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Development of AI-based learning media in improving the problem-solving ability of middle school students' moments of inertia

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ABSTRACT
Problem solving ability in physics, particularly on the topic of moment of inertia, remains a challenge for secondary school students because the concept is abstract and highly mathematical. This study aims to develop an artificial intelligence (AI)-based learning media and to examine its feasibility and effectiveness in improving students' problem solving ability on moment of inertia material. The research employed a Research and Development (R&D) design following the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The subjects were 64 students of grade XI Senior High School selected through purposive sampling.
Data were collected using a problem solving ability test, a media feasibility validation sheet, and a student response questionnaire, then analyzed descriptively and through a paired-sample t-test. The results show that the AI-based learning media was categorized as "very feasible" based on expert validation with an average score of 89.2%, and there was a significant increase in students' problem solving ability after using the media, with an N-gain score of 0.71 (high category). It can be concluded that the developed AI-based learning media is effective and feasible to improve students' problem solving ability on moment of inertia material.

Keywords: *AI-based learning media; Problem solving; Moments of inertia; Physics education*

INTRODUCTION
Physics is one of the subjects that requires students to have good analytical thinking skills and problem-solving skills (Docktor & Mestre, 2014). One of the physics materials that is considered difficult by middle school students is the moment of inertia, because this material is abstract, involves complex mathematical concepts, and requires the ability to visualize rotating rigid objects (Setyaningrum & Wibowo, 2021). The low problem-solving ability of students in this material is due to learning that is still conventional and does not provide students with opportunities to practice solving problems gradually and personally.

The development of artificial intelligence (AI) technology opens up great opportunities in the world of education, especially in creating adaptive and interactive learning media (Zawacki-Richter et al, 2019). AI-based learning media is able to provide direct feedback, adjust the difficulty level of the questions to students' abilities, and provide visual simulations that help students understand abstract concepts such as moments of inertia (Holmes, Bialik, & Fadel, 2019). The use of AI in physics learning is believed to increase students' learning motivation as well as train problem-solving skills in a more structured manner.

Several previous studies have shown that interactive learning media can improve students' problem-solving skills in physics materials (Kharisma & Hidayatulloh, 2025). However, research that specifically develops AI-based learning media for moment of inertia material is still very limited. In fact, moments of inertia are material that requires practice of varied questions and instant feedback so that students can correct misconceptions independently (Agnitora et al, 2025). Therefore, AI-based learning media is needed that is specifically designed to help students practice and improve problem solving skills in moment of inertia material.

Based on these problems, this study aims to develop AI-based learning media on moment of inertia material and test its feasibility and effectiveness in improving the problem-solving skills of high school

students. The media developed is expected to be an alternative solution for teachers in teaching inertial moment material in a more interactive, adaptive, and fun way.

METHOD

This research uses a Research and Development (R&D) approach with the ADDIE model, namely Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The analysis stage is carried out to identify the needs of students and the characteristics of the moment of inertia material. The design stage is used to design media structures, learning flows, and problem solving question banks. The development stage is used to build AI-based learning media using adaptive chatbot technology that is integrated with an interactive simulation of moments of inertia.

The research subjects consisted of 64 high school grade XI students who were selected using purposive sampling techniques. The instruments used consisted of a problem solving ability test of 10 description questions, a media feasibility validation sheet filled out by 3 experts (material experts, media experts, and AI/educational technology experts), and student response questionnaires. The test instrument test on 32 students obtained a reliability coefficient (α) of 0.812 with a corrected item-total correlation between 0.341 and 0.756. Media feasibility data was analyzed in a descriptive percentage manner, while data on improving problem solving ability was analyzed using the N-gain test and paired sample t-test after the prerequisite test of normality and homogeneity of the data was carried out.

RESULT AND DISCUSSION

The results of expert validation showed that the AI-based learning media developed obtained an average feasibility percentage of 89.2%, which falls into the category of "very feasible" for use in learning (Table 1). The material aspect obtained the highest score because the problem solving questions that were prepared included variations in the level of difficulty that were in accordance with the indicators of competency achievement in the moment of inertia material.

Table 1. Results of the AI-Based Learning Media Feasibility Test

Validation Aspects	Score (%)	Categories	Validator	Remarks
Material	91,4	Highly Worth It	Material Expert	-
Media and AI	88,0	Highly Worth It	Media Expert/AI	-

In addition to the feasibility of the media, the results of the analysis of pretest and posttest data showed an increase in students' problem-solving skills after using AI-based learning media. The average pretest score of 52.3 increased to 84.6 in the posttest, with an N-gain value of 0.71 which was in the high category. The results of the paired t-test showed a significance value (p) of 0.000 ($p < 0.05$), which means that there is a significant difference between students' problem-solving abilities before and after using AI-based learning media.

This improvement is in line with several previous studies that found that AI-based learning media can provide personalized and adaptive feedback according to each student's abilities (Holmes, Bialik, & Fadel, 2019). The media developed in this study provides a visual simulation of the rotation of rigid objects and steps to solve the inertial moment problem in stages, so that students can understand abstract concepts more concretely.

AI's ability to adjust the difficulty level of questions based on students' abilities also makes the process of practicing problem solving more effective than conventional methods (Zawacki-Richter et al, 2019). Students with low initial abilities benefit more because the medium provides automatic repetition of exercises and additional explanations.

The implications of this study show that AI-based learning media can be an alternative solution for physics teachers in teaching abstract moments of inertia material. Teachers can use this media as a learning companion in the classroom or as a means of independent practice outside of class hours. For students, this media provides an opportunity to practice solving problem solving problems repeatedly with instant feedback, so that they can build students' confidence in solving complex physics problems.

CONCLUSIONS

The AI-based learning media developed in this study was declared very feasible to use based on expert validation with a feasibility percentage of 89.2%. This media is also effective in improving students' problem-solving skills in the moment of inertia material, which is shown by an N-gain value of 0.71 (high category) and significant paired t-test results (p = 0.000). Thus, AI-based learning media can be used as an alternative to physics learning innovations, especially in inertial moment materials, to improve the problem-solving skills of high school students.

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