Development of Differentiated Project Based Learning Teaching Modules to Foster Critical and Creative Thinking Skills in Students

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Abstract *- Teaching modules are one of the teaching tool innovations in the Merdeka Curriculum. Differentiated Project Based Learning (PjBL) teaching modules are teaching tools that are tailored to the needs and characteristics of students. This study aims to develop differentiated teaching modules with the PjBL model in fostering students' critical and creative thinking skills in schools with different accreditation and analyzing the characteristics, feasibility and students' responses to teaching modules. The research method used is Research and Development (RnD) with the ADDIE model which consists of five stages, namely Analysis, Design, Development Implementation and Evaluation. The data analysis technique used is feasibility analysis with expert judgment assessment method based on V-Aiken's scale and percentage. The characteristics of the developed teaching module are using a differentiated PjBL model in learning activities and presenting questions according to critical and creative thinking indicators. The validity test results of the differentiated PjBL teaching module indicate it is valid (V-Aiken = 0.90 for A-accredited schools and 0.91 for B-accredited schools). Student responses to the LKPD as part of the teaching module demonstrated appealing criteria (N=88%). These findings suggest that the differentiated PjBL teaching module is suitable for use in physics learning across all school accreditation levels.*

Keywords: *Critical Thinking; Creativity; Differentiated Project Based Learning; Teaching Module*

INTRODUCTION

In the evolving landscape of 21st-century education, the urgency to design instructional practices that nurture higher-order thinking skills is more pressing than ever. Education is no longer limited to the acquisition of static knowledge; it now demands the cultivation of creativity, criticality, collaboration, and communication in which collectively known as the 4C (Rohmatin et al., 2023). In Indonesia, this paradigm shift is embodied in the Merdeka Curriculum, which marks a significant departure from traditional, teacher-centered pedagogies by empowering educators to design adaptive, differentiated, and student-centered learning environments (Angga et al., 2022; Kurniati et al., 2022).

At the heart of this curriculum is the expectation that instructional design should respond to the diversity of learners, allowing flexibility in pace, content, and assessment. The "modul ajar" or teaching module is a core instrument within this curriculum reform, envisioned as a living document that guides the teacher in orchestrating contextual, meaningful, and equitable learning experiences (Maulida, 2022; Ramadhan, 2023). However, despite the conceptual clarity of the Merdeka Curriculum, the operationalization of teaching modules remains a significant challenge. Teachers often lack the competencies or frameworks needed to integrate curriculum goals with pedagogical strategies that engage students' critical and creative faculties (Maulida, 2022; Warliani et al., 2023).

Simultaneously, international research continues to affirm the pedagogical value of differentiated instruction, especially when combined with constructivist, inquiry-based models such as Project-Based Learning (PjBL) (Baş & Beyhab, 2010; Han et al., 2015). Differentiated instruction acknowledges that students vary in readiness, interest, and learning profiles and thus promotes the customization of content, process, and product (Tomlinson et al., 2003). When paired with PjBL in which situates learners in authentic, problem-solving contexts, this approach fosters deeper cognitive engagement and builds transferable skills necessary for real-world challenges (Suhandi & Robi'ah, 2022).

Despite their individual merits, there remains a paucity of studies in the Indonesian context that develop and empirically validate a teaching module that systematically integrates both differentiated instruction and PjBL, particularly within the physics domain. This disciplinary gap is of notable concern. Topics such as fluid dynamics specifically Bernoulli's Principle have been persistently difficult for students due to their abstract and counterintuitive nature (Affandy et al., 2019). Research consistently shows that students in Indonesia exhibit low levels of critical and creative thinking when engaging with these physics concepts (Dores et al., 2020; Kurnia, 2021), often compounded by misconceptions and fragmented understanding (Arumsari & Susanti, 2023).

Empirical data collected from SMA Al-Uswah confirms these trends. Interviews and observations reveal that not only do students struggle with critical and creative thinking in physics, but teachers also face difficulties designing instructional materials that align with both curriculum demands and students' cognitive needs. While previous studies have explored the development of teaching modules using either PjBL or differentiated instruction (Martanti et al., 2022; Wagiswari Santika et al., 2023), some of reseach have examined how the integration of both can impact higher-order thinking skills, particularly when developed under a systematic instructional design model such as ADDIE.

This study, therefore, positions itself at the confluence of curriculum innovation, instructional design, and cognitive development. It aims to develop and analyze a differentiated teaching module based on Project-Based Learning for the topic of Bernoulli's Principle in grade XI physics. The study employs the ADDIE model known as Analysis, Design, Development, Implementation, and Evaluation in which to ensure that the instructional design process is robust, systematic, and scalable. By focusing on both the development and the characteristics of the module, this research contributes to the literature by introducing a structured, empirically grounded tool that can address the dual challenges of cognitive engagement and curriculum fidelity.

Ultimately, this research offers more than a didactic product; it offers a pedagogical intervention grounded in theory, aligned with policy, and responsive to local classroom realities. The module is designed not only to improve physics learning outcomes but also to serve as a scalable model for future curriculum implementation efforts in Indonesia and comparable educational contexts. Its novelty lies in the integration of differentiated pedagogy with project-based methodologies, applied within a discipline-specific context and validated through a structured development model, offering a contribution that is both scholarly and practical.

RESEARCH METHODS

This study employed a research and development (R&D) method aimed at designing and validating an instructional product in the form of a differentiated learning module integrated with the Project-Based Learning (PjBL) model. The development process followed the ADDIE framework, consisting of five systematic stages: Analyze, Design, Develop, Implement, and Evaluate. (Branch, 2009; Okpatrioka, 2023). According to Branch, the ADDIE model is a systematic framework in which each stage informs and strengthens the next; therefore, its procedures must be carried out sequentially and comprehensively to ensure the development of a high-quality instructional product.

In this study, the research and development procedures encompassed all five stages of the ADDIE model. The Analysis stage involved identifying curriculum requirements, learner characteristics, and learning difficulties related to Bernoulli's Principle. The Design stage produced a structured blueprint for the differentiated PjBL module, including learning objectives, activity flow, assessment strategies, and differentiation components. The Development stage focused on producing the teaching module draft and integrating feedback from physics education experts. The Implementation stage consisted of a limited pilot test involving Grade XI students to evaluate the practicality and student responses to the module. Finally, the Evaluation stage combined expert validation results and student response data to determine the feasibility and quality of the final product.

The product developed was a printed learning module on the topic of Bernoulli's Principle for Grade XI physics, designed to foster students' critical and creative thinking skills. The research involved two groups of subjects: fourteen physics teachers from accredited schools (A and B) who served as expert validators, and nineteen Grade XI students from SMA Al-Uswah as the end users to assess the practicality and student response to the module.

Primary data were collected using observation, interviews, and questionnaires. Observations were conducted alongside interviews to capture natural teaching contexts and learning challenges. Interviews focused on existing instructional practices, students' learning difficulties in which understanding Bernoulli's Principle and the feasibility of differentiated instruction using PjBL (Sarnoto, 2024). A structured questionnaire using a Likert scale was employed to collect validation input from expert teachers, addressing aspects such as content appropriateness, pedagogical alignment, and instructional clarity. The interview protocol is documented in the appendix.

Data analysis comprised two stages. The characteristics of the developed module were analyzed descriptively based on the structure and expert comments. Feasibility analysis was conducted using percentage agreement and the V-Aiken's validity index, which is recommended for quantifying expert judgment in educational research (Demo et al., 2019). This integrated approach ensured that the developed module not only met pedagogical standards but also aligned with the differentiated and project-based learning demands outlined in the Kurikulum Merdeka framework.

RESULTS AND DISCUSSION

This research produces an Independent Curriculum teaching module with a differentiated Project Based Learning (PjBL) model. This teaching module consists of general information, core components, and attachments. In this section, the feasibility characteristics of the differentiated PjBL teaching module adapted to the ADDIE development model will be explained.

Results

To assess the quality and effectiveness of the differentiated physics module based on the Project-Based Learning (PjBL) model, a thorough validation process was carried out using both qualitative assessments and quantitative scoring. This evaluation focused on four core feasibility aspects: content, presentation, language, and graphics. The panel consisted of 14 expert physics teachers from nationally accredited schools (A and B accreditation levels), who provided structured feedback through a Likert-scale instrument. The resulting data were analyzed using the V Aiken's formula to determine the degree of expert agreement on each item's relevance.

Content Feasibility received an overall rating of 90.68%, a score categorized as "very valid" within the V Aiken's framework for 0,91. Validators commended the module's accuracy in representing physics concepts in this case is for particularly Bernoulli's Principle and modul's ability to connect theoretical knowledge with real-world application. The module emphasized the importance of higher-order thinking skills by embedding inquiry-based tasks and reflection activities into each learning unit. Furthermore, the logical organization of content, from basic concepts to applied problem-solving, ensured a scaffolded and cumulative learning process. This structure not only complied with the expectations of the Merdeka Curriculum but also addressed varying student competencies by providing entry points for both advanced and struggling learners.

Presentation Feasibility scored the highest among the four dimensions, with a remarkable average of 92.1%. The high V Aiken's index shows for 0,90 which is for this domain demonstrated strong agreement among validators regarding the coherence and instructional clarity of the module. The layout was recognized for its intuitive navigation, use of clear subheadings, and integration of learning objectives with activity sequences. Teachers emphasized that the learning phases in which diagnostic, guided inquiry, investigation, presentation, and reflection which then offered students opportunities for both independent exploration and structured collaboration. This dual approach encouraged student autonomy while preserving teacher facilitation.

Language Feasibility was rated at 91% and 0,91 for the V Aiken's score indicating that the module effectively employed accessible and appropriate language for its intended student demographic. Validators noted the linguistic simplicity and conceptual precision of the instructional texts, which were written in a tone that maintained scientific rigor while avoiding overly technical jargon. The use of Bahasa Indonesia was optimized to support students' comprehension, and terminological updates (e.g., replacing KKM with KKTP) were made to ensure consistency with current educational regulations. Additionally, sentence structure and phrasing were tailored to meet the needs of diverse student profiles, including those with different literacy levels.

Graphics Feasibility received a commendable score of 89.3%. This domain assessed the quality and pedagogical contribution of visual components such as diagrams, illustrations, layout spacing, and visual cues. The V Aiken's coefficient again showed high validator consensus regarding the relevance and functionality of these design elements with score of 0,90. Visual aids were especially beneficial in enhancing the interpretability of abstract physics concepts such as fluid flow, air pressure, and energy transformation. The inclusion of step-by-step diagrams, schematic drawings, and engaging icons supported student focus and memory retention, fulfilling a vital role in multimodal learning.

Collectively, these results confirm the high feasibility of the module across all dimensions. The module not only complies with pedagogical and curriculum standards but also reflects deliberate instructional planning, visual literacy considerations, and adaptive teaching methodologies. Therefore, all of which are critical for successful implementation in 21st-century classrooms.

Creative Thinking Analysis

The module's impact on students' creative thinking skills was evaluated using indicators derived from Munandar's (2021) framework, which included fluency, flexibility, originality, and elaboration. These indicators were measured through student projects, open-ended written reflections, and observational data collected during the learning process.

The fluency indicator achieved an average score of 84.2%, demonstrating students' ability to generate multiple, relevant ideas when tackling project challenges. Throughout the phases of inquiry and experimentation, learners proposed a wide range of approaches to explain fluid mechanics, including experimental models, real-life analogies, and creative presentations.

Flexibility was scored at 83.6%, reflecting students' adaptive thinking and willingness to explore alternative solutions when their initial hypotheses or designs required adjustment. This was evident when students responded to peer critiques and modified their approaches accordingly.

In terms of originality, a score of 82.7% indicated that students consistently produced novel interpretations and personal insights, particularly when designing project artifacts that explained Bernoulli's Principle in unconventional yet accurate ways.

Elaboration had the highest score at 85.4%, confirming that students were able to provide comprehensive explanations, integrate visuals into their narratives, and detail their scientific reasoning in written reports. These results affirm that the module fosters a learning environment that encourages imaginative exploration without sacrificing conceptual depth.

Critical Thinking Analysis

The module also aimed to cultivate critical thinking skills as conceptualized by Ennis (2011), including clarification, reasoning, inference, and decision-making. Assessment instruments included structured worksheets, performance rubrics, and group evaluation logs.

Clarification scored 87.1%, indicating that students were able to identify key questions, clarify definitions, and isolate relevant information from supporting data. This was especially visible in project planning and discussion sessions. Reasoning and Evaluation averaged 85.5%, with students successfully constructing evidence-based arguments, evaluating experimental outcomes, and engaging in critical dialogues with peers and facilitators. Inference achieved a score of 84.9%, showing students' ability to draw meaningful conclusions from empirical observations, relate them to theoretical concepts, and project their implications. Strategic Decision-Making stood at 86.3%, as students consistently demonstrated the ability to weigh alternatives, prioritize tasks, and refine their methods based on formative feedback.

Overall, the critical thinking component reinforced the module's goal of developing intellectual rigor, scientific reasoning, and self-directed learning which all aligned with national competency standards and global educational demands.

Implementation Phase

The final stage of the research involved piloting the module with 19 students from SMA Al-Uswah. Data were collected through post-module student questionnaires, which used a 5-point Likert scale, along with observational notes during implementation.

Student responses averaged 88.2%, reflecting a high level of engagement and satisfaction. Specifically, the content structure scored 89%, linguistic clarity 87%, and learning experience 89.7%. Students reported that the module was easy to follow, intellectually stimulating, and enjoyable. They appreciated the integration of real-world tasks, which made the physics material feel more relevant and applicable.

Classroom observations supported these perceptions. Students were actively involved in all stages of the project, demonstrated enthusiasm in collaborative work, and showed improvements in articulation and analytical expression. The differentiated approach helped accommodate diverse learning preferences, while the PjBL framework encouraged meaningful exploration.

In summary, the implementation validated the results of the validation and thinking skill assessments. The module not only met the technical and pedagogical requirements but also proved to be an effective and engaging tool for improving student learning outcomes in physics education.

Discussion

The development of a differentiated teaching module using the Project-Based Learning (PjBL) model, as presented in this research, reveals a confluence of educational theory and practical classroom implementation that substantively addresses the goals of the Merdeka Curriculum. The findings demonstrate the successful integration of pedagogical responsiveness to learner diversity with instructional design that fosters higher-order thinking, notably critical and creative thinking. This section discusses the implications of the findings in light of relevant literature, theory, and previous studies.

The high validation scores in the four feasibility aspects: content (90.68%), presentation (92.1%), language (91.0%), and graphics (89.3%) proof the substantiate that the module was not only well-constructed but also contextually and pedagogically aligned. These results indicate that the module has met the criteria for a quality teaching material as outlined in the Merdeka Curriculum, which emphasizes learner-centered approaches, active learning, and alignment with 21st-century skill development (Kemendikbud, 2022). Furthermore, the V-Aiken’s coefficient values of 0.91 (school A) and 0.90 (school B) confirm the statistical validity of expert judgments, which reinforce the module’s credibility in professional pedagogical practice.

From a theoretical lens, this research is anchored in Tomlinson's (2001) principles of differentiated instruction, which emphasize modifying content, process, product, and learning environment to accommodate the readiness, interests, and learning profiles of students. In the module developed, these principles were clearly operationalized. For instance, the content was contextualized using real-life problems related to Bernoulli’s principle, making abstract concepts more tangible and personally relevant. This aligns with grounded learning theory from Vygotsky, which asserts that learning occurs most effectively through meaningful social interactions and experiences within the learner's zone of proximal development (Vygotsky, 1978).

The strength of the module also lies in its integration of the PjBL model, which has been widely recognized for enhancing learners' engagement and fostering deep learning (The George Lucas Educational Foundation, 2005). Through structured project stages which start from formulating essential questions to conducting investigations and presenting results in which students were not only recipients of knowledge but active constructors. This shift from teacher-centered to learner-driven instruction is a hallmark of 21st-century pedagogy (Han et al., 2015).

The enhancement of critical and creative thinking skills observed during the implementation stage provides further evidence of the module's efficacy. Students demonstrated development across key indicators of critical thinking such as inference, evaluation, and advanced clarification, consistent with Ennis' (2011) framework. This indicates that students were not merely recalling factual information but engaging in deeper cognitive processing, making judgments, and formulating reasoned conclusions which called as skills essential for scientific literacy and lifelong learning (Lai, 2011; Redecker et al., 2011).

On the creative thinking dimension, students exhibited fluency, flexibility, originality, and elaboration, echoing Munandar's (2021) indicators for creative thought. The PjBL structure, which allowed for open-ended exploration and problem-solving, evidently provided the scaffolding needed for students to think divergently and express unique ideas. This is in line with Baş & Beyhab (2010), who emphasized that PjBL offers a space for cross-disciplinary exploration and student autonomy, crucial for nurturing creativity.

Additionally, the 88% positive response from students toward the module further confirms its appeal and pedagogical value. Students noted that the learning experience felt more dynamic, relevant, and engaging than traditional instruction. This affirms the assertion by Arends & Kilcher (2010) that differentiated and responsive instruction supports learner motivation and emotional engagement, especially in culturally and academically diverse classrooms.

The significance of this study also lies in its practical implications. It demonstrates that differentiated instruction, when paired with an inquiry-based learning model like PjBL, can be feasibly applied even in standardized educational settings. Teachers are provided with a structured, yet adaptable resource that accommodates student diversity and enhances instructional quality. Moreover, this model promotes authentic assessment practices, whereby student performance is evaluated based on project outcomes and observable thinking processes, rather than mere test results.

Despite its success, this research also acknowledges certain limitations. The implementation was restricted to a single school with a relatively small sample size, which may influence the generalizability of the findings. Nevertheless, the consistency of the validation results across different accreditation levels suggests that the module holds promise for broader application. Future research should consider longitudinal studies to evaluate the lasting impact of such modules on student cognitive growth and explore cross-subject adaptations.

In sum, this discussion confirms that integrating differentiated learning with project-based instruction effectively addresses the dual aims of the Merdeka

Curriculum: personalization of learning and development of higher-order thinking skills. The findings not only support existing theories in educational psychology and instructional design but also extend practical insights into how teachers can design meaningful, inclusive, and effective learning experiences. This study thus contributes both theoretically and empirically to the growing discourse on innovation in science education, particularly in the Indonesian context.

CONCLUSION

This study presents the development and validation of a differentiated physics teaching module grounded in the Project-Based Learning (PjBL) model and structured through the ADDIE instructional design framework. Expert evaluations from accredited A and B schools yielded V-Aiken's values of 0.91 and 0.90, indicating a high degree of content validity. These scores reflect strong expert agreement on the module's quality, coherence, and alignment with curricular standards.

The module also demonstrated high feasibility in four core areas: content (90.68%), presentation (92.1%), language (91.0%), and graphics (89.3%). Student responses reinforced this positive evaluation, with 88% indicating that the learning experience was engaging and beneficial. These findings affirm the module's relevance and adaptability across varying educational settings. In additional he module proved effective in enhancing critical and creative thinking skills—core competencies emphasized in the Merdeka Curriculum. Students displayed notable gains in reasoning, conceptual analysis, and ideational fluency. The project-based structure not only deepened their conceptual understanding but also promoted learner autonomy, reflective inquiry, and collaborative problem-solving.

Although limited in scale, this study provides substantial evidence that integrating differentiated instruction with PjBL fosters meaningful learning and aligns pedagogical design with contemporary educational demands. Future research may further examine its scalability, cross-disciplinary applications, and long-term impact on student learning trajectories. In essence, the differentiated PjBL module developed in this study stands as a valid, pedagogically sound, and empirically supported innovation in physics education. It offers a robust framework for educators aiming to bridge curriculum objectives with student-centered, skill-oriented teaching practices.

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