



Digital Meaningful Learning Module For Two-Dimensional Kinematics To Enhance Critical Thinking Skills In High School

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Abstract

This research aims to develop a digital module based on the Meaningful Learning approach to enhance high school students' critical thinking skills in two-dimensional kinematics as self-paced learning material that supports 21st-century learning demands. The study employed a Research and Development (R&D) method using the Dick and Carey model. The product developed is an interactive digital module containing contextual and meaningful learning activities designed to improve students' critical thinking skills. Expert validation results showed that the module was highly feasible, with scores of 86.3% for the media aspect, 95.83% for the content aspect, and 96.3% for the learning aspect. Limited trials involving 28 students obtained a positive response rate of 95.13%, while trials involving two educators resulted in a score of 93%, both categorized as strongly feasible. To evaluate critical thinking improvement, a preliminary one-group pretest-posttest study design was utilized. Findings from this limited trial indicate a potential improvement in students' critical thinking skills, as evidenced by an increase in the average pretest score from 57.62 to 74.52 on the posttest, with an N-gain score of 0.43 categorized as medium. Therefore, the developed digital module is highly feasible as a self-paced instructional material and shows promising preliminary potential for fostering students' critical thinking skills through meaningful learning experiences; however, further large-scale trials are needed to fully establish its overall effectiveness.

INTRODUCTION

Educational developments in the 21st century require students to possess critical thinking skills as part of the essential competencies in the Merdeka Curriculum (Hanipah, 2023; Khusna et al., 2023). Critical thinking skills are necessary so that students can analyze, evaluate, and make rational decisions regarding various issues (Jamaluddin et al., 2020). However, because learning is still focused on knowledge transfer and rote memorization, students' critical thinking skills have not yet developed to their full potential (Umroh et al., 2025). This situation also applies to physics education, which requires both conceptual understanding and the ability to apply scientific principles in everyday life (Amelia & Chusni, 2024). In fact, the Merdeka Curriculum emphasizes physics education that fosters critical thinking, creativity, collaboration, and problem-solving skills (Kaniawati et al., 2025).

The low level of critical thinking skills among students is reflected in the results of the 2022 PISA study, which ranked Indonesia 69th out of 81 countries in terms of higher-order thinking skills (Aziz & Ardiansyah, 2024). High school students' critical thinking skills in physics class are still in the low range (Asniar et al., 2022; Selvi et al., 2025). These low levels of proficiency indicate that physics instruction has not yet been fully effective in helping students develop deep and reflective conceptual understanding. According to Fisher (2011) critical thinking develops when students are trained to analyze information, evaluate evidence, and reflect on the reasoning process used to draw conclusions. In addition, meaningful learning requires the integration of learning and thinking processes so that students can construct a deeper understanding of concepts rather than merely memorize information (Harpaz, 2014). Therefore, physics learning should provide opportunities for students to actively connect concepts, reflect on their understanding, and apply knowledge in various contexts.

The problem becomes even more apparent in the topic of two-dimensional kinematics, which requires conceptual understanding, mathematical skills, and the ability to visualize motion simultaneously. To

investigate this issue, a preliminary needs analysis was conducted. The participants involved 58 twelfth-grade students and one physics teacher from a public high school in Jakarta. The data collection instruments consisted of a structured questionnaire for the students, which was administered via Google Forms, and an in-depth interview guide for the teacher. During the procedure, the students completed the questionnaire to evaluate their specific learning difficulties and preferred instructional media, while the teacher was interviewed to explore current teaching constraints and the instructional methods utilized in the classroom. The collected data were then evaluated using descriptive percentage analysis.

Based on the results of this needs analysis, 51 out of the 58 students stated that the topic of two-dimensional kinematics was still difficult to understand, while 93.1% of students admitted that they did not yet understand the concepts involved. These difficulties are influenced by the use of monotonous instructional media that fails to connect physics concepts with real-life situations. Interviews with physics teachers also revealed that students struggle with solving calculation problems, exhibit low motivation to learn, and are less active in exploring concepts because instruction remains dominated by lecture-based methods and the use of PowerPoint presentations. These conditions cause students to tend to be passive and under-trained in analyzing problems or making decisions based on the physics concepts they have learned. Therefore, more innovative and interactive learning media are needed to create meaningful learning experiences so that students can understand physics concepts more deeply while developing critical thinking skills.

The use of digital technology in education is one way to address these challenges. Technological advancements have driven the transformation of educational media toward digital formats that are more flexible, interactive, and accessible to students (Sinaga & Firmansyah, 2024). One medium with the potential to support physics learning is the digital module. A digital module is an electronic teaching resource that includes

text, images, animations, audio, and video, enabling students to understand abstract concepts in a more concrete way (Ar et al., 2022). The use of digital modules in physics education has been shown to improve conceptual understanding and provide flexibility for independent learning (Abdilah et al., 2025; Wibowo et al., 2023). In addition, the interactive and adaptive nature of digital modules allows students to learn at their own pace and according to their individual needs. However, the use of digital modules must be integrated with a teaching approach that connects students' prior knowledge with new concepts to make learning more meaningful.

One relevant approach to supporting meaningful learning is the Meaningful Learning approach. The Meaningful Learning approach emphasizes the process of linking new information to learners' existing cognitive structures, thereby fostering a deeper and more contextual understanding (Nurlina et al., 2021). This approach also encourages students' intellectual engagement through critical thinking, problem-solving, and reflection (Mystakidis, 2021). Throughout the process, students are guided to gradually build conceptual connections through the stages of advance organizer, progressive differentiation, integrative reconciliation, and consolidation, so that the understanding they develop becomes deeper and more lasting (Harefa, 2013; Novak & Ridley, 1988). Thus, Meaningful Learning has the potential to support physics education that focuses not only on conceptual mastery but also on the development of students' critical thinking skills.

Several previous studies have developed digital modules for physics education. For instance, an interactive digital module based on guided inquiry and scaffolding was developed for linear motion kinematics, achieving excellent feasibility results (Jannah, 2024). Other studies have utilized 3D and 4D developmental models to enhance general conceptual understanding in topics such as sound waves and parabolic motion (Cahyanto et al., 2022; Marcelina, 2022). While these studies demonstrate the benefits of digital modules, a significant research gap remains. Theoretically, previous research has primarily focused on media

feasibility and basic comprehension, rarely integrating the Meaningful Learning approach specifically to cultivate higher-order critical thinking skills within the complex domain of two-dimensional kinematics. Methodologically, many existing studies rely on the 3D or 4D development frameworks. In contrast, this research employs the comprehensive Dick and Carey instructional design model to systematically align learner characteristics, Meaningful Learning principles, and critical thinking assessments. By addressing these theoretical and methodological gaps, this study provides a novel, systematically designed learning tool aimed at explicitly fostering students' critical thinking skills.

Based on the above description, the novelty of this study lies in the development of a digital module using the Meaningful Learning approach to two-dimensional kinematics to foster critical thinking skills among high school students. The digital module was developed by integrating activities that connect students' prior knowledge with physics concepts. This study also employs Dick and Carey's systematic development model, ensuring that the resulting product is expected to be relevant to the physics learning needs outlined in the Merdeka Curriculum.

The main issue in this research is the lack of digital modules based on the Meaningful Learning approach that can help students understand the concepts of two-dimensional motion while optimally developing their critical thinking skills. Therefore, this study aims to develop a digital module using the Meaningful Learning approach on two-dimensional motion kinematics to train the critical thinking skills of high school students and to test the feasibility of the developed digital module as self-paced learning material for physics.

METHOD

Research Design

This research employs a Research and Development (R&D) approach utilizing the Dick and Carey instructional design model to systematically develop and evaluate the educational product. The research process

was conducted systematically to ensure that the resulting product possesses high validity and practicality (Gall et al., 2003; Sugiyono, 2013). The research procedure was explicitly mapped to the stages of this model. Specifically, this study implemented the first nine stages: (1) identifying instructional goals to establish the basis for product development, (2) conducting instructional analysis to determine necessary knowledge and skills, (3) analyzing learners and contexts to understand the educational environment, (4) writing performance objectives, (5) developing assessment instruments aligned with these objectives, (6) developing instructional strategies to guide the learning process, (7) developing and selecting instructional materials, (8) designing and conducting formative evaluations through expert validation and pilot testing, and (9) revising the instructional materials based on empirical feedback. The tenth stage of the model, designing and conducting a summative evaluation, was omitted because it is considered an optional step in the instructional design process that is typically conducted by independent evaluators. Thus, the scope of this research was limited to evaluating the feasibility of the developed product. This systematic nine-stage adaptation ensures the developed digital module is rigorously tailored to the students' real learning needs.

Based on the results of this analysis, the researcher established performance objectives to define the expected learning outcomes. The next step was to develop assessment instruments aligned with the learning objectives, followed by designing instructional strategies to serve as guidelines for implementing the instruction. After that, instructional materials were developed in accordance with the designed strategies to ensure they were organized systematically and coherently. The final stage involved conducting a limited-scale formative evaluation to test the initial feasibility and effectiveness of the product, with the possibility of making revisions if weaknesses were identified. These stages ensure that the developed product is systematically designed and tailored to the real needs of the learners.

Instruments and Data Collection

The research instruments used in the development of this digital module consisted of expert evaluation forms and user response questionnaires for both students and educators. To ensure instrument validity and reliability, the content and construct validity of all instruments were established through expert judgment by university lecturers prior to data collection. The expert evaluation forms were administered to three experts specifically, Physics Education lecturers from Universitas Negeri Jakarta acting as a subject matter expert, a media expert, and an instructional design expert. These forms were used to assess the suitability of the module across three domains: the content aspect (10 items), the media aspect (12 items), and the learning process (15 items). Furthermore, the user response questionnaires were organized based on specific indicators; the student questionnaire comprised 20 items evaluating design appeal, presentation techniques, and the learning process, while the educator questionnaire, administered to two physics educators, included 25 items assessing the module's overall pedagogical utility. All instruments utilized the Likert scale presented in Table 1.

Table 1. Likert scale criteria

Score	Interpretation
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

Students response questionnaire was used during the limited pilot test phase to assess the appeal of the design, presentation techniques, and learning process that were developed. To analyze the data, a continuous scale interpretation technique was used, which is an analytical method that breaks down the variables under study into several indicators. These indicators were then used as the basis for formulating instrument items in the form of questions or statements. The validity of the instrument is indicated by the following Eq. 1:

$$\text{Score Interpretation} = \frac{\text{Score obtained}}{\text{Highest total score}} \times 100\%$$

The results of these calculations are then used to determine the feasibility interpretation percentage. This percentage is subsequently used as a reference for categorizing the feasibility level of the module based on the established interpretation ranges, as shown in Table 2.

Table 2. Feasibility interpretation

Total Value Score	Interpretation
$1,00 \leq I_s < 1,75$	25% $\leq I_s < 43,75\%$ Strongly Not Feasible
$1,75 \leq I_s < 2,5$	$43,75\% \leq I_s < 62,5\%$ Not feasible
$2,5 \leq I_s < 3,25$	$62,5\% \leq I_s < 81,25\%$ Feasible
$3,25 \leq I_s \leq 4,00$	$81,25\% \leq I_s \leq 100\%$ Strongly Feasible

(Rahmawati et al., 2023)

The N-gain calculation is used to determine the extent of improvement in students' learning outcomes before and after instruction using digital modules. The N-gain value is derived from the results of the pretest and posttest. The formula used to calculate the N-gain is as follows:

$$N - Gain = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Ideal Score} - \text{Pretest Score}}$$

Table 3. N-gain

Score	Interpretation
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$g < 0,3$	Low

(Mursyidah, 2025)

Digital Module Trial

The research was conducted at a public high school in Jakarta in 2026 with a sample of 28 tenth-grade students. The sample was selected using purposive sampling based on specific criteria. The primary criterion for participant selection was students who had already completed the prerequisite topics of uniform linear motion and uniformly accelerated linear motion, as these concepts are foundational for understanding two-dimensional kinematics. Additionally, the selected participants were students who exhibited moderate to low critical thinking skills, based on preliminary observations, and

who demonstrated a need for more interactive instructional media. Data collection was carried out through needs analysis, interviews, expert evaluation sheets, user pilot surveys, and critical thinking ability tests in the form of pretests and posttests. The pilot study involved these 28 students to obtain a more comprehensive picture of the feasibility and use of digital modules in learning. The results of the limited digital module trial were used as a basis for revising and refining the product before it was implemented more widely.

RESULT AND DISCUSSION

Digital Module Results

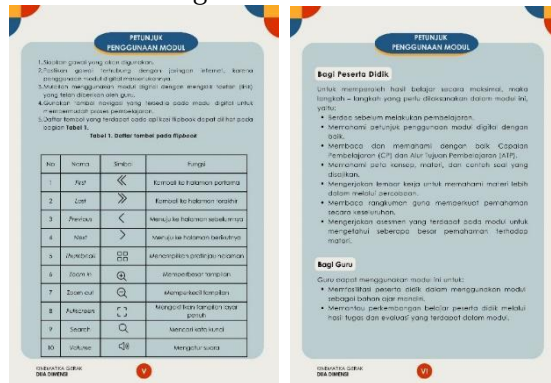
The research output is a digital module developed using a Meaningful Learning approach on the topic of two-dimensional kinematics to foster critical thinking skills among high school students. This digital module is designed as self-paced learning material for students to enhance their understanding of physics concepts, particularly in the context of two-dimensional kinematics. During the development process, the module was designed using the Canva application for graphic visualization and content organization, then published via the Heyzine web platform to be accessible online in an interactive format. The cover of the digital module is shown in Figure 1.



Figure 1. Cover of the digital module

This digital module includes user guides for teachers and students to facilitate its use in supporting learning objectives. The guides cover how to access digital content, participate in learning activities, and use interactive features. Additionally, the module includes learning outcomes and a learning objectives sequence aligned with the Merdeka

Curriculum. With clear learning outcomes, students are guided to understand the competencies they should achieve after using this digital module. The user guide, learning outcomes, and learning objectives sequence are shown in Figure 2.



(a)



(b)

Figure 2. (a) User guide (b) Learning outcomes

Figure 3 shows the profile of a digital module, which includes an explanation of the application of the Meaningful Learning approach, systematically organized learning stages, and the integration of critical thinking skill indicators included in formative and summative assessments. Critical thinking skill indicators consist of analyzing arguments, testing hypotheses, providing reasoning, analyzing the possibilities of an event, and providing problem-solving and decision-making.

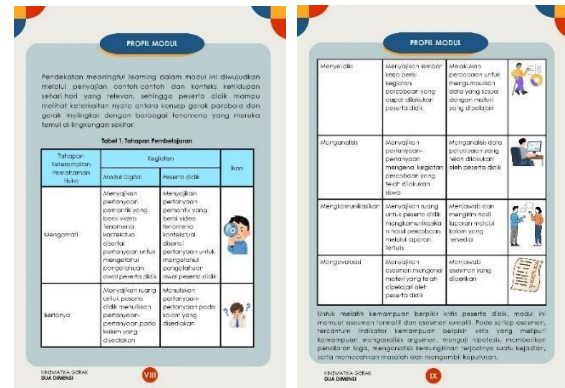


Figure 3. Profile of digital module

The digital module also includes a concept map designed to provide a comprehensive overview of the connections between subtopics in the Two-Dimensional Kinematics curriculum. This concept map helps students organize their knowledge, understand the learning sequence, and see the relationships between concepts, thereby making the learning process more meaningful. The concept map is shown in Figure 4.

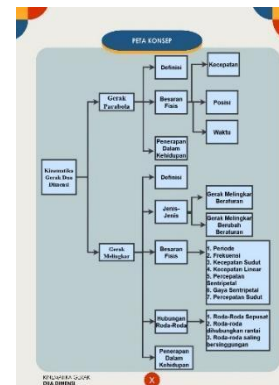


Figure 4. Concept map

This digital module consists of three learning activities, as shown in Figure 5. Each learning activity is systematically designed to help students understand physics concepts while developing critical thinking skills through observing phenomena, analyzing problems, and drawing conclusions. Thus, this module serves not only as self-paced learning material but also as a tool for developing critical thinking skills.



Figure 5. Learning activities

This digital module excels in content delivery because it features illustrations, animations, and educational videos that can be played directly within the module. These visual and audiovisual media help students understand abstract concepts in a more concrete way, in line with the principle of Meaningful Learning linking new knowledge to prior knowledge. Additionally, the materials and activities in the module have been aligned with the Merdeka Curriculum through the presentation of learning objectives and activities that emphasize student independence and active engagement. The various forms of content presentation are shown in Figure 6.

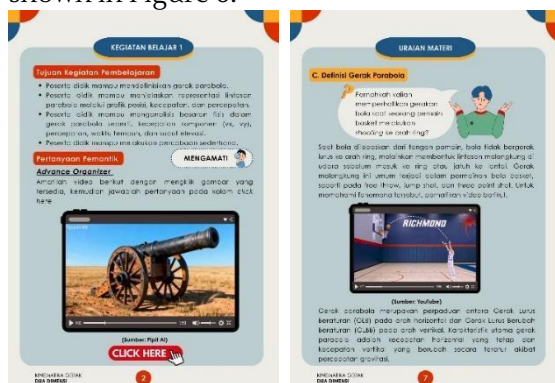


Figure 6. Digital module content

Digital Module Feasibility

The feasibility of a digital module using the Meaningful Learning approach for the topic of Two-Dimensional Kinematics to develop critical thinking skills was evaluated through expert assessment. This step was taken to ensure the quality, accuracy, and level of acceptance of the module before it is used more widely in physics education. The evaluation was conducted by three types of experts: content experts, media experts, and learning experts. The results of the digital module feasibility evaluation are presented in Table 4.

Table 4. Feasibility of digital module

Feasibility Aspects	Percentage	Interpretation
Subject Matter Expert		
Scope of Subject Matter	100 %	Strongly Feasible
Presentation of Subject Matter	87,5 %	Strongly Feasible

Feasibility Aspects	Percentage	Interpretation
Sentence Structure	100 %	Strongly Feasible
Media Expert		
Components of Digital Module	100 %	Strongly Feasible
Benefits of Digital Module	75 %	Feasible
Characteristics of Digital Module	85 %	Strongly Feasible
Criteria of Digital Module	84 %	Strongly Feasible
Sentence Structure	87,5 %	Strongly Feasible
Learning Expert		
Learning Structure	100 %	Strongly Feasible
Meaningful Learning	88,88 %	Strongly Feasible
Critical Thinking Skills	100 %	Strongly Feasible

Based on the results of the feasibility test conducted by subject matter experts, an average score of 95.83% was obtained, which falls into the strongly feasible category. This indicates that, in general, the content in the digital module meets high standards of feasibility. This high percentage is influenced by the content coverage and language aspects, which received the highest score of 100%, indicating that the content aligns with the curriculum and uses clear, easy-to-understand language. Meanwhile, the content presentation aspect received the lowest score of 87.5%, suggesting that there are still some areas that can be improved in terms of organization or presentation style. Based on the feasibility test results by media experts, an overall score of 86.3% was obtained. The digital module components received a score of 100%, while the module's benefits received a score of 75%. This overall score indicates that the digital module falls into the strongly feasible category. Based on the feasibility test results by a learning expert, an overall score of 96.3% was obtained, categorized as strongly feasible. In detail, the learning structure and critical thinking skills aspects each received a score of 100%, while the Meaningful Learning aspect

received 88.88%. The final assessment results for the three aspects show that the content aspect received a score of 95.83%, the media aspect 86.3%, and the learning aspect 96.3%, with an overall average score of 92.81%, which falls into the strongly Agree category. These results indicate that the developed digital module has successfully facilitated the connection between new knowledge and students' prior knowledge through the use of concept maps, visualizations, and various learning activities.

Limited Digital Module Trial

Following an evaluation by experts, the digital module was also pilot-tested with 28 students to gather direct user feedback. During this phase, the students used the module in their learning activities and then completed a feedback questionnaire covering aspects such as design appeal, presentation techniques, and the learning process. The results of the students' feedback are presented in Table 5.

Table 5. Student responses

Aspect	Percentage	Interpretation
Design Appeal	95,83 %	Strongly Feasible
Presentation Techniques	94,74 %	Strongly Feasible
Learning Process	94,82 %	Strongly Feasible

Based on the results of the product usability assessment conducted during the limited trial involving 28 students, an average score of 95.13% was obtained, falling into the strongly feasible category. The highest score was in the design appeal category at 95.83%, while the lowest score was in the presentation technique category at 94.74%. Overall, these results indicate that the developed product performs very well in use.

After conducting a limited trial of the digital module with students, the module was also pilot-tested with two educators to gather feedback on its use in the classroom. At this stage, the educators were asked to evaluate the module using a feedback questionnaire that covered the aspects of media, content,

and instruction. The results of the educators' feedback are presented in Table 6.

Table 6. Educators' responses

Aspect	A	B	Average	Interpretation
Media	92,8 6%	92,8 6%	92,86 %	Strongly Feasible
Subject Material	92,8 6%	85,71 %	89,30 %	Strongly Feasible
Learning	95,45 %	97,73 %	96,6 %	Strongly Feasible

The results of the product usage assessment by educators showed an average score of 93%, classified as strongly agree with the media aspect scoring 92.86%, the content aspect 89.3%, and the learning aspect 96.6%. These scores indicate that the digital module developed meets very high-quality standards, particularly in the learning aspect, which performed most optimally, although the content aspect still scored lower than the other aspects.

This study also obtained limited data on improvements in students' critical thinking skills to support the initial implementation of the digital module. Measurements were taken through pretests and posttests administered on different days, each with a duration of 25 minutes. The pretest aimed to assess students' initial critical thinking abilities, while the posttest was used to measure improvements in these specific skills following the use of the digital module. The results showed that the average pretest score of 57.62 increased to 74.52 on the posttest. This improvement was analyzed using N-Gain, yielding a value of 0.43, which falls into the medium category.

The development of a digital module on two-dimensional motion kinematics in this study emphasizes the Meaningful Learning approach, which connects new knowledge with students' prior knowledge and real-world experiences. This approach was chosen because the needs analysis revealed that 93.1% of students struggled to understand the abstract concepts of two-dimensional motion and required visual aids. Additionally, preliminary data gathered from interviews with the physics teacher confirmed that

students' critical thinking skills remain at a moderate level, necessitating more interactive and contextual learning media. Expert evaluations indicate that the digital module meets the criteria for a high-quality self-paced digital learning resource, though some refinements are still needed regarding media presentation and visual consistency. These findings align with research Cahyanto et al. (2022) and Marcelina (2022) which indicate that interactive multimedia-based physics e-modules have a very high level of feasibility and are effective for teaching material that requires conceptual visualization. Other studies have also shown that the use of interactive digital modules can increase student engagement in physics learning because the presentation of the material becomes more engaging, systematic, and easy to understand (Jannah, 2024; Wibowo et al., 2023). In addition, according to Abdilah et al. (2025) digital modules offer greater learning flexibility than conventional teaching materials because they can be accessed at any time and support students' independent learning.

The results of this research also indicate that integrating the Meaningful Learning approach into digital modules helps students connect physics concepts to real-life situations, thereby making learning more meaningful. This finding aligns with Ausubel's theory, which states that learning is easier to understand when new information is linked to the cognitive structures students already possess (Nurlina et al., 2021). The use of digital modules based on the Meaningful Learning approach is expected to help students connect physics concepts with real-life situations as well as enhance their conceptual understanding in a more in-depth manner (Irchami, 2025). According to Hernández & Vergara (2022), meaningful learning can enhance conceptual understanding because students do not merely memorize information but build deep connections between concepts. Mystakidis (2021) research further supports these findings by stating that Meaningful Learning can develop higher-order thinking skills, such as critical thinking, problem-solving, and metacognition, through students' active engagement in the learning process. This indicates that the Meaningful

Learning approach is highly relevant for physics instruction, which requires conceptual understanding and analytical skills.

The high level of engagement among students indicates that the digital module is visually appealing and helps students understand the material more easily. Students stated that the inclusion of images, videos, animations, simulations, and real-life application examples helped them grasp the concepts of two-dimensional motion, which had previously been difficult to visualize. These findings support the view that interactive digital media creates a more engaging, flexible, and contextual learning experience compared to conventional media (Apriyanto et al., 2025; Margareta, 2024).

However, a comprehensive evaluation must also address the weaker aspects identified during the validation and trial phases. For instance, the 'benefits of the module' aspect received the lowest score from media experts (75%), and 'presentation techniques' scored the lowest in the large-group student trial (94.74%). These lower scores correlate with specific user-interface limitations; experts noted that the thumbnail navigation was not fully optimized and lacked a persistent 'home' button, which slightly hindered the module's practicality and ease of access. Furthermore, educators pointed out inconsistencies in the visual nuances of the illustrations and highlighted the need for proper source citations for the media used, including AI-generated images. Pedagogically, the 'Meaningful Learning' aspect scored relatively lower (88.88%) among instructional experts, indicating that certain sections of the module did not optimally activate students' prior knowledge or explicitly bridge their everyday experiences with abstract physics concepts. Acknowledging and refining these specific design and pedagogical constraints will be crucial for improving the module's overall effectiveness in future iterations.

The inclusion of concept maps, learning outcomes, and learning objective sequences in the module also helps students build a conceptual framework before delving deeper into the material. Learning activities are structured in stages, beginning with observing phenomena through videos,

answering guiding questions, conducting simple experiments, analyzing experimental results, drawing conclusions, and completing formative and summative assessments. This systematic presentation of learning not only helps students understand physics concepts but also fosters the development of critical thinking skills through the assessments provided. This aligns with the Meaningful Learning approach, which emphasizes students' active engagement in building deep understanding.

In addition, the digital modules developed have been aligned with the Merdeka Curriculum through the presentation of learning activities that emphasize independence, active engagement, and the strengthening of students' competencies. The use of digital modules also supports the development of 21st-century skills, particularly critical thinking skills. Although the module is primarily designed as a self-paced learning material for independent study, collaborative learning elements such as group discussions, along with the use of simulations, simple experiments, and interactive media, can be seamlessly integrated during classroom implementation, as well as formative assessments designed to train students' critical thinking skills.

Nevertheless, this study still has several limitations, particularly regarding the media presentation and visual design, which need to be refined to ensure greater consistency and appeal. Furthermore, this study has not yet reached the stage of summative evaluation, so the effectiveness of the module on a broader scale cannot yet be fully determined. Therefore, future research could focus on developing more interactive features, such as virtual laboratories or augmented reality, as well as testing the module's effectiveness with a wider range of students.

CONCLUSION

Based on the research findings, it can be concluded that the digital module based on the Meaningful Learning approach to train critical thinking skills in two-dimensional kinematics is highly suitable for use as a self-

paced learning material. The product's high feasibility was demonstrated through evaluations by media, content, and learning experts, obtaining an overall average score of 92.81%. Furthermore, regarding user responses, limited trials conducted with students resulted in a positive response rate of 95.13%, while educator trials obtained a score of 93%, both categorized as very good. In addition, preliminary implementation data indicated a positive trend in students' critical thinking performance shown by the increase in average pretest scores from 57.62 to 74.52 on the posttest, yielding an N-Gain score of 0.43 (moderate category) which serves as supporting evidence of the module's potential rather than a definitive measure of broad instructional effectiveness. Overall, the developed digital module is highly feasible for physics learning to support students' critical thinking skills.

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