Development of Physics Interactive Learning Media based on Problem Based Learning assisted by SAC Application to Improve Student Problem Solving Ability

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Abstract: This study aims to see the feasibility and effectiveness of interactive learning media based on problem-based learning to improve problem solving skills. This type of research is research and development with ADDIE model and one group pretest-posttest design. The results showed that the physics interactive learning media was very feasible to use based on the results of the assessment from the validator with a value of 0.92. The increase in problem solving ability can be seen from the highest average pretest score of 46, in the posttest it rose to 82. It can also be seen from the results of the paired sample T-test test that the significance value <0.05 is inaccordance with the test criteria if Sig. (2-tailed) is smaller than 0.05, it means that there is a significant difference berween the result of the pretest and posttest score. The result of the paired sample T-test test are reinforced by the N-Gain test, which is 0.66, these result can be explained that N-Gain category is in the moderate category with $0.3 \leq 0.66 \leq 0.7$. It can be said that interactive learning media is effective in improving student problem solving skills and the average improvement result are in the moderate category.

Keywords: Learning media; Problem based learning; Problem solving skills

Introduction

In the modern era as it is today, technological development is progressing very rapidly and plays a very important role for the progress of the nation. One of the important roles of technology is in the field of education (Bhakti et al., 2019). In the field of education, technological developments cannot be avoided, teachers are required to be able to adapt learning activities to technological improvements (Aisyah et al., 2018). One of the utilization of technology in the field of education is learning media, which can be used as a means to convey material more interestingly (Pikri, 2022). Technology must be fully utilized and used because it is in line with the development of the 4.0 revolution era (Thahir et al., 2019). Learning media is one of the solutions to improve the quality of learning and student interest in learning materials.

Learning media has an important role in the learning process in the classroom. Through technological developments, learning media is also increasingly innovative, which will make the learning process more interesting (Guswan, 2020). Learning media can be used to convey messages or lesson content, stimulate students' attention and abilities (Usman et al., 2020). The use of learning media can improve learning outcomes (Darsih et al., 2021), proof ability (Tristanti et al., 2022), and problem solving ability (Mahuda et al., 2021). Therefore, learning media can be a solution to improve the quality of learning.

The development of learning media can also be made with various kinds of assistance applications, one of the applications used is smart apps creator (SAC). SAC-based learning media can be used to assist teachers in delivering learning materials (Nofitasari et al., 2021). The results of SAC can be exe, apk, or HTML5 (Azizah

et al., 2020). SAC is used to create interesting interactive learning media, and can be used based on android (Mudinillah, 2021). There have also been many development studies on SAC-assisted learning media, including (Afriana, 2021; Mahuda et al., 2021). So, smart apps creator can be one of the platforms for developing good learning media.

Good utilization of learning media is expected to improve physics learning abilities in the classroom. One of the abilities needed in physics learning is problem solving ability (Parno et al., 2021). The aspects of problem solving ability are identifying problems, diagnosing problems, formulating alternative strategies, determining strategies, and evaluating strategies (Aisyah et al., 2018). Problem solving skills must be possessed by students in order to help get maximum learning outcomes (Wulandari, 2021). The concepts that students receive must be truly understood by students so that these concepts can be used in solving physics problems. However, in fact, problem solving skills are still in the moderate category (Winingsih et al., 2023), Problem solving skills are important in the learning process and can be supported by the right learning model.

One of the learning models that teachers can use to manage classes to run effectively is the problem-based learning (PBL) model. The PBL model can also be integrated with learning media (Sari et al., 2021) and can improve problem solving skills (Putri et al., 2020). This learning model can be used by teachers to make students think critically in solving existing problems (Pramana et al., 2020). The use of PBL-based learning media in the learning process can also help teachers in providing real problems in the classroom.

Based on the observation, it was found that the learning model that is very often used is a conventional learning model, rarely using a variety of models. Another problem found in the classroom is that teachers do not involve students to actively participate in the learning process. So that students become very passive and are not accustomed to solving problems both authentically and academically. Also reinforced by the results of research from Aristiawan (2022) still shows that problem solving skills are still in the medium category. Meanwhile, problem solving ability is one of the most important things that must be possessed by students, because it will affect the learning outcomes of students.

Some studies suggest that the use of learning media has many advantages. Learning media has a positive impact on students' learning activities such as material demonstration, motivation, tutorials and time effectiveness (Agustini et al., 2020). In this research, interactive learning media is designed using smart apps creator, with home features, before button, after button, and learning menu. Several reasons why the media chosen in the form of interactive learning media, namely to overcome the difficulty of students solving complex physics problems and students will be more active in learning activities. Therefore, this study aims to see the feasibility and effectiveness of using interactive learning media based on problem-based learning physics to improve problem solving skills.

Method

This research is a development research with ADDIE model. This model is divided into five stages, namely analyze, design, develop, implement and evaluate (Smith, 1999). This research was conducted from March to May 2023 at SMA Negeri 1 Depok Yogyakarta. The development procedure in this study starts from the analyze stage, this stage aims to determine and define the needs in the learning process. At this stage, interviews were conducted with physics teachers. Furthermore, the design stage (planning), at this stage what is done is to compile an outline of media design and learning content in the media which includes presentation of material, as well as visualization. Interactive learning media is also designed based on problem-based learning.

The development stage contains realization activities from the design stage, starting based on the grids that have been prepared, and designed using the Smart Apps Creator application with the final result in the form of an application. In the development stage, content validation is also carried out to measure the feasibility of the product, after which the first revision is made from the results of the validator's input. After the next development stage there is an implement stage, at this stage trials are carried out to determine the effectiveness of the media that has been developed. The last stage is evaluate, in this stage what is done is an evaluation by the supervisor, and validators after being tested.

The subjects in this study were students of class XI MIPA 2 with a total of 35 students. Learning was carried out using interactive learning media based on problem-based learning. The instruments used in this research are problem solving ability test and lesson plan. The problem solving ability test instrument consists of 5 esay questions. The data obtained in this study are qualitative and quantitative. Qualitative data is obtained from the results of interviews, observations, suggestions and comments of validators, while quantitative data is obtained from the results of learning media validation, validation of learning instruments, and pretest and posttest scores of students. The data that has been obtained is then analyzed to answer the research objectives to be achieved.

The feasibility analysis of instruments in the form of learning media, test questions, and lesson plans was carried out using the Aiken V test. The validation or feasibility is reviewed based on the assessment score obtained from the validator. The equation for calculating the feasibility of the instrument can be seen in Equation 1.

$$V = \frac{\sum s}{N(c-1)} \quad (1)$$

With, $\sum s = r - 1$; r: the value given by the validator; 1: the lowest validity assesment number; c; the highest validity assesment number; n: the number of assessors. The value of V Aiken's calculation of an item can be categorized based on the score range. The V Aiken category can be seen in Table 1.

Table 1. Aiken's V Categories (Aiken, 1985)

Score Range	Quality Category
$0.2 < V \leq 0.4$	Less Feasible
$0.4 < V \leq 0.6$	Decent Enough
$0.6 < V \leq 0.8$	Worth
$0.8 < V \leq 1$	Very Feasible

The data analysis technique used in this research is to use descriptive quantitative using the Paired Sample T-Test test to see the difference in pretest and posttest scores, the data is tested using SPSS 25. Data analysis to determine the improvement of problem solving skills using the N-gain test. The formula of the N-gain test can be seen in Equation 2.

$$< g \geq = \frac{S post - S pre}{S maxs - S pre} \quad (2)$$

With, g: *N-gain*; S_{post}: *post-test score*; S_{pre}: *pre-test score*; S_{maks}: maximum score of the question. The results of the n-gain calculation are then categorized into the criteria in Table 2.

Table 2. N-gain Assessment Criteria (Hake, 1999)

Value	Criteria
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Medium
$g < 0.3$	Low

Result and Discussion

Analyze Stage

At this stage, a field study was carried out with class observations and interviews with physics teachers in class XI at SMA Negeri 1 Depok Yogyakarta. The results of classroom observations are that students still have difficulty understanding the material, there are also students who are sleepy and look bored. This is because the teacher still uses the lecture model, less interaction with students. On the other hand, there is a lack of teaching materials other than school books that support and teachers still do not connect learning with daily life events. The results of interviews with teachers are that teachers have never developed interactive learning media before. Teachers only rely on what is in the book, and teachers also only occasionally use learning videos on YouTube as a learning resource.

During learning, teachers also rarely pay attention to students' problem solving skills, teachers only see the final results of learning. Based on the results of interviews and observations, it is concluded that learning media is needed that can help teachers deliver material more interestingly. Therefore, this research produces a product in the form of interactive learning media to improve students' problem solving skills.
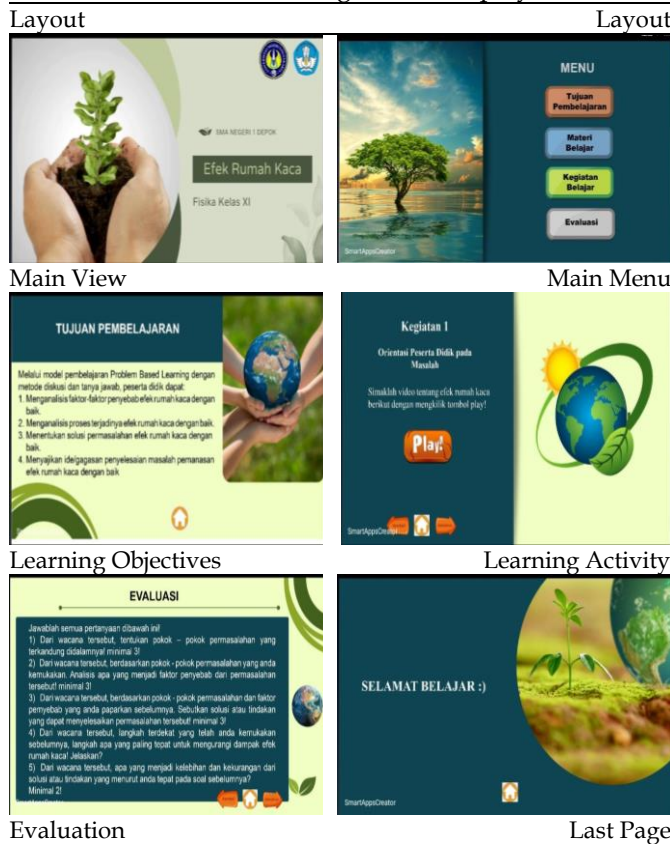
Design Stage

At this stage, what is done is to compile an outline of interactive learning media in the form of designing learning content in problem-based learning-based media. The interactive learning media created contains components, namely, the main display, main menu, learning objectives, learning activities, evaluation, and closing display. The material included in the learning media is global warming material, problem-based learning syntax is included in learning activities. So, the interactive learning media created is based on problem-based leaning. Interactive learning media is designed using smart apps creator.
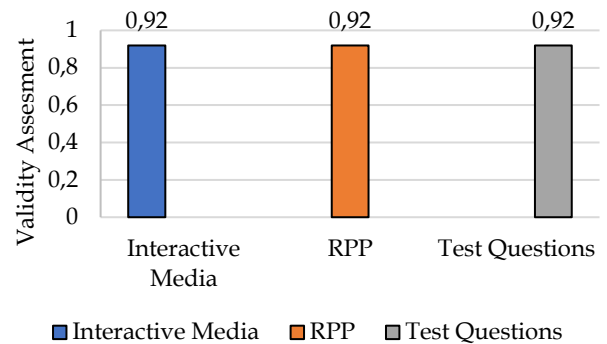
Development Stage

At this stage, the realization of the design stage is carried out based on the grids that have been made, which then produces interactive learning media in the form of applications. As for some displays of interactive learning media that have been developed can be seen in Table 3. In the development stage, validation is also carried out to see the feasibility of the media products that have been made. The validation process of interactive learning media is carried out with the aim of seeing the feasibility of the media based on the validator's assessment. The results of the validator's assessment of whether or not the product is feasible are presented in Figure 1.

The results of the learning media assessment get some input and suggestions which are then revised before being used in learning. In applying learning media during learning, it must use appropriate instruments as well. The results of the feasibility assessment of the instruments used in learning starting from the lesson plan, and the problem solving ability test questions can be seen in Figure 1.

Table 3. Interactive Learning Media Display

Layout	Layout
Main View	Main Menu
Learning Objectives	Learning Activity
Evaluation	Last Page

Table 3 shows the results of the interactive learning media that has been developed using the smart apps creator application. The media is run by installing the application first, after which the existing menu can be clicked to go to the desired page. The main display contains the uny logo, kemdikbud logo, material title, school and class name. The main menu contains menu pages contained in the media, starting from learning objectives, learning materials, problem-based learning activities, and evaluation questions. The learning objectives page contains learning objectives to be achieved during learning. Learning activities 1 contains learning activities that will be carried out, these learning activities are problem-based learning, and there is a play feature that will directly direct to learning videos on YouTube. Evaluation contains questions that students will do after learning. The closing page contains a home feature which if clicked will direct to the main menu. After that, the learning media that has been made is saved in the form of an application file that can be installed on an android cellphone.

Figure 1 show the results of the validity assessment with the V Aiken category being very feasible. This is categorized as very feasible because the validity results get a V Aiken value of 0.92, which is included in the very feasible category. The V Aiken value of 0.92 is in the range of values between $0.8 < V \leq 1$, so the interactive

learning media developed is very feasible to use for further testing to students. As for some validator suggestions, namely to relate media content to daily life, add problems and add evaluation questions. The results of the validity of the instruments that will be used in learning also get a V Aiken value for the lesson plan which is 0.92 and the problem solving ability test question is 0.92. The V Aiken value of 0.92 is in the range of values between $0.8 < V \leq 1$, so the lesson plans and test questions that have been made in the category are very feasible and can be used in learning.

Figure 1. Results of feasibility of learning media and instruments

Implement

Stage In the implementation stage, interactive learning media was tested on students of class XI MIPA 2 at SMA Negeri 1 Depok to see the effectiveness of interactive learning media in improving problem solving skills. Interactive learning media application files are shared with students to be downloaded and installed on each student's smartphone. Before the implementation, a pretest was conducted first, and after the implementation, a posttest was conducted. This is done to measure the effectiveness of improving student's problem solving skills before and after learning using interactive learning media on global warming material.

Problem solving ability test questions consist of 5 esay questions. Data on the test results of students' problem solving skills on global warming material using interactive learning media can be seen in Table 4. The results of the validity of the problem-solving ability test are with an average V Aiken with a value of 0.92, this value is included in the criteria for very high validity and is feasible to use.

Table 4. Results of Pretest and Posttest Test of Problem Solving Ability

Class	Ability	Total Data	Highest Score	Lowest Score	Average
XI MIPA 2	Pretest	35	67	20	46
	Posttest	35	100	67	82

Table 4 shows the results of the problem-solving ability test obtained by students before and after learning using interactive learning media based on problem-based learning in class XI MIPA 2. From the results of the test scores, it can be explained that the lowest pretest score is 20 and the highest score is 67, while the lowest posttest score is 67 and the highest score is 100. The average pretest score is 46 and the average posttest score is 82, it can be explained that there is an increase, this is in line with the results of research from Harahap et al. (2021) which obtained the results of the study that students' problem solving skills also increased by increasing from an average of 51.6 to 81.6 as well as the number of positive activities that occurred after the implementation of learning. The results of the average pretest and posttest scores can be seen in Figure 2.
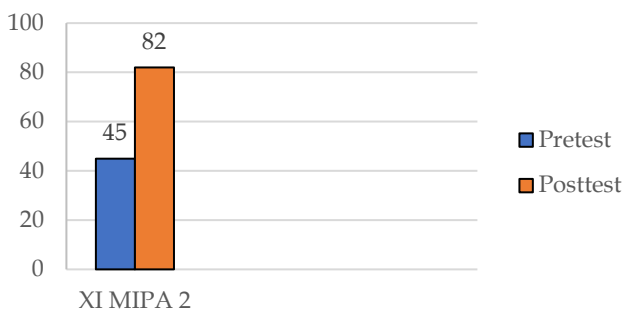

Figure 2. Average score of problem solving ability test for students

Based on Figure 2, it can be explained that the results of the average value of the problem solving ability test of students in class XI MIPA before and after learning appear to increase. It can be seen from the average value of the pretest which is 46, it explains that the problem solving ability of students at first is still low. While the average value of the posttest is 82, this explains that the problem solving ability of students has increased. It can be seen that the average value of the pretest which was originally 46 rose to 82 during the posttest. This explains that interactive learning media based on problem-based learning can improve students' problem solving skills. In addition, the results of the pretest and posttest improvement were also analyzed using the paired sample T-test. The results of the paired sample T-test can be seen in Table 5.

Table 5. Paired Sample T-Test Results

	t	df	Sig. (2-tailed)
Pretest - Posttest	-16.903	34	.000

Based on the results of the paired sample T-test it can be explained that the results show a significance value <0.05, this is in accordance with the test criteria if Sig. (2-tailed) is smaller than 0.05, it means that there is

a significant difference between the results of the pretest and posttest scores. From these results it can be explained that interactive learning media based on problem-based lerning makes a significant difference to the improvement of students' problem solving skills. The results of the paired sample T-test are reinforced by the N-Gain test. The results of the N-Gain test can be seen in Table 6.

Table 6. N-Gain Test Results

N gain_score	35	.18	1.00	.6604	.17500
N gain_Persen	35	18.18	100.00	66.0443	17.50034
Valid N (listwise)	35				

Table 6 shows the results of the N-Gain test on getting a result of 0.66. These results can be explained that the N-Gain category is in the moderate category with $0.3 \leq 0.66 \leq 0.7$. So, the increase in student's problem solving skills on average falls into the moderate category. After knowing that interactive learning media based on problem-based learning can improveBased on the results of research, data analysis, and discussion, it can be concluded that the use of interactive student's problem solving ability, after that it will also be seen the problem solving ability of student's in each aspect. The results of the improvement of each aspect can be seen in Figure 3.
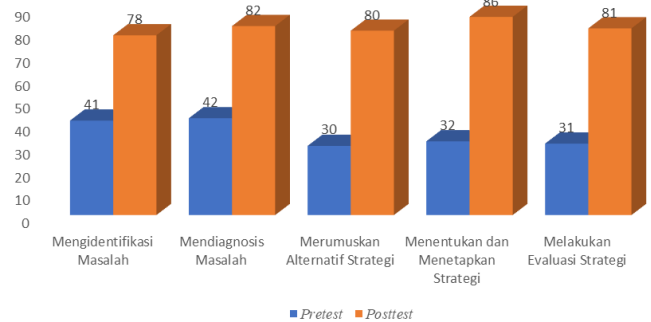

Figure 3. Improvement of problem solving ability based on aspects

Based on Figure 3, it can be seen the results of improving students' problem solving skills in each aspect. From the results of the data in general, it can be seen that all aspects have increased, starting from the aspects of identifying problems, diagnosing problems, formulating alternative strategies, determining and determining strategies, and evaluating strategies. In general, it can also be explained that from the initial low problem solving ability of students, after learning using interactive learning media based on problem-based learning, students' problem solving ability increases.

From Figure 3 the aspect that has the lowest pretest results is the aspect of formulating alternative strategies

with a score of 30, this is because students still have difficulty formulating problem solving from the test. But after learning the posttest results are 80, it can be explained that the score after learning has increased. While in the aspect of determining and applying strategies has the highest average score, which is 86. It can be seen that interactive learning media based on problem-based learning can improve aspects of problem solving skills that were initially low to high.

Evaluate Stage

Based on the results of the data analysis of the validator's assessment, the final decision is that the learning media product that has been developed is in the category of very feasible to use with revisions according to the validator's suggestions and comments. These results are in line with research from Mahuda et al. (2021) with the results of research that android-based learning media assisted by SAC are in the category of very valid and suitable for use. The results of the analysis of the average posttest score, paired sample T-tests, and supported by the N-Gain test and improvement data on each aspect, show an increase in the problem solving ability of students of physics interactive learning media based on problem-based learning assisted by the SAC application. This is in line with the results of research from Fatma et al. (2019) with the research results that android-based learning media can optimize the improvement of problem solving skills. Based on this, interactive physics learning media based on problem-based learning is effective in improving students' problem solving skills.

The advantages of learning media using SAC are that it is easy to access via cellphone or laptop, attractive appearance, does not require special skills to create media. This is in line with the results of research from Azizah et al. (2020) that SAC is easy to use in learning activities both independently and in groups. Meanwhile, the disadvantages of SAC-based media are that it requires clear images, writings, and videos, and there is a time limit for use. This is in line with research from Mahuda et al. (2021) that the use of media is only free for 30 days, so after that you have to pay or reinstall. In the preliminary activities carried out by researchers, they have been able to direct and prepare students well to take part in learning, starting from greeting, praying, taking attendance, motivating, apperception and directing students to learn. Learners also follow the researcher's directions well when dividing groups and when installing learning media applications.

Conclusion

Based on the results of research, data analysis, and discussion, it can be concluded that the use of interactive

physics learning media based on problem-based learning assisted by SAC is in the category of very feasible and can improve students' physics problem solving skills. This can be seen from the results of media product validation with a V Aiken validity assessment score of 0.92. The results of the average pretest score are 46, while the average posttest score is 82, this explains that the problem solving ability of students has increased. The improvement in students' problem solving skills can also be seen from the results of the paired sample T-test, it can be explained that the results show a significance value <0.05, this is in accordance with the criteria if Sig. (2-tailed) is smaller than 0.00, it means thet there is asignificant difference between the result of the pretest and posttest scores. The result of the paired sampel T-test are reinforced by the N-gain test, which is 0.66, these result can be explained that the N-gaim category is in the moderate category with $0.3 \leq 0.66 \leq 0.7$. So, interactive learning media is affective in improving student problem solving skills and the average increase is in the moderate category. Suggestions for further research are to be able to make interactive learning media based on problem-based learning on other physics materials. This study also only looks at the problem solving ability of students, and the improvement of problem solving ability is still in the medium category, it is hoped that future researchers will pay attention to other aspects such as affective and psychomotor aspects.

Author Contributions
The first author, Anggriani Aristaria contributed to research design, instrument preparation, research implementation, data collection and analysis, and article writing. The second author, Insih Wilujeng guided throughout the research process. The third author, Nadya Intan Herawati contributed to was also research design, and writing the article.

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