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Development of an e-module based on the Self-Organized Learning Environment (SOLE) model assisted by Artificial Intelligence (AI) on kinematics material

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Abstract

This development research aims to develop an e-module based on the Self-Organized Learning Environment (SOLE) model assisted by Artificial Intelligence (AI) on kinematics material. The research and development method uses the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) approach created by Robert and Maribe Brach. This model includes the following stages: 1) Analysis, 2) Design, 3) Development, 4) Implementation, 5) Evaluation. The subjects of this research were students from two schools, and the data collection instruments were questionnaires provided to expert validators and students. The data generated is qualitative and analyzed using assessment criteria guidelines to determine the quality of the product. The results of this research produced teaching materials and determined the quality of the developed product: 86% from material experts (categorized as highly feasible), 95% from media experts (categorized as highly feasible), 87% from educators, and 93% from students in small-scale trials, with 87% in large-scale trials, all categorized as very attractive. Based on these results, it can be concluded that the E-module based on the Self-Organized Learning Environment (SOLE) model assisted by Artificial Intelligence (AI) for kinematics material is highly feasible and attractive for use in high school physics learning for 11th-grade students.

Keywords: artificial intelligence; e-module; kinematics; self-organized learning environment.

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INTRODUCTION

Learning media serve as tools that assist the learning process, helping educators deliver instructional content to students more effectively and efficiently (Latifah et al., 2020). In the learning process, students are indirectly encouraged to be more active by discovering their innovations (Mustari et al., 2019). Technology-based learning media can take the form of systematically arranged teaching materials presented in an electronic format, known as e-modules (Komikesari et al., 2020). An e-module is a digital learning resource or guide. Since it is designed by educators, it can be customized to align with the planned curriculum, allowing control over the content students study. E-modules are

innovative media that can enhance students' interest in learning. These digital modules, which include text, images, or both, contain electronic material and simulations suitable for use in teaching (Herawati & Muhtadi, 2020).

Technological advancements in the 21st century have led people to think more creatively and fully utilize available systems (Haka et al., 2021). One of the technologies currently being widely discussed is artificial intelligence (AI). AI refers to a technology that can think like humans but is operated by machines, not naturally by humans. Examples of AI applications that assist students with tasks include ChatGPT, Canva, Slides Go, Capcut, Grammarly, paraphrasing tools, Google Meet, Zoom, and many more (Arly et al., 2023).

The researchers developed the e-module using the Canva application. Canva offers a shorter learning curve, spell-checking tools, and a variety of design tools such as for presentations, resumes, posters, pamphlets, brochures, and more. It allows users to create visually appealing presentations quickly, which can help improve audience engagement and learning (Howell et al., 2022).

Canva makes it easier for educators to develop learning media and enhances the distance learning process. It is an online graphic design tool that provides fonts, graphics, videos, audio, and photos (https://www.canva.com). Canva provides a blank canvas that allows creators to design the learning process according to their preferences. For those new to designing, Canva also offers pre-made templates, so users do not have to start from scratch (Ilyas et al., 2023).

Canva allows users to insert audio, video, and images, and it can create illustrations of everyday life within videos (Serevina & Hamidah, 2022). Canva has several advantages: 1) A wide variety of attractive design templates, 2) It simplifies the design process by offering ready-made templates that can be customized, such as text, colors, sizes, and images, 3) It is accessible to a wide range of users, available on both Android and iPhone, and can be used on laptops via a web browser without needing to download the application (Mudinillah et al., 2022).

Additionally, the researchers incorporated the Self-Organized Learning Environment (SOLE) model into the e-module using Canva. The SOLE model emphasizes independent learning by utilizing internet-connected media. In a school setting, this model can help educators guide students in understanding the material by leveraging their natural curiosity (Marlina, 2021). The SOLE model encourages students to work and learn to answer questions that stimulate their interest, using the internet as a resource. SOLE-based learning fosters self-discovery, knowledge sharing, and spontaneity (Rosniadi Pratama et al., 2022).

The steps in the SOLE model are 1) Questioning, where the educator poses questions that spark curiosity about the material; 2) Investigation, where students form small groups and search for answers using the internet; and 3) Review, where each group presents their answers (Utami & Utami, 2022).

SOLE-based learning can be an efficient strategy, having a positive impact on teaching. In this study, the development of an e-module using Canva and the SOLE model focuses on 11th-grade high school physics, specifically linear motion kinematics.

Kinematics is the study of the movement of points, objects, and mechanical systems without considering the physical properties or forces involved. Kinematics, often called the geometry of motion, models movement mathematically using algebra. The systems studied in kinematics take into account variables like speed and acceleration. An example of a model used in kinematics is the gears in a vehicle’s transmission (Dwiyanto, 2022).

The researchers conducted a preliminary study in two schools, distributing questionnaires to 11th-grade students. The results showed that 42.3% of students enjoyed physics, while 57.7% were not

interested in learning if they relied solely on textbooks without supplementary media. Consequently, 86.8% of students expressed the need for learning media that could increase their interest in learning. This study has been carried out previosly, however, it differs in its application of augmented reality, the specific subjects covered, and the locationss where the research was conducted. The position of the research against existing reasearch is a study on developing an AI-powered SOLE based AR learning module for rotation dynamiscs revealed that the module was highly feasible and received very positive feedback from students, with average scores of 85,96% and 90,01%, respectively. AI powered SOLE based e-modules for kinematics are vital as they can: 1) make learning more angaging for students. 2) improve learning efficiency. 3) take advantage of teachonolgy to enhance learning experiences. 4) help overcam students disintterest in kinematics.

Based on these findings, the researchers conducted a study titled "Development of an E-Module Based on the Self-Organized Learning Environment (SOLE) Model Assisted by Artificial Intelligence (AI) on Kinematics Material." The objectives of this research are to explore the development, assess the feasibility, and evaluate educator and student responses regarding the attractiveness of the e-module based on the Self-Organized Learning Environment (SOLE) model with AI assistance for kinematics material.To put ini succinctly, the objective of this research is construct a more captivating and efficacios learning resource for kinrmatics, with the ultimate goal of augmenting students learning motivation.

METHODS

In developing the e-module based on the Self-Organized Learning Environment (SOLE) model with the assistance of artificial intelligence, the researchers used the Research and Development (R&D) method following the ADDIE approach (Analysis, Design, Development, Implementation, and Evaluation) as developed by Robert and Maribe Brach (Wang, L. & Chen, 2023). This model consists of five stages: 1) Analysis, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation. The specific steps of the Robert and Maribe Brach model are shown in Figure 1.

The instruments used in this study include non-test instruments such as validation sheets to assess feasibility, which were filled out by material experts, media experts, and educators, as well as students (Mutmainna et al., 2022). Data analysis was carried out using questionnaires with a Likert scale, ranging from 1 (lowest score) to 5 (highest score) (Ariama & Adrin Burhendi, 2022).

The researchers followed the steps of the Robert and Maribe Brach model, which included the implementation phase at two schools, namely SMA Muhammadiyah 2 Bandar Lampung and MA Mathlaul Anwar Gisting. The researchers focused on assessing the feasibility of the product based on evaluations from content experts, media experts, educators, and student feedback, to measure the attractiveness of the e-module. The data was analyzed using the Likert scale.

The researchers collected two types of data:

1. Quantitative data—This includes scores obtained from evaluation questionnaires filled out by validators and student responses.
2. Qualitative data—This refers to descriptive feedback, including suggestions and critiques from validators on the developed product, as well as descriptions of the product trial implementation (Sapbrina et al., 2021). Data was collected using validation sheets from experts, and feedback forms from educators and students, and analyzed using the Likert scale.

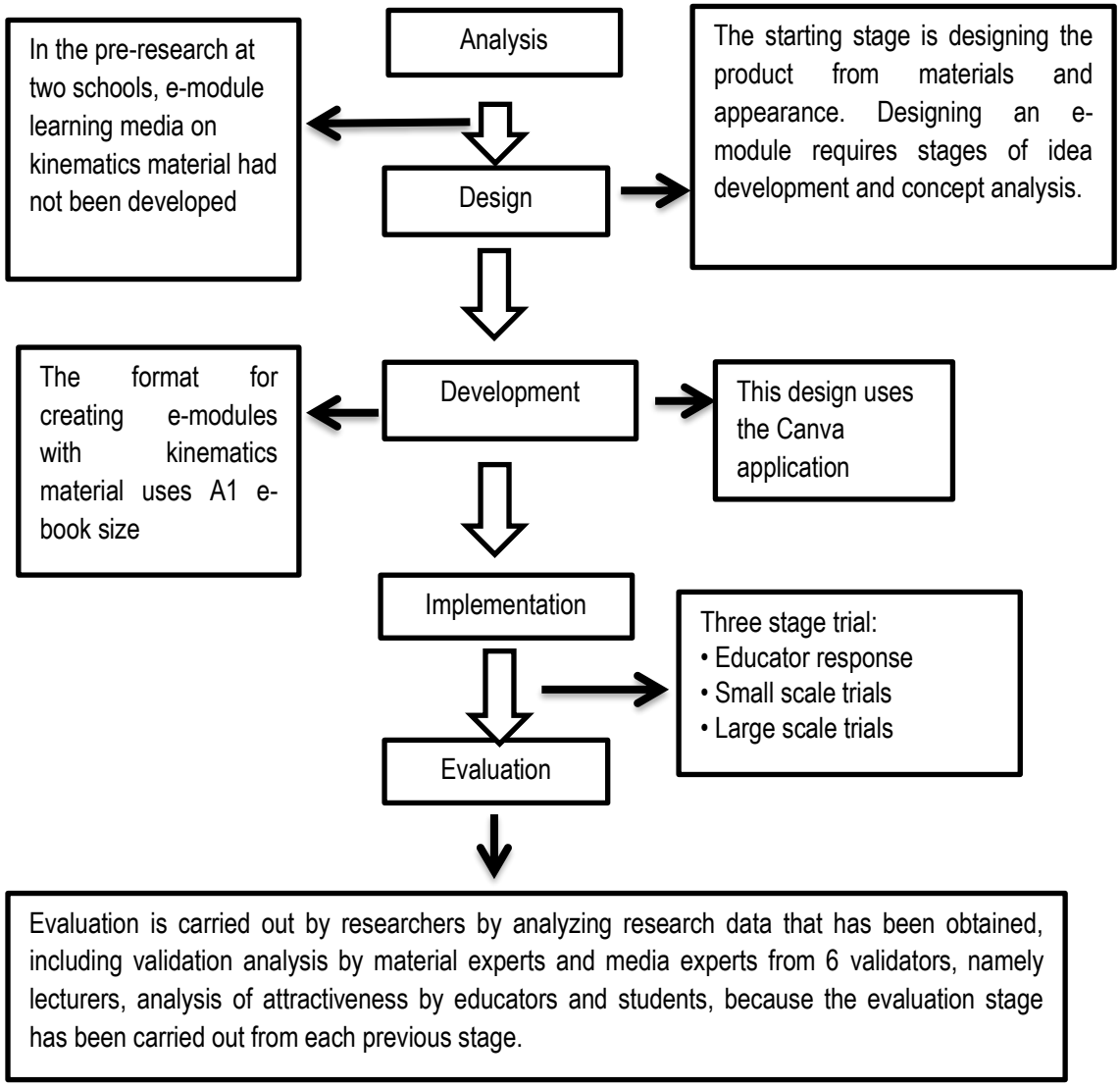


Figure 1. Research Stages According to Robert and Maribe Brach

The results of the questionnaire were analyzed using a Likert scale, with the evaluation criteria shown in the Table 1.

Table 1. Expert Validation Scores

Category	Score
Highly Feasible	5
Feasible	4
Moderately Feasible	3
Less Feasible	2
Not Feasible	1

The scores obtained were converted into percentages to determine the feasibility percentage for each aspect, using the equation (1) (Ruhansih, 2021):

$$X_i = \frac{\Sigma s}{S_{max}} \quad (1)$$

Where Xi is the feasibility score for each aspect, ∑s is the total score, and Smax is the maximum score. The percentage score is then interpreted into qualitative values using the equation (2) (Cahaya et al., 2022):

$$P = \frac{\sum skor}{y \times 100\%} \quad (2)$$

Where P is the percentage score and y is the highest likert score × number of respondents.

Table 2. Feasibility Interpretation Scale

Feasibility Score	Criteria
0 ≤ X ≤ 20%	Very Not Feasible
20% ≤ X ≤ 40%	Not Feasible
40% ≤ X ≤ 60%	Moderately Feasible
60% ≤ X ≤ 80%	Feasible
80% ≤ X ≤ 100%	Highly Feasible

Table 3. Attractiveness Interpretation Scale

Attractiveness Score	Criteria
0 ≤ X ≤ 20%	Very Unattractive
20% ≤ X ≤ 40%	Unattractive
40% ≤ X ≤ 60%	Moderately Attractive
60% ≤ X ≤ 80%	Attractive
80% ≤ X ≤ 100%	Highly Attractive

Based on the feasibility interpretation scale shown in Table 2 and attractiveness interpretation scale shown in Table 3 (Nadori & Hoyi, 2021), the developed e-module meets the requirements for both material and media suitability, as well as educator and student responses for the kinematics material in 11th grade, achieving categories of "good" and "very good."

RESULTS AND DISCUSSION

The research and development of the e-module followed five stages. The first stage, Analysis, involved problem analysis and identifying learning needs. Researchers analyzed the situation to identify the potential and challenges. This stage also helped determine the appropriate material to be used. Data collection methods included questionnaires, school observations, documentation, and interviews with students, resulting in 86.8% of data from two schools.

The second stage was Product Design, which focused on creating an e-module based on the Self-Organized Learning Environment (SOLE) model, assisted by AI. The e-module was designed in A1 size (59.4 cm x 84.1 cm), with a font size of 13 for regular text, 34 for chapter titles, and 40 or 50 for subheadings. Fonts like "Lucky" or other reader-friendly fonts were used to ensure ease of reading, commonly used in e-modules.

E-module based on the SOLE approach have great potential to enhace learning quality. By providing flexibility, independence and more engaging learning experiences, these modules can help learners reach their full potential.

Table 4. Expert's comments on content revisions

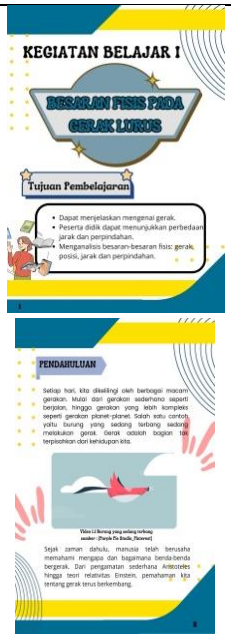
No.	Recommendations for improvement	Before the improvement	After the improvment
1.	Post material SOLE phase in the e-module		
2.	Supplementing the e-module with additional materials		

Table 5. Expert's comments on media revisions

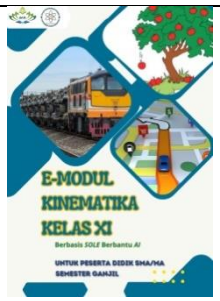
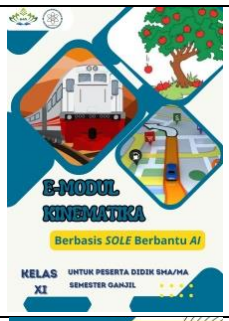
No.	Recommendations for improvement	Before the improvement	After the improvment
1.	Revisions to the train illustration and title color combination for the e-module.		
2.	Attaching a perrsonal video as proof of owwnership.		

Table 6. Final Design of the E-Module

No.	Section Name	Appearance	Information
1.	Initial View		The initial display contains illustrative images related to kinematics material.
2.	Preliminary display		On the next sheet, there is an introduction containing a description of the material, prerequisites for studying the e-module, instructions for using the e-module and the flow of learning objectives.
3.	Concept maps		There is a concept map, helps to identify main ideas, and sub-topics.
4.	Display of learning activities I, II, III		There are three learning activities as shown below: • Learning activity I am about position, distanceand displacement. Activity II speed, speed, and acceleration. Activity III uniform liniear motion and uniformly

No.	Section Name	Appearance	Information
			accelerated linear motion. Equipped with learning objectives.
5.	SOLE and AI stages. The SOLE and AI stages are found in each learning activity I, II, and III.		In the display on the side, there are SOLE stages which include: questions, investigation, and review, and are equipped with Gemini AI. The tool can help teachers check how well their students can analyze texts, spot biases, and solve problems. Gemini AI also gives students personal feedback to help them see what they're good at and what they need to work on. There are quizzes in the e-module and games using Wordwoll as well as learning evaluations made on Google Form.

No.	Section Name	Appearance	Information
6.	Quiz sheet, Evaluation sheet.		There are quizzes in the e-module and games using Wordwoll as well as learning evaluations made on Google Forms.

In the Development stage (third stage), the e-module was developed and then evaluated for content and media feasibility by six expert validators, all of whom were lecturers. At this stage, the expert provides notes on improvements as suggestions for improving the product being developed, as presented in Table 4 and Table 5, with the results of improvements based on the expert's notes presented in Table 6. Moreover, Table 7 present the scores from material expert validation results and Table 8 for media expert validation results.

Table 7. Material Expert Validation Results

Validator	Score Percentage	Criteria
Material Expert I	84%	Highly Feasible
Material Expert II	90%	Highly Feasible
Material Expert III	84%	Highly Feasible
Average	**86%**	**Highly Feasible**

Table 8. Media Expert Validation Results

Validator	Score Percentage	Criteria
Media Expert I	97%	Highly Feasible
Media Expert II	96%	Highly Feasible
Media Expert III	90%	Highly Feasible
Average	**95%**	**Highly Feasible**

The fourth stage, Implementation, involved applying the SOLE-based AI-assisted e-module in learning sessions. The trials included three phases: educator response, small-scale trials, and large-scale trials. These trials involved 11th-grade students from SMA Muhammadiyah 2 Bandar Lampung and MA Mathlaul Anwar Gisting, Tanggamus. The results showed that the e-module was highly attractive, with an average score of 87% from educators and 93% from students in the small-scale trials, while the large-scale trials resulted in an 87% score. The results are shown in Table 9.

Table 9. Educator Responses

Respondent	Score Percentage	Criteria
Educator 1	92%	Very Attractive
Educator 2	84%	Very Attractive
Educator 3	84%	Very Attractive
Average	**87%**	**Very Attractive**

Small-scale trials were conducted with 10 students, as shown in the Table 10.

Table 10. Small-Scale Trial Results

Assessment Aspect	Percentage	Criteria
Display/Content Appeal	94%	Very Attractive
Presentation	91%	Very Attractive
Language	92%	Very Attractive
Graphics	97%	Very Attractive

The large-scale trial involved 59 students from two schools, SMA Muhammadiyah 2 Bandar Lampung and MA Mathlaul Anwar, Tanggamus, as presented in Table 11.

Table 11. Large-Scale Trial Results

Assessment Aspect	Percentage	Criteria
Display/Content Appeal	86%	Very Attractive
Presentation	86%	Very Attractive
Language	86%	Very Attractive
Graphics	88%	Very Attractive

The fifth and final stage was Evaluation. The researchers evaluated the collected data, including expert validation from six lecturers for both material and media, as well as educator and student feedback on the e-module's attractiveness. Since evaluation was conducted at each stage, the final results indicated that the SOLE-based AI-assisted e-module was deemed highly feasible and highly attractive for use in 11th-grade physics lessons.

Based on the collected data, the developed SOLE-based e-module can be considered effective. This conclusion aligns with Fiqrillah et al. (2022), who stated that a product is considered effective if it achieves the learning objectives, as shown by student learning outcomes. Similar studies conducted by Arsal et al. (2019), Fiqrillah et al. (2022), Adilah et al. (2022), and Ummah et al. (2020) also support the conclusion that e-modules are feasible and help students engage in active learning, enhancing understanding and improving learning outcomes.

CONCLUSION

The e-module designed for learning based on the Self-Organized Learning Environment (SOLE) model, with the assistance of Artificial Intelligence (AI), has been successfully developed for the topic of linear motion kinematics using the Borg and Gall model, which encompasses the stages of analysis, design, development, implementation, and evaluation. The e-module underwent validation by content

and media experts, achieving an average feasibility score of 86% from material experts and 95% from media experts, indicating that it meets the required standards for use.

Additionally, product trials were conducted three times with educators and included both small-scale and large-scale trials involving students, yielding scores of 87%, 93%, and 87%. These results demonstrate that the e-module is highly feasible and engaging, making it an excellent resource for the learning process.

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