growth. Furthermore, the inclusion of creative thinking indicators such as originality, fluency, flexibility, and elaboration ensures that students are not only solving problems but also developing the capacity to think innovatively and critically throughout the learning process.

The table demonstrates that PjBL is a comprehensive pedagogical approach that goes beyond content mastery. Activities such as defining essential questions, designing project plans, scheduling, monitoring progress, testing results, and evaluating experiences provide opportunities for students to refine their ideas, work collaboratively, and adapt their strategies in response to challenges. By embedding SEL skills and creativity within the framework of STEM learning, PjBL prepares students to become independent thinkers capable of addressing complex, real-world problems with innovative and well-reasoned solutions. This alignment highlights the importance of integrating cognitive, social, and emotional dimensions to achieve holistic educational outcomes.

SEL components strengthen the creative process by developing self-awareness, emotional regulation, and social relationship skills. When students face challenges in their projects, the ability to manage emotions and build relationships becomes vital in fostering a learning spirit, openness to new ideas, and confidence in presenting unique or untested ideas. This aligns with (Mathew & Nair, 2024), who stated that SEL integration can enhance creative thinking skills. The implementation of the PjBL-STEM model integrated with SEL develops not only cognitive abilities but also students affective and social aspects, which are essential for facing 21st-century challenges. This is in line with the principles of Education for Sustainable Development (ESD), which promote the development of creative thinking as part of the learning process to solve problems from different perspectives and generate innovative, unexpected solutions (Purnamasari et al., 2024). Integrating SEL with PjBL-STEM had a notably positive impact on students creative thinking skills in the science topic of the solar system. This was evident from the creative thinking indicators observed during the learning process.Based on observation data during the learning process using a learning design that integrates PjBL, STEM, and SEL components, studentscreative thinking indicators showed improvement. The observation results are presented in Table 5.

Table 5. Observation Results on Creative Thinking Indicators

Indicator	Percentage (%)	Category
Fluency	82	Very Good
Flexibility	87	Very Good
Originality	72	Good
Elaboration	79	Very Good

Based on student reflection questionnaires after being taught with the integrated PjBL-STEM-SEL learning design, the creative thinking indicators also showed improvement. These results are presented in Table 6.

Table 6. Questionnaires Results on Creative Thinking Indicators

Indicator	Percentage (%)	Category
Fluency	89	Very Good
Flexibility	81	Very Good
Originality	74	Good
Elaboration	71	Good

Fluency is the ability to generate many ideas for solving a problem. Observation yielded a score of 82% (Very Good), while the questionnaire showed 89% (Very Good). This indicates students were able to express various ideas during the learning process, supported by project-based activities and interdisciplinary STEM views. SEL helped boost confidence and courage to share and accept ideas. Flexibility reflects studentsability to generate varied ideas and view problems from multiple perspectives. It scored the highest: 87% from observation and 81% from questionnaires (both Very Good). Project planning, especially selecting appropriate materials and methods for creating the solar system model, encouraged students to explore alternatives. SEL supported teamwork and openness to others viewpoints.

Originality refers to the uniqueness of ideas. It scored 72% (Good) from observations and 74% (Good) from questionnaires. Although lower than fluency and flexibility, these results still indicate that many students were able to generate fairly original ideas. The project's emphasis on innovation encouraged students to seek creative alternatives, while SEL support helped them build the confidence to be different and think outside the box. Elaboration, which reflects the ability to develop and refine ideas systematically, scored 79% (Very Good) from observations and 71% (Good) from questionnaires. These findings suggest that students were capable of expanding and detailing their ideas, though not yet consistently across contexts. The sustainability of these results lies in their role as a foundation for continuous improvement: while originality and elaboration showed positive progress, their moderate scores highlight the need for further reinforcement in future cycles. Therefore, even if the impact does not yet appear fully significant, the data demonstrate a clear trajectory of growth and provide a basis for enhancing instructional strategies that strengthen all aspects of creative thinking. The difference suggests that while teachers observed structured presentation skills, students felt their elaboration could still improve. Group discussions and project reports were key to strengthening this skill. Overall, the integration of PjBL, STEM, and SEL was effective in improving students creative thinking skills especially fluency and flexibility. Originality and elaboration also showed good results but need further reinforcement. This learning design, which allows for exploration, collaboration, and reflection, effectively fosters a learning environment that supports holistic creativity development in students.

The pronounced gains in fluency (82% observed; 89% questionnaire) and flexibility (87% observed; 81% questionnaire) are consistent showing that open ended, collaborative project learning with STEM rapidly increasesstudents ability to generate many ideas and shift perspectives. Guilford's and subsequent divergentthinking frameworks identify fluency and flexibility as dimensions most responsive to tasks that collect multiple solutions, and recent empirical syntheses confirm this patternSTEM-PjBL interventions have produced large overall effects on creativity in recent meta-analyses (Kwon & Lee, 2025), and broader PjBL reviews report moderate positive effects on creative thinking measures (Zhang & Ma, 2023). Importantly, the integration of SEL amplifies these outcomes by creating psychological safety and promoting self-efficacy, emotional regulation, and cooperative normsconditions that reduce fear of negative evaluation and encourage idea sharing, which in turn boost idea quantity and perspective taking (Cipriano et al., 2023; Oliveira et al., 2021). Together, these theoretical and empirical accounts explain why students in the solarsystem design project produced many and varied ideas during planning and prototyping phases under an integrated PjBL-STEM and SEL design.

By contrast, originality (72% observed; 74% questionnaire) and elaboration (79% observed; 71% questionnaire) commonly show slower, smaller gains unless instruction includes explicit scaffolds for novelty generation and sustained practice in idea refinement. Contemporary work on divergent thinking and creative cognition notes that originality and elaboration depend more heavily on domain knowledge, tolerance for ambiguity, metacognitive strategies, and extended iterative cyclesfactors that require deliberate instructional time and feedback (Runco, 2024; Pasarín-Lavín et al., 2024). Metaanalytic findings also report substantial heterogeneity across PjBL-STEM studies (Kwon & Lee, 2025), indicating that implementation fidelity (duration, teacher scaffolding, explicit creativity prompts) moderates gains in novelty and elaboration. Thus, while SEL creates the affective and social conditions that permit risk-taking (supporting incipient originality), achieving higher levels of originality and systematic elaboration typically requires added, targeted interventionssuch as explicit divergent-thinking training, reflective peer review, and structured elaboration promptsimplemented across multiple PjBL cycles to consolidate these higher-order creative skills (Zhang, 2023; Cipriano et al., 2023).

4. CONCLUSION

The implementation of integrated PjBL-STEM and SEL through the mini-planetarium project effectively enhanced students creative thinking skills, with the most significant improvements observed in fluency and flexibility, indicating students growing ability to generate and shift between multiple ideas. While originality and elaboration showed positive but more moderate gains, these results suggest the need for continued scaffolding and iterative practice to strengthen higher-order creative skills. The combination of PjBL-STEM's interdisciplinary, hands-on problem-solving approach with SEL's emphasis on collaboration, confidence, and emotional safety created a supportive learning environment that encouraged risk-taking, idea sharing, and perspective-taking. This study contributes to the literature by demonstrating that integrating SEL within PjBL-STEM can amplify its impact on creativity development, particularly in promoting psychological safety and engagement, and highlights the importance of sustained cycles and targeted strategies to deepen originality and elaboration over time.

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