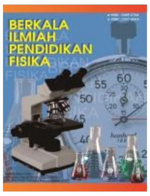


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# The Development of A Physics Teaching Module Using Multimodel to Improve Students' Understanding of Concepts

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**Abstract**

Conceptual understanding is a fundamental component that students must possess in science learning. However, various studies have shown that students' conceptual understanding is still not taught optimally. The availability of teaching modules, supported by appropriate instructional models, can contribute significantly to improving students' conceptual understanding. This study aims to develop a physics teaching module on the topic of momentum and impulse using a multimodel approach that is valid, practical, and effective in enhancing students' conceptual understanding. This research employed a Research and Development (R&D) design using the ADDIE model. The research subjects consisted of 21 students from Class XI at an SMA in Amuntai City. The instruments used included a module validation sheet, an observation sheet for learning implementation, and a learning outcome test. The results showed that the developed teaching module demonstrated a very high level of validity with an average score of 3.37. The module, which includes learning materials, student worksheets, and a learning outcome test, was also categorized as highly valid. Observations of the module implementation over three meetings indicated a very good level of practicality. Moreover, the module was considered effective based on an n-gain score of 0.60. Therefore, the multimodel-based physics teaching module developed in this study is feasible for use in improving students' conceptual understanding in physics learning. This finding implies that the development of teaching modules using multimodal approaches can be a potential alternative strategy for educators to enhance students' understanding of concepts and make learning more meaningful.

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## INTRODUCTION

Physics is one of the subjects that is difficult for students to understand. Physics requires a deep understanding of a topic rather than merely memorizing facts. It emphasizes conceptual understanding by studying natural processes physically and expressing those findings mathematically (Maulidina et al., 2020). To grasp concepts, more than just knowledge is required. Loliyana et al. (2019) state that understanding can be achieved when students are able to see, comprehend, and experience an object or problem from a broad perspective. According to Radiusman (2020), understanding is the process through which students describe, illustrate, classify, formulate, conclude, compare, and explain a topic. Understanding is a pattern of relationships used to classify something using a knowledge scheme (Churchill, 2017). One of the key components of successful physics learning is concept understanding (Dewi et al., 2019). In addition, understanding concepts is crucial before applying the theories learned previously, as physics is closely related to concepts and their applications in the real world (Shidik, 2020). A strong conceptual understanding enables learners to build a stable cognitive structure, serving as the foundation for critical thinking in the face of contextual challenges (Bransford et al., 2000). However, in practice, many students still struggle to understand fundamental physics topics (Docktor & Mestre, 2014). As explained by McDermott & Redish (1999), many learners can solve physics numerical problems but fail to grasp the conceptual meaning behind them, which highlights the importance of an approach that emphasizes deep understanding. According to Suendarti & Liberna (2021), conceptual understanding is a fundamental ability in interpreting ideas, which involves the ability to explain concepts received in a more easily understood way. Many factors influence students' conceptual understanding ability. A lack of interest and motivation of students to review the material that has been learned, students only memorizing formulas without understanding the formulas used, the inability to manipulate equations with more than two variables, and the inability to understand problems accurately are factors that can lead to low conceptual understanding among students (Riwanto et al., 2019).

A preliminary study conducted by researchers at an SMA in Amuntai City in the 2024-2025 academic year shows that the average score of students' concept comprehension test is categorized as very low. This was due to incomplete learning resources, including learning modules, and the lack of variety in the teaching models and methods used by teachers.

The solution to the above problem is to develop a physics teaching module and introduce variations in the learning process to enhance students' understanding of concepts through multimodal learning. Multimodal learning is a combination of several learning models (Maria, 2012). Multimodal learning helps teachers develop instructional activities that correspond to the learning goals. Multimodal learning makes learning more engaging and encourages students to participate more actively. Dori & Belcher (2005) suggest that employing a multimodal approach, which integrates visual, verbal, and mathematical forms of representation, can improve conceptual comprehension. The learning models used in this study are the direct instruction model and the cooperative learning model. The characteristics of physics learning, which include theories, formulas, and principles related to the order of nature, require teachers to present the subject matter methodically and systematically so that students can overcome the challenges of physics in a practical setting. The direct instruction model is one of the models that teaches procedural skills (Safputri et al., 2016).

Direct instruction is a teacher-centered instructional model. The Direct Instruction (DI) model is a learning model where students learn directly from the demonstration of knowledge by the teacher, particularly to acquire knowledge and information (Nisa et al., 2014). Direct instruction is intended to help students master declarative knowledge and procedural skills (Arends, 2008). The direct instruction model is very effective in improving students' conceptual understanding of physics topics. This learning model can take the form of lectures, demonstrations, practical activities, or assignment work. Rosenshine (2012) points out that when teachers use clear, step-by-step direct instruction, students' understanding of concepts tends to improve over time, especially for those who might struggle more.

Cooperative learning is considered an effective instructional model for enhancing students' interest in learning and creating a more engaging learning atmosphere, where students play an active role and are able to cooperate and interact with one another (Rusiati et al., 2015). The cooperative learning model is considered one of the most comprehensive learning models with a very complete strategy. The cooperative learning model encompasses learning to know, learning to do, learning to be, and learning to live together, which has a positive impact on increasing students' interest and motivation to learn (Sulisworo et al., 2018). By using a cooperative learning model, students can help each other understand complex physics material, with more knowledgeable students serving as peer tutors for others. According to Johnson & Johnson (2009), cooperative learning plays a crucial role in strengthening students’ conceptual comprehension and interpersonal skills through meaningful peer interaction. This model was chosen with the consideration that the topic of momentum and impulse requires good numerical operation skills and necessitates analysis in problem-solving (Selvizia et al., 2016). The concept of impulse momentum falls into a complex concept with phenomena that tend to be unobservable directly. By using direct teaching models and cooperative learning, students can learn from teacher demonstrations and with their peers to enhance their understanding of the concepts.

The implementation of direct instruction and cooperative learning models will be more optimal if supported by teaching modules that clearly outline learning objectives, learning steps, assessments, and learning media. These modules enable students to gain a deeper understanding of concepts, while educators have effective and structured guidelines for implementing learning. According to Anggraena et al. (2022), a teaching module is a curriculum device that includes learning objectives, learning steps, assessment methods, teaching media, and other learning resources and references to assist educators in implementing effective teaching. Research on the development of teaching modules to enhance conceptual understanding has been conducted several times, but none have implemented the learning outcomes of Wiggins and McTighe in designing indicators or learning objectives. According to Wiggins and McTighe, the aspect of understanding is not merely C2 on Bloom's cognitive process dimension. However, the aspect of understanding has two general connotations, namely (1) applying understanding, knowledge, and skills effectively in new situations, and (2) making inferences (interpretations, conclusions) and finding patterns/meanings, which leads to understanding.

Understanding a concept involves the ability to express it in a form that is easy to understand and apply the concept according to the cognitive structure possessed (Sanjaya, 2009). According to Wiggins and McTighe, understanding can be demonstrated through a combination of six aspects, namely: 1) Explanation, which includes describing an idea in one's own words, explaining the reasons behind a method or procedure, and/or utilizing facts to support a theory. 2) Interpretation, which includes translating narratives, artistic creations, or situations. 3) Application, which is the use of knowledge and skills in real contexts. 4) Perspective, which is viewing something from a different viewpoint, allowing students to criticize, explain, and understand the overall picture and the underlying assumptions. 5) Empathy, which is placing oneself in another's position and understanding the feelings experienced by others. 6) Self-reflection, which is the ability to understand oneself in terms of one's weaknesses and strengths.

The physics teaching module developed in this research utilizes multimodal learning and implements the learning outcomes of Wiggins and McTighe in designing learning objectives, aiming to enhance students' conceptual understanding. This research aims to describe the feasibility of the physics teaching module developed using multimodal learning on the topic of momentum impulse at one of the SMA in Amuntai City.

## METHODS

This study is a Research and Development study aimed at creating a physics teaching module using multimodal approaches to enhance students' conceptual understanding, employing the ADDIE development model. The ADDIE model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Nasution & Rasyidah, 2022). The subject of this research is the feasibility of using multimodal approaches in physics teaching modules to improve conceptual understanding among students, assessed based on validity, practicality, and effectiveness. The students selected as the trial subjects were class XI students from an SMA in the city of Amuntai during the 2024/2025 academic year.

The data collection instruments used are the validation sheet for the teaching module, the implementation sheet of the teaching module, and the learning outcome test sheet. The analysis technique used is quantitative descriptive statistics to depict the data phenomena, which are then described to understand the results of the conducted research, including validity analysis, practicality analysis, and effectiveness analysis. The validity of the teaching module is evaluated based on aspects such as format, language, content, presentation, and the benefits of the teaching module. The implementation sheet measures the practicality of the teaching module. The results of the validity and practicality score calculations for the teaching module are compared with the validity and practicality categories in Table 1.

Table 1 Validity and practicality categories of teaching modules

| **No.** | **Score ($\bar{x}$)** | **Category** |
|---|---|---|
| 1. | $\bar{x} > 3.2$ | Very valid |
| 2. | $2.4 < \bar{x} \leq 3.2$ | Valid |
| 3. | $1.6 < \bar{x} \leq 2.4$ | Less valid |
| 4. | $0.8 < \bar{x} \leq 1.6$ | Invalid |
| 5. | $\bar{x} \leq 0.8$ | Very invalid |

Adapted from Widoyoko (2012)

The results of the reliability of the teaching materials is calculated according to the categories in Table 2.

Table 2 Reliability category of teaching modules

| **No.** | **Reliability coefficient** | **Category** |
|---|---|---|
| 1. | 0.80 - 1.00 | Very high |
| 2. | 0.60 - 0.80 | High |
| 3. | 0.40 - 0.60 | Medium |
| 4. | 0.20 - 0.40 | Low |
| 5. | 0.00 - 0.20 | Very low |

Arikunto (2019)

To evaluate the effectiveness of the teaching module, a post-test was administered, and the resulting scores were analyzed using normalized gain (N-Gain) classification presented in Table 3.

Table 3 N-gain (g) category

| **Gain score** | **Category** |
|---|---|
| $(g) > 0.70$ | High |
| $0.30 \leq (g) \leq 0.70$ | Medium |
| $(g) < 0.30$ | Low |

Hake (1998)

The achievements of students for each indicator in the science ability dimension are adjusted according to the criteria in Table 4.

Table 4 Criteria for learning outcomes

| **Score** | **Category** |
|---|---|
| 80 – 100 | Very good |
| 70 – 79 | Good |

| Score | Category |
|---|---|
| 60 – 69 | Fairly good |
| 50 – 59 | Not good |
| 0 – 49 | Very not good |

Arikunto (2019)

This research takes place from October 2024 to March 2025. The development design used in this study compares the conditions before and after using the developed teaching module, which is the one-group pretest-posttest design.

## RESULTS AND DISCUSSION

The product developed in this research is a physics teaching module using multimodal approaches to enhance students' conceptual understanding. This physics teaching module was developed and structured based on the Merdeka Curriculum. The developed teaching module can be seen in Figure 1. This teaching module is created for teachers as a guideline for learning activities.

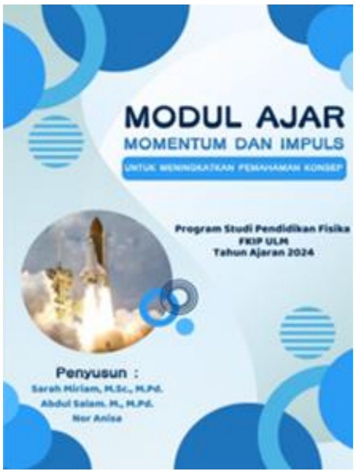
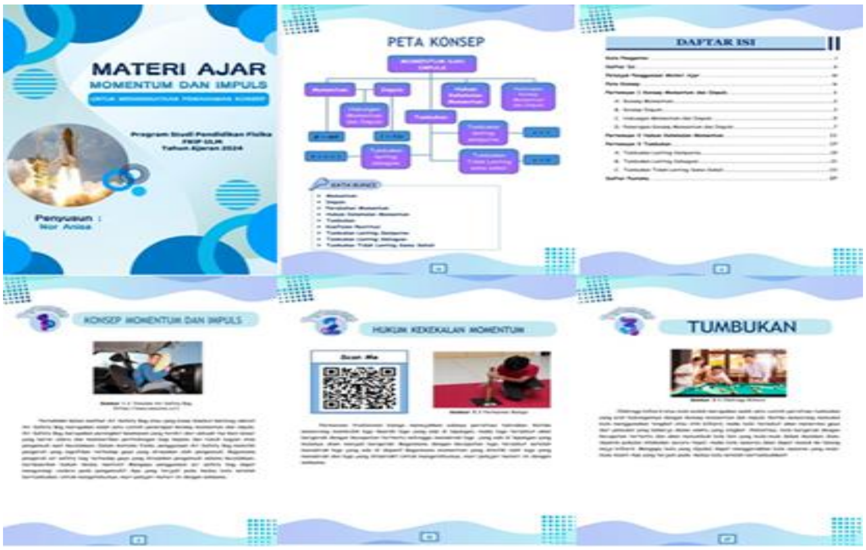
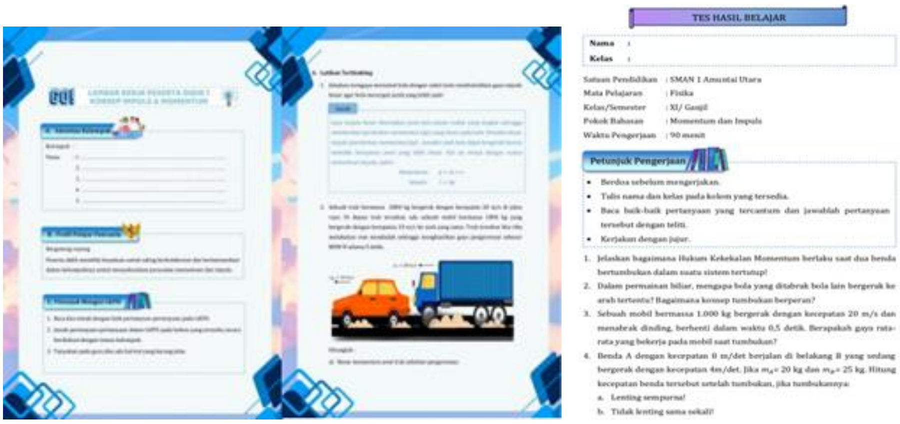



Figure 1 Teaching module on impulse momentum

The designed physics teaching module includes reading materials for students, as shown in Figure 2, student worksheets in Figure 3, and learning outcome tests, as seen in Figure 4.




(a)




(b) (c)

Figure 2 (a) Materials 1-3, (b) Student worksheet, and (c) Learning outcome test

The learning model implemented in this physics teaching module includes direct teaching (Meeting 1) and cooperative learning (Meetings 2 and 3), covering three subsections: momentum and impulse, the fundamental law governing momentum preservation, and interactions in collisions. The physics teaching module developed by the researcher has several innovations that are detailed in Table 5.

Table 5 The novelty of the physics teaching module

| No | Novelty |
|---|---|
| 1. | The physics teaching module is designed to enhance students' understanding of concepts by implementing the learning outcomes of Wiggins and McTighe in designing learning indicators or objectives. It supports the formation of the Pancasila student profile found in the Merdeka Curriculum, namely, collaboration. |
| 2. | Teaching modules are prepared using a multimodal approach that includes direct instruction models and cooperative learning models. |

This discussion examines the feasibility of the developed physics teaching module, assessing its validity through validation by three validators, its practicality through the implementation of the learning phases, and its effectiveness through cognitive learning outcome tests of the students.

**Validity of the Teaching Module**

The validation results of the teaching module encompass the evaluation of its format, language, content, presentation, and overall benefits, as detailed in Table 6.

Table 6 Validity and reliability of the physics teaching module

| Teaching Module Review Aspects | Validity | |
|---|---|---|
| | Score | Category |
| 1. Teaching module format | 3.17 | Valid |
| 2. The language used | 3.27 | Very valid |
| 3. Content of the teaching module | 3.43 | Very valid |
| 4. Presentation | 3.44 | Very valid |
| 5. Benefits of teaching modules | 3.50 | Very valid |
| Average Score | 3.37 | Very valid |
| Reliability | 0.90 | Very high |

First, from the aspect of format, the teaching module is categorized as valid, indicating that it has an attractive cover, a clear numbering system, and an appropriate font type and size, as well as good design, spacing, and layout. Second, from the aspect of language, it is categorized as very valid, showing that the language used in the teaching module adheres to the PUEBI guidelines, is consistent in terminology use and symbols, has no double meanings, and does not contain SARA. Third, from the aspect of content, the teaching module is categorized as very valid, which means it contains all the complete components of the Merdeka curriculum teaching module that meet the needs. Fourth, from the aspect of presentation, it is categorized as very valid, indicating that the teaching module is structured with appropriate time allocations for lessons and subtopics discussed per meeting, as well as comprehensive learning steps. Fifth, from the aspect of benefits categorized as very valid, it shows that the teaching module can be used as a guideline for teachers in learning and can be easily understood by them.

The teaching module contains material, student worksheets, and assessment instruments that are categorized as very valid in terms of construction and content. Overall, from the aspects reviewed, the developed teaching module is categorized as very valid with an average validity score of 3.37 and a reliability of 0.90, which is categorized as very high. This means that the assessment of the teaching module from the three validators is categorized as reliable or consistent. Based on the validity results, the teaching module on momentum and impulse using multimodal approaches to improve conceptual understanding is suitable to be tested in schools and is appropriate for addressing student issues, as well as meeting the standards of a good module. The validity of this learning module is consistent with Nieveen (1999), who stated that an educational product is valid when its content and construction are theoretically sound and address practical needs. Similarly, Plomp (2013) emphasized that validity is a key indicator of product quality, reflecting coherence between content, objectives, and implementation. Thus, the high validity score of the multimodal-based physics module indicates that it meets the standards of instructional material development, is relevant to the needs of the Merdeka Curriculum, and has strong potential to improve classroom teaching and learning effectiveness.

**Practicality of Teaching Modules**

Based on the analysis results of the implementation of teaching modules by the three observers, it can be seen that the observed aspects include the phases of learning during the teaching and learning process, including the introductory, core, and closing activities. The implementation of the teaching module can be described by comparing the average scores of the observers for each meeting. At the first meeting, using the direct teaching model with the material of momentum and impulse, practicality was obtained with an average of 3.22, categorized as very good. This indicates that in the first meeting, the implementation of learning using the direct teaching model was categorized as very good. Meanwhile, its reliability was categorized as very high at 0.81. In the second meeting, using the cooperative learning model on the material of the law of conservation of momentum, practicality was obtained with an average score of 3.21, categorized as very good, and a reliability level of 0.89, also categorized as very high. The third meeting, which utilized the cooperative learning model on the topic of collisions, achieved practicality with an average score of 3.31, categorized as very practical, and a very high reliability level of 0.89.

Overall, from the first meeting to the last meeting, the teaching module on momentum and impulse using multimodels is categorized as very practical in its implementation. This indicates that teachers can use the module as a guide to teach the material of momentum and impulse in improving students' understanding of the concepts. The practicality of the teaching module aligns with the view of Gall et al. (2007), who stated that practical instructional materials are characterized by ease of use, clear learning steps, and alignment with teachers' instructional practices. Similarly, Reigeluth (2013) emphasized that instructional products with high practicality allow teachers to focus more on guiding students' conceptual understanding without being hindered by procedural difficulties. Therefore, the findings of this study reinforce that the multimodal-based physics module is not only easy for teachers to implement but also has strong potential to improve teaching efficiency and deepen students' conceptual understanding.

**Effectiveness of Teaching Modules**

The learning outcomes of students measured using the N-gain are generally 0.6, which is categorized as moderate. From these results, it can be said that the developed teaching module is classified as effective with a moderate category for improving students' conceptual understanding. Based on these findings, the developed teaching module is effective in a moderate capacity for enhancing students' conceptual understanding. Additionally, Springer et al. (1999) confirmed through a meta-analysis that cooperative learning has a positive influence on academic achievement, attitudes, and student retention. Therefore, the multimodal-based physics module developed here is consistent with previous evidence, highlighting the benefits of integrating direct and cooperative learning to strengthen conceptual understanding in physics. The calculations show that the students' average score increased substantially from 5.9 on the pre-test to 61.6 on the post-test. The enhancement of student achievement indicates that conceptual understanding can be progressively developed through well-structured content and representations tailored to students' cognitive frameworks (Redish & F, 2003). The average proportion of students' learning outcomes in each aspect of conceptual understanding is shown in Table 7.

Table 7 Average learning outcomes proportion

| **Aspect** | **Average proposition** | |
|---|---|---|
| | ***Pre-test*** | ***Post-test*** |
| Explanation | 0.27 | 0.86 |
| Interpretation | 0.11 | 0.67 |
| Application | 0 | 0.56 |
| Perspective | 0.02 | 0.61 |
| Empathy | 0 | 0.68 |
| Self-reflection | 0.07 | 0.44 |

Based on Table 7, it can be seen that the aspect of self-recognition (self-reflection) has experienced a lower increase in scores compared to other aspects of conceptual understanding. This is because some students are not yet able to analyze and introspect. According to Delwey, reflection is a process of critical thinking about experiences to find solutions to problems, which requires continuous practice (Aulia, 2019). However, overall, it can be seen that after using the multimodal teaching module, the students' conceptual understanding has improved. This is also supported by research by Fautin et al. (2021), which shows that the use of multimodal-based physics teaching materials is effective in improving students' learning outcomes in the kinetic gas theory. Research by Wieman & Perkins (2005) also shows that using a multimodal approach tailored to students' needs can create a deeper and more contextual learning experience. Based on the research results, physics teaching modules using multimodal methods to enhance students' conceptual understanding are suitable for use in learning as they meet the criteria of validity, practicality, and effectiveness. However, the limitation of the study lies in the scope of the sample, which is restricted to one class in one educational institution; thus, wider trials are needed to obtain more representative generalizations of the findings. The implications of this research indicate that the development of teaching modules using multimodal methods can be a potential alternative strategy for educators to enhance students' conceptual understanding and make learning more meaningful. The teaching module on momentum and impulse using multimodel can serve as one reference for teachers in schools for learning activities aimed at enhancing students' understanding of concepts. The research results, presented in this multimodel teaching module, can also yield new findings that are useful for schools in supporting physics learning and improving school quality.

## CONCLUSION

Based on the research findings, it can be concluded that the multimodel-based physics teaching module developed for the topic of momentum and impulse is feasible for use in classroom instruction. This feasibility is supported by a high level of validity across multiple aspects, including format, language, content, presentation, and utility, with an average validity score of 3.37 and a reliability coefficient of 0.90. In terms of practicality, the module demonstrated excellent implementation across all sessions, both in direct instruction and cooperative learning models, with high inter-observer reliability. Regarding effectiveness, the module significantly improved students' conceptual understanding, as indicated by an average N-gain score of 0.6, classified as moderate, and substantial gains across all dimensions of conceptual comprehension. However, the study is limited by the scope of its sample, which involved only a single class within one educational institution, thereby constraining the generalizability of the findings. The implications of this research suggest that the multimodel-based teaching module represents a promising alternative instructional strategy for physics educators to enhance students' conceptual understanding and to support more meaningful and contextual learning experiences, in alignment with the principles of the Merdeka Curriculum.

## CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

## AUTHOR CONTRIBUTIONS STATEMENT

This article was collaboratively written by three authors, each of whom contributed significantly from the early stages of development through to the final publication. The first author was responsible for conducting the research, developing the teaching module, and drafting the initial manuscript version. The second author was actively involved in preparing the teaching module, ensuring the quality and feasibility of the learning content, and refining the language and structure of the article. The third author also contributed from the module development stage, particularly in composing the key components of the learning material, supporting its field implementation, and editing the manuscript to meet publication standards. All authors have reviewed and approved the final version of this article.

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