Innovation of Self Regulated Learning using PjBL-based Physics Learning Modules Integrated with Local Wisdom

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Abstract. In the subject of kinematics in physics, there are still abstract topics that require deep understanding and direct practice. Therefore, teaching materials are needed that can visualize this material in an everyday context. One solution is a PjBL-based physics learning module integrated with local culture. The aim of this research is to determine the feasibility of the PjBL-based physics learning module integrated with local culture. The research method used is R&D with the ADDIE model. The results showed that the learning module was categorized as feasible with a material validation score of 86% and media validation score of 82%. This learning module can be used as an innovation for self regulated learning in studying physics, linked with local culture, so that students can understand the material more contextually.

Keywords: self regulated learning, physics learning, physics learning module, local wisdom

1 Introduction

The challenge faced by secondary education is the low proficiency in three main areas: mathematics, science, and literacy [1]. This is reflected in the results of the Programme for International Student Assessment (PISA), where Indonesia ranked 67th out of 81 countries in 2022 [2]. Additionally, in the Global Innovation Index (GII) released by the World Intellectual Property Organization (WIPO) in 2021, which also includes educational components, Indonesia ranked 87th out of 132 countries [3]. In response, the government is striving to improve this situation through national education reform with the concept of "Merdeka Belajar" (Freedom to Learn). This policy aims to give each educational institution the freedom to innovate by adapting the learning process based on culture, local wisdom, socioeconomic conditions, and educational infrastructure [4,5].

The core of the "Merdeka Belajar" (Freedom to Learn) policy is to empower teachers and students to innovate and independently enhance the quality of the teaching and learning process

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[6,7]. The spirit intended to be fostered through this policy is to create a comfortable learning environment that can inspire enthusiasm for learning, so that students do not feel burdened by the material being taught [8]. The concept of "Merdeka Belajar" focuses on restoring the national education system to align with the essence of the law, where schools are granted the freedom to interpret the basic competencies of the curriculum according to their own assessments [9].

One solution to address this issue is to implement a Project-Based Learning (PjBL) model that focuses on local culture. PjBL is a learning method in which students gain hands-on experience through projects to produce a product [10,11]. This model integrates various student skills, such as proficiency in science, mathematics, and literacy simultaneously. The advantages of PjBL include increased learning motivation, problem-solving abilities, cooperation, as well as skills in seeking and managing knowledge resources. However, the disadvantages of this model include difficulties in managing the classroom environment, which can become noisy, and the need for teachers to have strong classroom management skills. Additionally, students may struggle with gathering information, and some may become less active within groups [12]. The main focus of PjBL is the project outcome developed by students. The use of local culture as a basis for learning aims to introduce students to local wisdom [13-15].

In practice, many physics teachers are still unable to implement the Project-Based Learning (PjBL) model based on local culture. Teachers often face difficulties in designing projects for learning, especially when they need to be integrated with local culture [16,17]. As a result, teaching tends to revert to conventional methods, leading to suboptimal student understanding of physics concepts. If this situation continues, the goals of educational reform through the "Merdeka Belajar" concept will be difficult to achieve. Based on interviews and observations at several schools in the West Java region, many schools have not yet integrated physics learning with local culture. This is because teachers still struggle to link physics concepts with the local culture. Local culture is very important for students to recognize so that they do not forget their own cultural heritage.

Therefore, there is a need for teaching materials that can provide concrete examples to teachers and students in applying the Project-Based Learning (PjBL) model based on local culture. One such material is a physics learning module. A project-based physics learning module can serve as a teaching resource that integrates the PjBL model with local cultural elements. This module is designed to help teachers and students understand physics concepts in real-life contexts by including local cultural elements, such as the use of traditional tools in physics experiments, engaging instructional videos, and interactive quizzes to reinforce concept understanding.

2 Methods

The development model applied is ADDIE, which consists of Analysis, Design, Development, Implementation, and Evaluation. The type of research used is the Research and Development (R&D) method. The development model used is ADDIE, which consists of Analysis, Design, Development, Implementation, and Evaluation. The stages of the ADDIE model can be seen in Figure 1.

Fig 1. ADDIE Model

The instruments used include a validation questionnaire for the learning module, conducted by subject matter experts and media experts. The data analysis employed both qualitative and quantitative methods. Quantitative analysis is used to describe the results of observations, interviews, suggestions, validation feedback, and documentation notes during implementation. This data is analyzed qualitatively, with some suggestions being used to improve the learning media during the revision stage, while documentation notes are described to assess the usefulness of the developed product when used in student learning. Meanwhile, quantitative analysis is used to describe the quality of the media based on the assessments of subject matter experts and media experts.

Table 1. Blueprint of the Media Expert Validation Test Instrument

No	Aspect	Number of Statements
1.	Design of learning media	5
2.	Quality and Usage	4
3.	Effectiveness of learning media	7
4.	Feasibility	2

Table 2. Blueprint of the Material Expert Validation Test Instrument

No	Aspect	Number of Statements
1.	Learning materials	7
2.	Learning clarity	3
3.	Relevance to learning syntax	3
4.	Material delivery	5
5.	Quality and Usage	3

3 Results

The product of this research is a Project-Based Learning (PjBL) module integrated with the local culture of West Java.

Analysis Stage. The first step in the analysis stage was conducting a needs analysis. Through observations and interviews with students and teachers, it was found that physics is considered a fairly difficult subject by students. Teachers expressed the need for innovative, contextual teaching materials that are flexible and can assist them in teaching, so that students can master physics concepts more deeply. Teachers also desired physics lessons to be integrated with local culture, so that students not only learn physics but also develop an appreciation for their own local culture.

The second step was conducting a material analysis. During this stage, the researcher analyzed various existing curricula. The material analysis focused on physics, particularly kinematics, and served as the foundation for developing this learning module. The purpose of the material analysis was to formulate achievement indicators, learning objectives, and the complexity of the material. The core topic chosen for this research is the concept of work in kinematics at the high school level.

Design Stage In the design stage, the tasks include creating the module's content framework as well as designing the cover and layout of the learning module.

Development Stage The development stage involves bringing the design or plan to fruition. This stage begins with the creation of the learning module and expert validation. The module is designed using Canva to create the layout and appearance of the content. Once the module is completed, the next step is to conduct a validation assessment with media and subject matter experts to evaluate the module's feasibility. This research is currently at the development stage. The media expert validation is carried out by three experienced validators in educational modules.

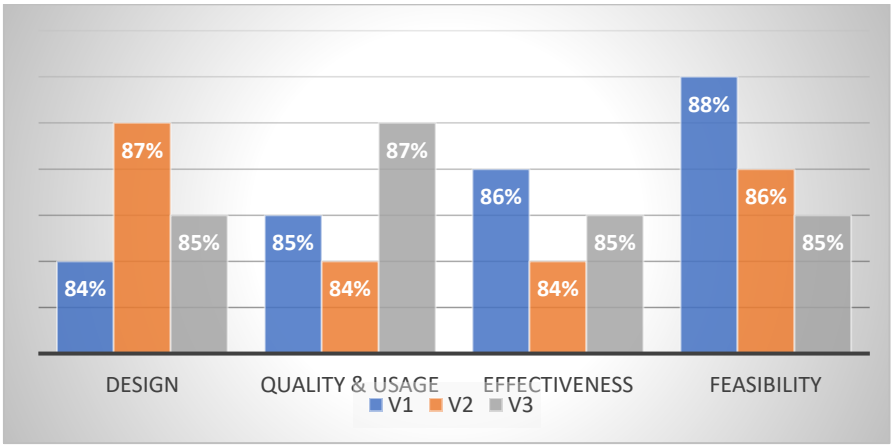

Fig 2. Results of media expert validation assessment

Based on fig.2, the average rating from three media experts is 86%, indicating a very feasible category. In terms of design, the module cover is appropriate and the layout of the learning module is well-organized. The quality and usefulness of the module can also be assessed from its content. It is evident that, in terms of feasibility, this teaching module is suitable for use in physics instruction and supports the Merdeka Curriculum.

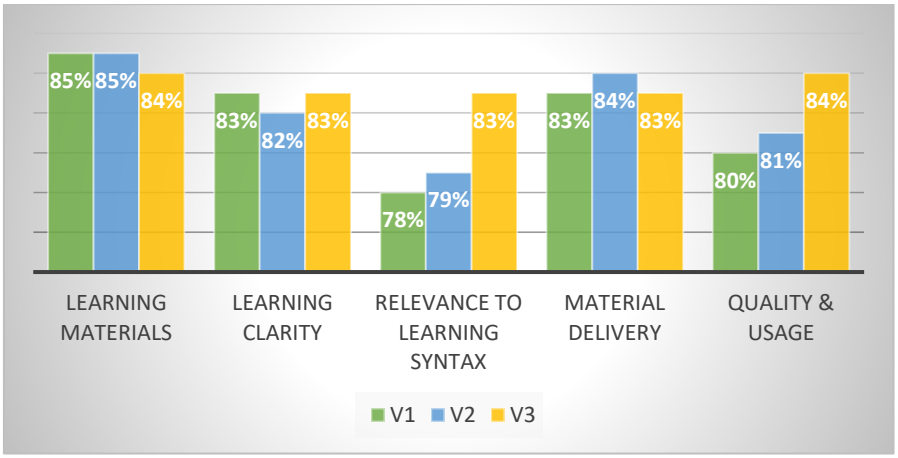

Fig 3. Results of material expert validation assessment

Based on fig 3, the average rating from three subject matter experts is 82%, indicating a very feasible category. The content within the learning module is aligned with the Merdeka Curriculum. The learning material has also been integrated with local culture. The module's content is clear and consistent with the PjBL learning steps. From these results, it is concluded that the PjBL learning module, which integrates local culture, is suitable and can be used in physics instruction. Below is the appearance of the module content after revisions based on expert feedback.

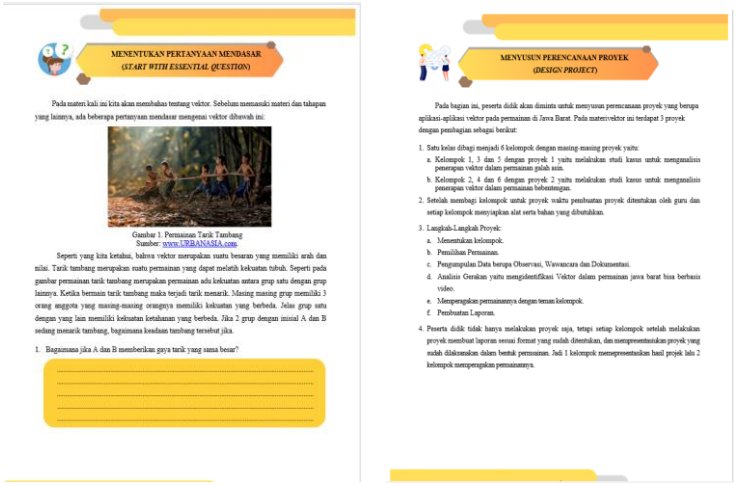

Fig 4. Display of module contents according to PjBL syntax

In Figure 4, the content of the physics learning module based on the PjBL learning syntax is visible. Each step of the PjBL process is included in the module, and students complete the tasks according to the instructions. The PjBL steps used are: Defining the Essential Question, Developing the Project Plan, Creating a Schedule, Monitoring Students and Project Progress,

Assessing Results, and Evaluating Experience. The module also clearly shows different icons for each learning step, corresponding to the activities performed by the students.

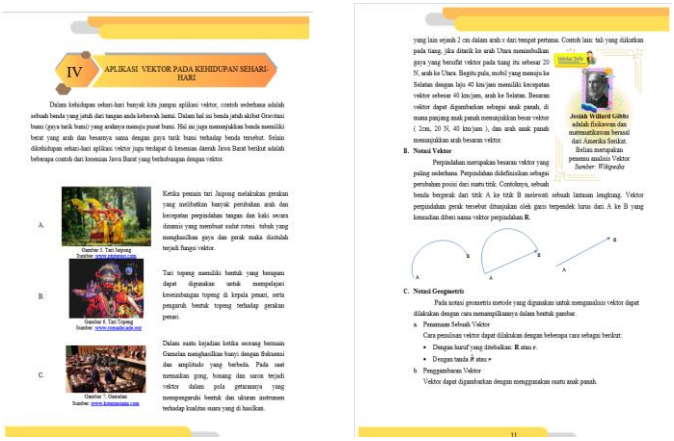

Fig 5. Display of material module contents

In Figure 5, the content of kinematics for one semester in the 11th grade of high school is visible. The physics material is linked with the local culture of traditional games from West Java. The module also includes instructional videos connected to YouTube via QR codes, allowing students to understand the material clearly through visualizations. Additionally, the module features historical figures in physics to enhance students' scientific knowledge.

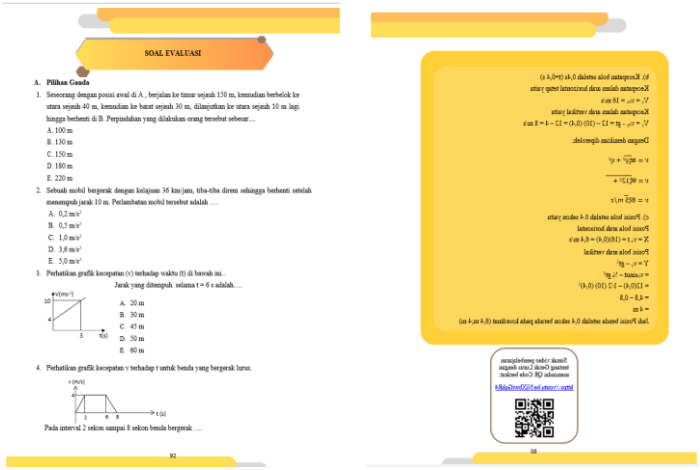

Fig 6. Display Quiz

In Figure 5, the display of practice questions and evaluations is visible. The module includes practice questions and explanations presented in visual and video formats. Evaluation questions are provided at the end of each chapter and consist of multiple-choice and essay questions.

E-Modules in education are seen as more convenient and accessible because students can access them on their smartphones at any time and place, helping them meet their learning objectives

[18]. The competency analysis indicates that learning with the E-Module is effective and enhances students' knowledge. These findings align with the research by. Ismaniati & Iskhamdhanah [19], which also concludes that using E-Modules in education can boost students' understanding.

The physics learning module based on Project-Based Learning (PjBL) integrated with the traditional games of West Java offers several significant advantages. First, this module helps students gain a deeper understanding of physics concepts by applying theory in contexts that are relevant and familiar to them. The integration with local culture, such as traditional games, makes learning more engaging and meaningful, as students can directly observe how physics concepts apply in everyday life [20-21]. Additionally, this approach strengthens students' appreciation for local culture, allowing them to learn physics while also valuing their cultural heritage. The module also supports the development of 21st-century skills, such as collaboration, creativity, and problem-solving, as students are encouraged to work in groups and complete projects related to local culture [22-24]. Thus, this module not only enhances conceptual understanding but also fosters students' character and social skills.

The physics learning module based on Project-Based Learning (PjBL) can significantly enhance students' science process skills [25]. In PjBL, students actively engage in the entire learning process, from formulating essential questions, designing experiments or projects, to analyzing the results obtained. This process encourages students to think critically, observe carefully, collect and interpret data, and develop solutions to the problems they encounter. Through direct involvement in real and relevant projects, students learn to apply the scientific method in meaningful contexts, ultimately improving their skills in designing and conducting experiments, as well as in drawing evidence-based conclusions [26-27]. Thus, this learning module not only facilitates a deeper understanding of physics concepts but also trains students to become more competent scientists by strengthening their science process skills.

The integration of local culture into this module can help students become more familiar with the existing culture. The local potential in each region of Indonesia can be used as a contextual learning too [28]. Traditional games can be directly played by students, allowing them to simultaneously learn about the physical concepts within these traditional games. The application of culture-based learning like this has the potential to develop an active, student-centered learning approach [29-30].

This module is aligned with current school learning and supports the Merdeka Curriculum. The Project-Based Learning (PjBL) model implemented in this learning module is relevant and can enhance students' learning independence. Modules equipped with engaging content can increase learning motivation and self regulated learning [31-32]. As a result, teachers serve only as facilitators, allowing students to learn independently using the module.

4 Conclusion

Based on the results and discussion, it can be concluded that the physics learning module based on Project-Based Learning (PjBL) and integrated with local culture is suitable for use in physics education at schools. This is evident from the validation results, with 86% from media experts and 82% from subject matter experts. The module's content is very engaging and connected to traditional games. Additionally, the module includes steps for Project-Based Learning, which facilitate students' learning and support independent learning.

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