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Statistic Fluida Teaching Module Oriented to STEM-PjBL for Improving Learners' Creativity

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Abstract
Creativity is a main concern in the 21st-century curriculum, but this is rarely implemented in the physics learning process in schools. This research aims to produce a STEM-PjBL-oriented static fluid teaching module worthy of its validity and practicality. This research is development research using the ADDIE model. The research trial subjects were 32 students in class XI 1 SMA consisting of 16 men and 16 women. Data was obtained through module validation sheets and teaching module implementation sheets. The data analysis technique is descriptive, qualitative, and quantitative. The expert and practitioner validation results obtained validity and reliability values for the teaching module of 3.46 and 0.60 with very valid and reliable categories. Apart from that, the results of observing student activities in STEM-PjBL can be carried out very well. In this way, the STEM-PjBL module that has been developed is suitable for use in physics learning.
Keywords: creativity; project-based learning; static fluid; STEM

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INTRODUCTION

The Industrial Revolution 4.0 has resulted in rapid changes in various fields of life, including education. Education plays an important role in shaping human character and mentality so that they are able to interact and contribute to their environment. In the 21st century, students are expected to be able to master the skills of critical thinking, problem-solving, communication, collaboration, creativity, and innovation (Dilekçi & Karatay, 2023; Thornhill-Miller et al., 2023). These skills are very important for high school students in order to adapt to world progress, especially in the fields of technology and information (Ananda et al., 2024; Apriyani et al., 2020; Mabrurah et al., 2023; Ridha et al., 2022; Umam & Jiddiyah, 2021).

Education in Indonesia is still insufficient to produce quality human resources, so the government implemented the Merdeka Belajar Curriculum to prepare generations to face social, cultural and technological changes. Meanwhile, at this time, learning is still centred on students. One of the efforts to improve students' scientific attitudes and creativity is to choose appropriate learning methods and provide opportunities for students to build and develop their knowledge. Learning models with problem-solving steps are needed in the learning process (Kusasi & Satui, 2021; Wibawa, 2022; Wicaksana, 2022).

Creativity is the ability of learners to organize, create or make things in a new and conceptual way, producing interesting products using a high degree of imagination. A creative person has the knowledge and inspiration to develop a framework that facilitates innovation. (Ayuningsih et al., 2022; Mamahit et al., 2020; Misbah et al., 2024; Suyidno et al., 2019). Creativity does not grow by itself but must be honed through stimuli that encourage the need to think creatively. (Budiarti & Malikin, 2020; Lusiana et al., 2024). Creativity is the ability to generate new ideas that can be applied to solving problems. Creativity can arise through a series of small steps, starting from an initial idea that can be modified and explained. (Umam & Jiddiyah, 2021; Zakiah et al., 2020). There are 4 components to creativity, namely fluency is the ability of learners to generate many ideas and problem solutions; flexibility is the ability of learners to apply different approaches to a problem and generate new relevant ideas; originality is the ability of learners to generate many new original ideas and elaboration is the ability of learners to provide a response in detail and systematically (Oliveira & Mahtari, 2022).

STEM is a learning approach that integrates science, technology, engineering and mathematics to solve real-world problems (Astuti et al., 2023). Project Based Learning (PjBL) is a learning model that organizes material as a project, where students are required to develop knowledge and exhibit new understanding through various forms of delivery or learning activities that focus on students and provide meaningful learning experiences. However, it is not enough to use the PjBL model; an approach in accordance with the PjBL steps is also needed, one of which is the STEM approach. The advantage of this model is that it can support students in understanding physics concepts because students are directly involved in projects to help students understand physics learning problems. In addition, learning with the STEM approach is in line with the demands of the 21st century, which can increase students' knowledge and innovation (Anggela et al., 2022; Dewi et al., 2021; Ridha et al., 2022; Solehah et al., 2023).

The results of the initial study showed that students' creativity was still low, with the subject of 32 students in class X1-1 SMA Negeri 1 Alalak obtaining an average value of student creativity of 39.6 with the category of less creative. 58% of students have difficulty determining to calculate using the right equation, 84% of students have difficulty determining phenomena in daily activities, 55% of students have difficulty determining the cause of a problem presented, and 94% of students have difficulty providing solutions to deal with a problem presented. Today's learning still uses teacher-centred conventional learning models, making students accustomed to memorizing material, not learning independently, and developing less creativity. As a result, students have difficulty applying the concepts learned in everyday life. To overcome this problem, more creative and fun learning models and approaches are needed, such as Project-Based Learning combined with STEM and the use of modules. This approach can make students more active, develop creativity, and motivate them to learn through project tasks that are relevant to the problem and technology that is easily accessible (Aini et al., 2022; Cahyani et al., 2020; Iklina & Fadilah, 2022; Irman, 2020; Venalia et al., 2022).

The results of research conducted by Qadafi & Hastuti (2022) show that the STEM-PjBL model can increase students' creativity. Students' creativity is higher when using STEM-PjBL than conventional learning. The results of research (Desi et al., 2023) show that there is an influence or increase in students' creativity after using STEM-PjBL.

Based on the problem description above, the solution is to develop a STEM-PjBL-oriented static fluid teaching module to increase students' creativity. This module is designed to integrate physics concepts, especially static fluid, with a STEM-PjBL approach that facilitates students in solving real-world problems. The advantage of this module lies in the ability to make complex material easy to understand and apply in everyday life. This module allows students to learn more practically and creatively and involves students actively in problem-solving. This study aims to produce a STEM-PjBL-oriented static fluid teaching module that is feasible to improve students' creativity in terms of the validity and practicality of the teaching module. The stages of the ADDIE model in this study are shown in Figure 1.

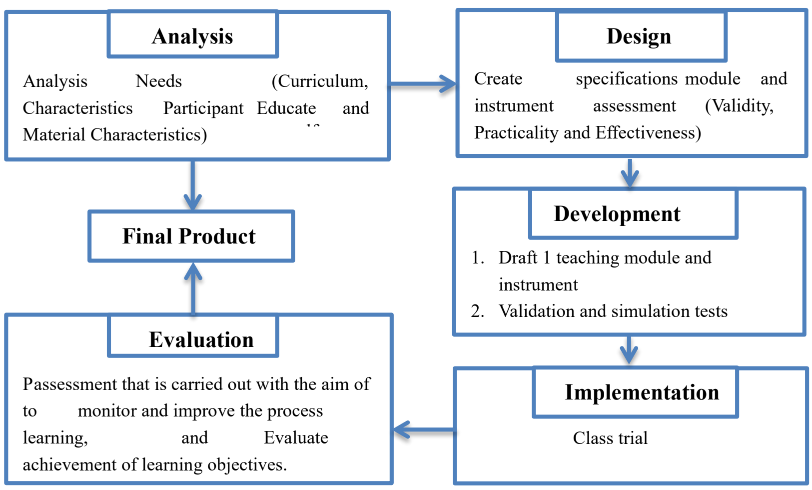

Figure 1 The stages of the ADDIE model (Anggraini et al., 2021; Giawa et al., 2022).

METHOD

The type of research used is development research. The research subject is the STEM-PjBL static fluid module to improve students' creativity and the test subject is 32 students in class XI-1 of one of the State High Schools in Barito Kuala Regency. The object of the research is the feasibility of STEM-PjBL-oriented static fluid modules to improve students' creativity. The research stages used the ADDIE development model (analysis, design, development, implementation, evaluation). The analysis technique used in validity data collection is that the teaching module developed will be validated by two academic validators and one practitioner validator using a validation sheet and a learning activity implementation sheet consisting of 1-4 scales after which the scores of the three validators are summed and averaged. The teaching module is said to be valid if it obtains at least a score of $2.80 < X \leq 3.40$. Then, the value of the validity results from the three validators is calculated for reliability to see the suitability of the teaching module validator assessment; the teaching module is said to be reliable if it at least gets a value of 0.60. While practicality is on the learning activity implementation sheet consisting of learning steps from meeting one to meeting three. The assessment of the implementation of the module was carried out by three observers using an instrument for the implementation of learning activities, which consisted of a scale of 1-4, the teaching module could be said to be practical if it obtained a score of 0.60 with a category of well implemented. of $2.80 < X \leq 3.40$ with the category well implemented.

RESULTS AND DISCUSSION

This research will develop a STEM-PjBL-oriented static fluid teaching module to promote students' creativity. Previously, this module underwent a validation process by academic experts and practitioners to assess validity, which is then simulated, and class trials were conducted to produce a valid and practical teaching module.

The teaching module that has been developed in this study is a STEM-PjBL-oriented static fluid teaching module to increase students' creativity, where the teaching module developed is to support teaching and learning activities for students in class XI 1 SMA and is useful for the continuity of physics learning on static fluid material. The teaching modules that have been developed are adjusted to the Merdeka Curriculum in accordance with the school's needs. The appearance of the STEM oriented PjBL module is shown in Figure 2.

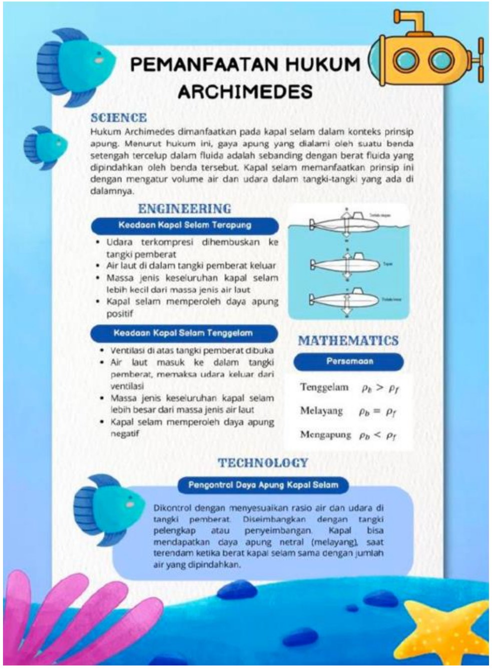

Figure 2 Display of STEM PjBL-oriented Module

The preparation of the developed teaching module consists of general information, core components, and attachments. This teaching module consists of a module *cover* design section, general information, core components, meeting list details, and attachment details. Table 1 shows the validity and reliability scores of teaching modules given by two expert validators and one practitioner validator.

The teaching module developed will be presented in printed form. The teaching module development will be validated by three validators, where the teaching module is said to be valid if the validity results are included in the valid and reliable categories. Reliability means the suitability of the assessment of the three validators. Based on the results of the validation test from two academic validators and one practitioner validator in terms of module *cover* design aspects, general information, core components, meeting list details, and attachment details can be seen in Table 1 The results of the validity and reliability of the teaching module show that the results of the validation of the STEM-PjBL-oriented static fluid teaching module to increase student creativity are considered very valid and high reliability. This indicates that the teaching module developed by the researcher is ready to be tested in the classroom. The results of the teaching module validation were revised in accordance with the suggestions given by the validator so that the teaching module can be used in the learning process.

Table 1 The results of the validity and reliability test of the learning module

Aspects	**Validity**		**Reliability**	
	Value	**Category**	**Value**	**Category**
Module cover design	3.58	Very valid		
General information	3.24	Valid		
Core components	3.50	Very valid	0.61	High
Meeting list details	3.40	Valid		
Attachment details	3.60	Very valid		

The validation results of the three validators on the teaching module include aspects of the teaching module cover design, general information, core components, meeting list details, and attachment details. The validity results of all aspects of teaching modules researchers have developed are highly categorized and reliably reinforced. The results are highly valid in the aspect of the teaching module cover. The teaching module cover on the Merdeka Curriculum contains the module identity, which includes the title of the material, the module compiler, the university logo, the logo of the school that will be the research site, the Merdeka Curriculum, tut wuri handayani, supporting images. It contains the name of the study program, department, faculty, university name and year of preparation of the teaching module, which means that the teaching module cover developed is in accordance with the provisions of the teaching module cover on the Merdeka Curriculum (Refmianti et al., 2023).

Concerning the general information component, validity results were obtained in the valid category. There are 7 sections of general information that are in accordance with the Merdeka Curriculum, namely module identity, learning outcomes, initial competencies, Pancasila learner profiles, facilities and infrastructure, target students, and learning models/methods. The Merdeka Curriculum is an educational initiative in Indonesia whose aim is to increase students' independent attitude and creativity. In order to improve the quality of students and create students who have independence and creativity, it is necessary to apply a learner-centred learning model so that the STEM-PjBL-oriented static fluid module can increase students' creativity (Iklina & Fadilah, 2022; Papaya & Hakeu, 2023; Salsabilla et al., 2023).

In the aspect of the core component obtaining results in a very valid category, there are 8 parts, namely learning objectives, meaningful understanding, triggering questions, learning preparation, learning activities, assessment, reflection activities, enrichment and remedial. While in the aspect of the attachment component, obtaining validity results in a very valid category. The attachment component has four parts: teaching materials, LKPD, research instruments, reflection sheets, learning outcomes, and creativity tests.

Teaching modules that have been validated will then be tested in class XI 1 SMA Negeri 1 Alalak. The practicality of the teaching module is measured by the results of implementing learning activities designed for three meetings. The following is the implementation of learning activities on the teaching module for three meetings presented in Table 2

.

Table 2 Practicality of teaching modules

Phase	Meeting 1		Meeting 2		Meeting 3	
	Value	Category	Value	Category	Value	Category
Define the fundamental question	3.40	B	3.89	SB	3.89	SB
Designing a product plan	3.50	SB	-	-	-	-
Creation of schedule	3.30	B	-	-	-	-
Monitor project activity and progress	3.10	B	-	-	-	-
Testing results	-	-	3.46	SB	3.80	SB
Evaluation of learning experience	3.60	SB	3.70	SB	3.76	SB

Description: B = Good, SB = Very Good

Figure 3 shows the average practicality results of the teaching module at meeting 1, with the category well implemented; meeting 2, with the category very well implemented; and meeting 3, with the category very well implemented.

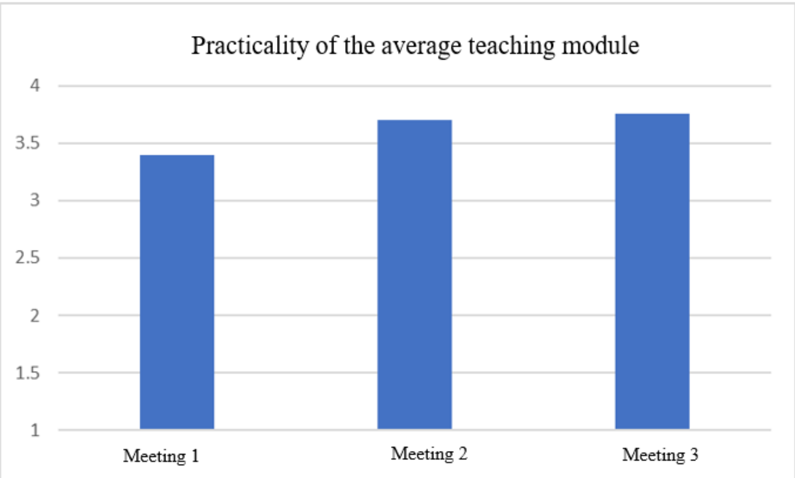

Figure 3 Average implementation of learning activities

The practicality value of the teaching module obtained is 3.62, so the STEM-PjBL-oriented static fluid teaching module developed by researchers is categorized as very well implemented, making it very practical for use in the learning process.

Phase 1 is very well implemented, where the educator's activity is to provide several questions that can stimulate students' creativity from the beginning of meeting 1 to meeting 3. Phase 2 is very well implemented, where the educator divides students into several groups with different topics. Then, the educator directs the students' project tasks by distributing LKPD to them. Phase 3 for the first meeting obtained results with the practical category, thus indicating that learning activities in phase 3 were well implemented. Where in this phase, the educator, together with students, agreed on a project preparation schedule. Phase 4 at the first meeting obtained practical results, thus indicating that the learning activities in phase 4 were well implemented. Phase 5 is very practical in the second and third meetings; in this phase, it is very well implemented. In this phase, students present the results of their projects, and educators provide additional or consolidation of the material. Phase 6 is categorized as very practical from the first to the third meeting; the practicality obtained from the first to the third meeting has increased. This phase is very well implemented, and the educator's activities draw conclusions and reflect on learning. The educator distributes practice questions to students.

Phases 2 to 4 are only carried out at the first meeting because the activities in that phase are only carried out by educators and students at the first meeting. In contrast, phase 5 is carried out at the second and third meetings because students are given one week to complete their projects, so testing the project results is carried out at the second and third meetings.

Practicality is a quality criterion for teaching modules that always exists in each phase. The practicality aspect is a criterion for the quality of teaching modules in terms of the ease of educators and students in applying the teaching modules that have been developed in the learning process (Abdollah et al., 2022; Faradayanti et al., 2020). The average practicality results obtained increased every meeting from the first to the third meeting. This is based on educators' ability to apply teaching modules in the classroom consistently; therefore, with the increasing practicality of the teaching modules applied, learning objectives will be achieved (Lestari et al., 2023).

Based on previous research, the STEM-PjBL-oriented static fluid teaching module that I developed has several significant aspects of novelty that can increase student creativity. This teaching module is PjBL-oriented combined with STEM, which has been adapted to the independent curriculum and the needs of grade XI students. This module can encourage the development of critical thinking, creativity, collaboration, and communication.

STEM-PjBL aims to help learners gain understanding and creativity and develop their creative thinking skills. In addition, STEM-PjBL helps learners find the best solutions to real-world problems. The learning objective is to create STEM concepts independently through product design to solve real-world problems (Rukmana et al., 2021; Suyidno et al., 2021).

PjBL is a learning model where the result of the learning process is a product created as a result of the learning being taught. The STEM approach in the PjBL model can encourage students to connect the four components, namely science, technology, engineering and mathematics, by focusing on solving real problems to train students' creativity; the PjBL- STEM model can realize students' creativity (Inzghi et al., 2023; Qadafi et al., 2022; suyidno et al., 2021).

Overall, validity and practicality complement and support each other in developing quality teaching modules. The validity of the teaching module is very valid, indicating that the teaching module that has been developed accurately and precisely measures what should be measured or taught. Teaching modules must be carefully designed to reflect the desired learning objectives and establish that the material presented is in accordance with the desired standards and concepts and is suitable for use (Ulfah et al., 2022). A valid teaching module will provide a strong basis for learning so that the learning activities designed in the developed teaching module are carried out very well. Therefore, a valid and practical teaching module will be able to improve students' learning outcomes and creativity.

CONCLUSION

This research produces a STEM-PjBL-oriented static fluid teaching module that is valid and practical for physics learning. Through the STEM-PjBL approach, students are encouraged to be creative and responsible in creating creative products to increase their creativity. This research opens space for further exploration of applying the STEM-PjBL approach in other fields. This research can be the basis for the development of project-based learning models in other disciplines with a focus on students' creative and innovative skills.

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