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Toward creative physics learning: need analysis of PjBL-based physics modules with deep learning

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ABSTRACT

This study aimed to analyze the need for developing a Project Based Learning (PjBL)-based physics module integrated with the Deep Learning approach to enhance students' creative thinking skills on the topic of climate change. A descriptive quantitative survey was conducted as the analysis phase of the ADDIE development model. The participants were physics teachers and Grade X students at SMA Negeri 5 Payakumbuh, selected through purposive sampling. Data were collected using classroom observations, semi-structured interviews, needs assessment questionnaires, and a creative thinking skills assessment. The data were analyzed descriptively using percentages and qualitative interpretation. The findings showed that physics instruction still relied on conventional teaching materials and teacher-centered practices, limiting students' opportunities to develop creative thinking skills. The needs assessment indicated that both teachers and students required a physics module integrating PjBL and the Deep Learning approach to support meaningful and contextual learning. Furthermore, students' creative thinking skills remained relatively low across the four dimensions of fluency, flexibility, originality, and elaboration. These findings provide empirical evidence supporting the development of an innovative physics module aligned with the Merdeka Curriculum to improve students' creative thinking skills and promote more active, student-centered learning on climate change.

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Introduction

Contemporary educational challenges require students to develop advanced competencies that enable them to apply scientific knowledge creatively in addressing complex and authentic problems (Ayu, Chusniyah, Kurniawati, & Purwanti, 2024; Bahari, 2025). In this context, physics education plays a strategic role in strengthening conceptual understanding while fostering creative thinking skills needed to address complex scientific and environmental challenges (Diastuti, 2024; Nazhifah, Wiyono, & Azairok, 2023). Consistent with the implementation of the Merdeka Curriculum (Tantri, Udyaningsih, & Kuswanto, 2025), physics learning is expected to provide active, contextual, and meaningful experiences that enable students to connect scientific concepts with real-world phenomena (Badriah & Adimayuda, 2024; Rahmania & Utama, 2025). Climate change is particularly relevant in this context because its complex and open-ended nature requires students to analyze interconnected causes, consider multiple perspectives, evaluate alternative solutions, and construct creative responses based on scientific concepts (Aswiroh, 2025; Nurlita, Suwarma, Aminudin, & Indonesia,

2025; Tamrin, 2023). Therefore, climate change provides an appropriate context for developing creative thinking through physics learning because it requires not only conceptual understanding but also fluency, flexibility, originality, and elaboration in addressing authentic environmental problems.

However, these expected learning conditions have not been fully reflected in classroom practices (Lestra, Darvina, & Novitra, 2024). Preliminary observations, needs analysis, and interviews conducted at SMA Negeri 5 Payakumbuh indicated that physics instruction still predominantly relied on textbooks and student worksheets, while learning modules specifically designed to facilitate creative thinking had not been optimally implemented. Classroom activities consequently remained focused on concept explanation and routine problem-solving, providing limited opportunities for students to investigate authentic problems, generate multiple ideas, consider alternative solutions, and elaborate their reasoning. This condition indicates a clear discrepancy between current classroom practices and the Merdeka Curriculum's emphasis on active, contextual, meaningful, and student-centered learning. The preliminary analysis also showed that students' creative thinking skills across the dimensions of fluency, flexibility, originality, and elaboration remained relatively low, while the majority of students expressed a need for more contextual, interactive, and creativity-oriented instructional materials. These findings demonstrate the need for instructional materials that can bridge existing classroom conditions with the creative and student-centered learning competencies expected in the curriculum.

Project-Based Learning (PjBL) provides a relevant pedagogical framework for addressing these needs because authentic projects, scientific inquiry, problem-solving, and collaboration can create opportunities for students to generate diverse ideas and develop creative solutions (Guo, Saab, Post, & Admiraal, 2020; Rahmani & Groot, 2023). In parallel, the Deep Learning approach emphasizes mindful, meaningful, and joyful learning, which is intended to strengthen conceptual understanding, student engagement, reflection, and the connection between knowledge and authentic contexts (Dewi et al., 2025; Feriyanto & Anjariyah, 2024; Ramadhan, 2025). Integrating these approaches may provide complementary learning mechanisms: PjBL structures authentic problem investigation and project development, while Deep Learning principles strengthen reflection, conceptual meaning, and students' engagement with the learning process (Dewi et al., 2025; Feriyanto & Anjariyah, 2024; Nurlita et al., 2025). Within this integration, project activities can stimulate fluency through the generation of multiple ideas, flexibility through consideration of alternative solutions, originality through the production of novel responses, and elaboration through the development and communication of detailed scientific reasoning. A systematically designed learning module is therefore needed to translate these pedagogical principles into structured learning activities and guide students through each stage of project-based learning (Virijai, 2024).

Although studies concerning PjBL, Deep Learning, and physics modules have increased, important gaps remain in their integration and instructional application. Previous PjBL studies have largely examined learning outcomes, scientific literacy, or critical thinking skills (Lestra et al., 2024; Lubis, Sunarto, & Walid, 2021; Nurhasanah, 2023), whereas studies concerning Deep Learning have predominantly discussed its general learning principles and implementation rather than its systematic integration into physics instructional materials (Hasanah, S, W, & K, 2025; Usnandri, Damayanti, Ramandhayani, & Donna, 2025; Waloyo, Prayitno, Taharudin, & Rahmawati, 2025). Studies on physics module development have also addressed project-based learning and creative thinking, but limited attention has been given to modules that systematically integrate PjBL stages with mindful, meaningful, and joyful learning principles to facilitate the four dimensions of creative thinking within the specific context of climate change. Moreover, although needs-analysis studies have provided important foundations for instructional material development (Ilham, Suherman, Ratnawulan, & Jhora, 2026; Novita & Sari, 2021), comprehensive analyses that simultaneously examine classroom learning conditions, teachers' and students' instructional needs, and students' initial creative thinking profiles remain limited. Addressing this gap is essential because needs analysis ensures that subsequent module design is grounded in actual learning conditions, learner characteristics, and curriculum requirements rather than solely in theoretical assumptions.

Based on these problems and research gaps, this study aims to analyze the need for developing a Project-Based Learning (PjBL)-based physics module integrated with the Deep Learning approach to support students' creative thinking skills in learning climate change. Specifically, the analysis examines existing physics learning practices and instructional challenges, teachers' and students' needs for instructional materials, students' expectations regarding module characteristics and creative-thinking activities, and their initial profiles of fluency, flexibility, originality, and elaboration. By integrating evidence from classroom conditions, instructional needs, and students' creative thinking profiles, this study provides an empirical basis for determining the pedagogical characteristics, learning activities, and assessment components required in the proposed module. The findings are expected to guide the subsequent design and development stages of a contextual and innovative

physics module aligned with the Merdeka Curriculum and responsive to the actual needs of teachers and students.

Method

This study employed a descriptive quantitative survey supported by qualitative data from observations and semi-structured interviews to analyze the need for developing a Project-Based Learning (PjBL)-based physics module integrated with the Deep Learning approach (Aminnudin, Suharno, & Sukarmin, 2026; Rahmawati, Sarwanto, & Budiawanti, 2021). The study constituted the Analysis phase of the ADDIE model, focusing on existing learning practices, instructional materials, teachers' and students' needs, and students' initial creative thinking profiles (Irwanto & Saputra, 2026). The research was conducted at SMA Negeri 5 Payakumbuh during the 2025–2026 academic year and involved physics teachers and Grade X Phase E students selected through purposive sampling based on their direct involvement in physics learning and climate change content (Ika, 2021). Data were collected using classroom observations, semi-structured teacher interviews, student needs-assessment questionnaires, and a creative thinking assessment. The instruments were reviewed for content validity before data collection to ensure alignment with the research indicators.

The needs-assessment questionnaire examined students' perceptions of existing instructional materials, desired module characteristics, and activities supporting creative thinking. Students' creative thinking skills were assessed through four indicators: fluency, flexibility, originality, and elaboration (Jumanto & Adi, 2022), using scores to determine their initial performance in each dimension. Quantitative data from questionnaires and creative thinking assessments were analyzed descriptively using percentages and interpreted according to predetermined categories, while observation and interview data were analyzed through data reduction, presentation, and conclusion drawing. The findings from these data sources were then triangulated to identify consistencies among classroom conditions, instructional needs, and students' creative thinking profiles, providing an empirical basis for determining the learning activities, module characteristics, and assessment components required in the subsequent module development stage.

Results and Discussions

Existing Learning Practices and Instructional Challenges

To identify the instructional conditions prior to module development, classroom observations and semi-structured interviews were conducted with the physics teacher at SMA Negeri 5 Payakumbuh. The observations focused on teaching practices, instructional materials, learning activities, and the implementation of the *Merdeka Curriculum*, while the interviews explored teachers' perceptions of classroom challenges and instructional needs. The findings are summarized in Table 1.

Table 1. Summary of Observation and Interview Findings.

No	Aspect	Findings
1	Teaching materials	Physics learning primarily relied on government-issued textbooks and student worksheets (LKPD). Learning modules designed to foster creative thinking had not yet been implemented.
2	Learning process	Classroom instruction was predominantly teacher-centered and emphasized concept explanation and routine exercises.
3	Student learning activities	Students had limited opportunities to investigate authentic problems, propose multiple solutions, and reflect on their learning experiences
4	Teacher's perspective	Existing instructional materials were insufficient to support project-based, contextual, and meaningful learning aligned with the *Merdeka Curriculum*
5	Instructional need	Teachers expressed the need for an instructional module integrating Project Based Learning (PjBL) and the Deep Learning approach to facilitate students' creative thinking skills

As presented in Table 1, physics instruction at SMA Negeri 5 Payakumbuh continues to depend primarily on conventional instructional resources, particularly textbooks and student worksheets (LKPD), with limited utilization of learning modules specifically designed to develop students' creative thinking skills. Consequently, classroom activities remain largely focused on concept explanation and routine problem-solving, providing insufficient opportunities for students to engage in inquiry, generate diverse ideas, evaluate alternative solutions, or elaborate scientific explanations (Amiruddin, Baharuddin, Takbir, & Setialaksana, 2023; Malika, Sapriya,

Rahmat, & Sopianingsih, 2026). These findings indicate that the current learning environment has not yet fully reflected the student-centered learning principles promoted by the *Merdeka Curriculum* (Kurniawan, 2023).

The interview results further revealed that one of the major challenges faced by teachers is the lack of instructional materials capable of integrating conceptual understanding with authentic problem-solving activities. Although the *Merdeka Curriculum* encourages meaningful and contextual learning experiences, existing teaching materials have not adequately supported students in connecting physics concepts with real-world environmental issues (Lestari, Susanti, Madlazim, Hariyono, & Uulaa, 2024; Sari, Dwikoranto, & Lestari, 2021). As a result, students tend to memorize concepts rather than construct conceptual understanding through investigation, collaboration, and reflection (Abaniel, 2021; Odden, 2021). This condition also limits opportunities for developing the four dimensions of creative thinking, namely *fluency, flexibility, originality,* and *elaboration*, which are essential competencies for solving complex scientific problems.

These findings are consistent with previous studies reporting that physics instruction in Indonesian secondary schools is still dominated by conventional teaching materials, while the use of innovative instructional modules remains relatively limited (Irsalina, Aviyanti, & Iryanti, 2025). Such learning conditions reduce students' opportunities to actively construct knowledge and participate in authentic learning experiences (Diani, Viyanti, Jalmo, & Lengkana, 2025). Therefore, the findings obtained in this study reinforce the importance of developing instructional materials that integrate Project Based Learning (PjBL) and the Deep Learning approach to create more meaningful, contextual, and student-centered physics learning experiences.

Students' Needs for PjBL-Based Learning Physics Modules with Deep Learning Approach

To further investigate students' expectations regarding instructional materials, a needs assessment questionnaire was administered to identify the characteristics of a physics module that could effectively support learning and enhance creative thinking skills. The questionnaire focused on three main aspects, namely the need for a learning module, the need for creative thinking activities, and the need for creative thinking assessment. The results are presented in Table 2.

Table 2. Students' Needs for PjBL-Based Physics Modules.

No	Statement	Percentage (%)
1	Students need a physics module that helps them understand the material while improving creative thinking skills	91.07
2	Students need a module containing learning activities or questions that encourage them to generate multiple solutions to physics problems	76.79
3	Students need a module equipped with creative thinking tasks to evaluate their ability to generate ideas, provide diverse responses, and elaborate solutions	82.14

As shown in Table 2, the majority of students expressed a strong need for an instructional module that not only facilitates conceptual understanding but also supports the development of creative thinking skills. The highest percentage (91.07%) indicates that most students perceived existing instructional materials as insufficient for promoting meaningful understanding and creativity simultaneously. This finding suggests that current learning resources have not fully accommodated students' expectations for more engaging and student-centered learning experiences (Irsalina et al., 2025).

Furthermore, 76.79% of the respondents indicated the need for learning activities that encourage them to explore multiple solutions to physics problems. This finding is particularly important because generating various alternative solutions represents one of the essential characteristics of creative thinking (Weiss & Wilhelm, 2022). However, the current instructional practices still emphasize routine exercises with predetermined answers, limiting students' opportunities to think divergently and construct original ideas (Bani & Angkotasan, 2026). Therefore, incorporating authentic project-based activities into instructional modules may provide more opportunities for students to investigate real-world problems and develop creative solutions through collaborative inquiry (Willemsen, de Vink, Kroesbergen, & Lazonder, 2024).

In addition, 82.14% of students expected the module to include creative thinking assessment tasks capable of measuring their ability to generate ideas, provide diverse responses, and elaborate scientific explanations. This finding indicates that students not only require learning materials for acquiring knowledge but also expect instructional resources that continuously facilitate the development and evaluation of higher-order thinking skills (Irsalina et al., 2025). Accordingly, the integration of Project Based Learning (PjBL) with the Deep Learning approach offers considerable potential for addressing these needs by engaging students in meaningful projects while encouraging reflective, contextual, and inquiry-oriented learning experiences (Taufik, Nurtamam,

Dewanto, & Santosa, 2025). Such learning environments are expected to support the development of the four dimensions of creative thinking (*fluency, flexibility, originality,* and *elaboration*) through authentic scientific investigations (Willemsen et al., 2024).

Overall, the needs assessment demonstrates that students have a high demand for instructional materials that extend beyond conventional textbooks and worksheets. The findings provide empirical evidence that developing a PjBL-based physics module integrated with the Deep Learning approach is relevant to current classroom needs and has the potential to create more meaningful learning experiences while fostering students' creative thinking skills.

Students' Creative Thinking Profile

In addition to identifying students' needs for instructional materials, this study examined the initial profile of students' creative thinking skills as an important consideration in designing the proposed physics module. Creative thinking was assessed based on four indicators, namely *fluency, flexibility, originality,* and *elaboration*. The results are presented in Figure 1.

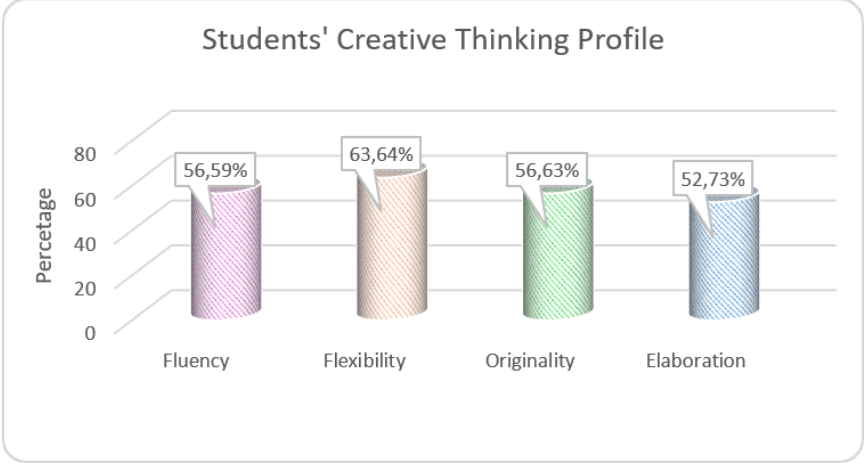

Figure 1. Students' Creative Thinking Profile

As illustrated in Figure 1, students' creative thinking skills were generally at a relatively low level across all assessed indicators. Among the four dimensions, flexibility demonstrated the highest achievement, whereas elaboration showed the lowest performance. Although students were able to produce more than one solution to a given problem in certain situations, they experienced considerable difficulty in developing their ideas into detailed scientific explanations or generating original solutions based on physics concepts (Hermansyah, Kaniawati, & Liliawati, 2026; Irvaniyah, Pandango, Saidan, & Parno, 2025).

The relatively low performance across the four indicators suggests that current learning practices have not yet provided sufficient opportunities for students to develop creative thinking through authentic scientific inquiry. Most classroom activities continue to emphasize the acquisition of conceptual knowledge and the completion of routine exercises with predetermined answers (Bani & Angkotasan, 2026). Consequently, students have limited experience in exploring multiple perspectives, proposing innovative solutions, or elaborating their reasoning when solving physics problems (Hermansyah et al., 2026). These findings are consistent with the observation and interview results, which indicated that existing instructional materials have not adequately facilitated inquiry-based, contextual, and student-centered learning (Irsalina et al., 2025).

Among the four indicators, the low achievement in originality and elaboration deserves particular attention because both dimensions require students to construct novel ideas and expand their reasoning beyond factual recall (Lestari & Fitriyah, 2023). These competencies are difficult to develop through conventional instructional approaches that emphasize memorization rather than exploration and reflection (Lestari & Fitriyah, 2023; Solehah, Umamah, & Budiono, 2025). Therefore, learning environments should provide opportunities for students to investigate authentic environmental issues, collaborate with peers, evaluate alternative solutions, and communicate their ideas systematically (Lestari et al., 2024). Such learning characteristics are accommodated through Project Based Learning (PjBL), particularly when integrated with the Deep Learning approach that encourages meaningful understanding, active participation, and reflective learning.

Overall, the creative thinking profile obtained in this study reinforces the findings of the needs analysis. The relatively low achievement across the four creative thinking indicators demonstrates that students require instructional materials capable of providing structured opportunities for creative exploration and contextual

problem-solving. Accordingly, the development of a PjBL-based physics module integrated with the Deep Learning approach is expected to support the improvement of students' creative thinking skills while promoting more meaningful learning experiences in the context of climate change.

Implications for Physics Module Development

The findings obtained from classroom observations, interviews, the students' needs assessment, and the creative thinking profile collectively provide important implications for the development of a physics module based on Project Based Learning (PjBL) integrated with the Deep Learning approach. The analysis revealed that existing instructional materials have not adequately supported student-centered learning, meaningful knowledge construction, or the development of creative thinking skills. At the same time, both teachers and students expressed the need for instructional materials that facilitate contextual learning, active participation, and authentic problem-solving (Aminnudin et al., 2026; Irsalina et al., 2025). These findings indicate that the proposed module should not merely function as a source of learning content but also serve as a structured learning guide that actively engages students in constructing scientific understanding.

Based on the identified needs, several essential characteristics should be incorporated into the proposed module. First, the module should adopt the syntax of Project Based Learning (PjBL) to encourage students to investigate authentic environmental problems, collaborate in designing project solutions, and communicate the outcomes of their investigations. Second, the module should integrate the principles of the Deep Learning approach by providing learning activities that promote mindful, meaningful, and joyful learning experiences. Such integration is expected to facilitate deeper conceptual understanding while encouraging students to connect physics concepts with real-life environmental issues, particularly those related to climate change (Lestari et al., 2024; Taufik et al., 2025).

Furthermore, the relatively low profile of students' creative thinking skills suggests that the learning activities embedded in the module should be intentionally designed to stimulate the four dimensions of creative thinking, namely fluency, flexibility, originality, and elaboration. Accordingly, the module should include open-ended problems, project-based investigations, collaborative discussions, reflective activities, and authentic assessments that provide students with opportunities to generate multiple ideas, evaluate alternative solutions, produce original responses, and elaborate their scientific reasoning (Gunawan et al., 2025). Such learning experiences are expected to support the achievement of the competencies emphasized in the *Merdeka Curriculum* while fostering students' ability to solve real-world environmental problems creatively (Rahayu, Kismiati, Noviyanti, Sudarso, & Abd Karim, 2025).

Overall, the needs analysis confirms that the development of a PjBL-based physics module integrated with the Deep Learning approach is highly relevant to current classroom needs. The findings not only justify the necessity of developing innovative instructional materials but also provide empirical guidance for determining the instructional design, learning activities, and assessment strategies that should be incorporated into the module. Therefore, the results of this study constitute an essential foundation for the subsequent stages of module design, development, and validation.

Conclusions

The findings of this study indicate that the current implementation of physics learning has not fully supported the development of students' creative thinking skills, primarily due to the limited availability of instructional materials that facilitate contextual, student-centered, and meaningful learning. The needs analysis revealed that both teachers and students expressed a strong demand for a physics module integrating Project Based Learning (PjBL) with the Deep Learning approach, particularly for learning climate change. In addition, the initial profile of students' creative thinking skills demonstrated the need for instructional materials that systematically promote fluency, flexibility, originality, and elaboration through authentic learning activities.

The novelty of this study lies in providing a comprehensive needs analysis that combines classroom learning conditions, teachers' and students' instructional needs, and students' creative thinking profiles as an empirical foundation for developing a PjBL-based physics module integrated with the Deep Learning approach. These findings provide practical guidance for designing instructional materials that are aligned with the objectives of the *Merdeka Curriculum* and support more meaningful physics learning. Nevertheless, this study was limited to the needs analysis stage and did not evaluate the validity, practicality, or effectiveness of the proposed module. Therefore, future studies are recommended to develop, validate, and evaluate the effectiveness of the proposed module in improving students' creative thinking skills across different educational contexts.

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