Effectiveness of Using the Mobile Learning App for STEM-Based High School Physics Materials as Indonesian Student Learning Resources on Learning Outcomes

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Effectiveness of Using the Mobile Learning App for STEM-Based High School Physics Materials as Indonesian Student Learning Resources on Learning Outcomes

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Abstract: This study aims to determine the effectiveness of using the STEM-Based Physics Mobile Learning App as a learning resource for students in Indonesia on learning outcomes. The method used in this research is the experimental method. To describe the experimental results, statistical analysis techniques were used, namely the N-Gain technique. The research was conducted at SMAN 1, Air Sugihan, Ogan Komering Ilir Regency. The analysis of the data reveals that the improvement in learning outcomes in the experimental class compared to the control class is evidence of the usage of STEM-based high school physics learning applications as a learning resource for teachers and students. The experimental class's average post-test score was 81.1, while the control class' average post-test score was 72.22.

Keywords: App Mobile; Outcomes; Physics Learning; STEM

Introduction

In the current era of globalization, mastery of science and technology is a significant indicator in accelerating the growth/development of a nation (Dharma, 2010). Based on this, the role of science, mathematics, and technology in the future is very important, so to a certain extent, science, mathematics, and technology should be mastered by every individual.

Physics learning that is in accordance with students' abilities and supports students' creative abilities is learning that trains 21st century life skills (Cahyani et al., 2020). This is consistent with STEM (Science, Technology, Engineering, and Mathematics) integrated learning, where the subject matter taught is connected to the fields of science, technology, engineering, and mathematics (Davidi et al., 2021).

Education in the STEM fields, which include science, technology, engineering, and math, is described as education to raise students' interest in and comprehension of scientific technology and to create STEM literacy based on scientific technology and the ability to address real-world problems (Almuharomah et al., 2019). This is supported by research done by Dewi et al. (2018) that looked at how teaching physics using the STEM approach could help students become better at solving problems related to dynamic electricity. The findings indicated that teaching physics using the STEM approach could help students become better at solving problems related to dynamic electricity.

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As with learning generally, there are a number of steps that need to be completed for STEM learning, including: (1) posing questions and defining problems; (2) creating and using models and creating plans for conducting investigations; (3) analyzing and interpreting material using mathematics and technology; (4) developing explanations that lead to solutions and evidence-based arguments; and (5) concluding, evaluating, and communicating (Kelley & Knowles, 2016). In supporting this, a STEM-based physics learning resource and media are needed as a source of student learning. However, the results of the author's monitoring in the field do not yet have teaching materials based on the STEM-based Physics Mobile App.

Based on the description above, it is deemed important to show how far the effectiveness of mobile apps for STEM-based high school physics materials that have been developed previously as a learning resource for Indonesian teachers and students has affected student learning outcomes.

Method

In this study, the authors used a descriptive-comparative research method, namely: quasi-experimental research (Sugiyono, 2019). Research that approaches a real experiment where it is not possible to control or manipulate all the relevant variables. There must be a compromise that determines internal and external validity according to existing limitations (Nazir, 2009). The "Pretest-Posttest Control Group Design" was the methodology used in this study (Sugiyono, 2019).

Table 1. Pretest-Posttest Control Group Design

Class	Pre-test	Treatment	Post-test
E	X_1	T_1	Y_1
K	X_2	T_2	Y_2

Explanation:
E : Experiment class
K : Control class
X1 : Experiment group pretest
X2 : Control group pretest
T1 : Learning using Rumah Fisika mobile app
T_2 : Learning without using Rumah Fisika mobile app
Y_1 : Experiment group posttest
Y_2 : Control group posttest

The population in this study was all 36 students in class X at Senior High School (SMAN) 1 Air Sugihan, Ogan Komering Ilir Regency, with 15 boys and 21 girls. Simple random sampling, a method for selecting samples from a population at random without taking into account the population's stratification, was employed as the sampling methodology (Sugiyono, 2019). Students from class X Mathematics and Science (MIPA) 3 as the experimental class and class X MIPA 4 as the control class were selected at random for this study. When a method is used in the research, the research instrument is a tool (Arikunto, 2010). The instruments used are tests and questionnaires.

Processing the test data begins with the normality test first. If one of the processed data sets is not normally distributed, a non-parametric statistical test is immediately used. But if the two sets of data are normally distributed, then a homogeneity test is carried out and a two-mean similarity test is carried out. To find out the increase in student learning outcomes, calculations are carried out using N-Gain. The questionnaire test was carried out by manual counting using the provisions used to calculate the questionnaire.

In this study, testing was carried out on the use of a mobile learning app for learning resources, namely *Rumah Fisika*, which consisted of three steps of learning activities: (1) material preparation, (2) material delivery, and (3) tests. In this material preparation activity, a mobile learning app that will be used by students is first prepared. Ensure that all students have been able to download the mobile learning app and have also been able to install it on each student's Android. As a result, the learning process can be carried out more effectively and to the greatest extent possible.

After the material preparation process is complete, proceed with the material delivery process. It should be noted that at this stage, the material preparation process must be carefully prepared because if a tool is forgotten, it will have a big effect on the learning process. When the teaching and learning process takes place, the teacher must explain the material to be delivered by demonstrating the tools used. This can be assisted by the visualization of images from the projector so that students gain a better understanding because they get a direct picture of the material being explained. After all of the material has been explained, the teacher asks the students questions to see if there are any parts that they did not understand. If there is a part that is not understood, the teacher explains it again.

To monitor student learning outcomes, a question-and-answer session is conducted. This is done to determine students' understanding of the material that has been explained. Students are given several questions about the material that has been explained, and to find out whether students understand or not, the teacher asks students to explain in front of the class with tools.

Result and Discussion

This study was carried out at SMAN 1 Air Sugihan, and data were collected from two classes, class X MIPA

3 and class X MIPA 4, which served as research samples. The experimental class was class X MIPA 3, while the control class was class X MIPA 4. There were 36 students in the experimental class, 15 of whom were men and 21 of whom were women. There were 36 students in the control group, 15 of whom were men and 21 of whom were women.

There is no difference between the media utilized in the experimental class and the control class. They differ in that the experimental class uses the *Rumah Fisika* mobile app, whilst the control class teaches using more traditional techniques. All students, both in the control class and the experimental class, took a pre-test before the treatment to gauge their starting skills and serve as a benchmark for enhancing learning results in each class. The table below shows the frequency distribution of the pre-test results for each class. The frequency distribution of the findings from the pretest in the control class is presented in Table 2.

Table 2. Middle Values and Pre-Test Frequencies in Control Class

Value Range	Middle Value	Frequency
10 – 21	15.5	3
22 – 33	27.5	4
34 – 45	39.5	8
46 – 57	51.5	3
58 – 69	63.5	8
70 – 81	75.5	10
Total		36

Meanwhile, the mean value and pre-test frequency in the experimental class can be seen in Table 3. Data on student learning outcomes in the experimental class were obtained from post-test results after being given treatment using the *Rumah Fisika* mobile learning resource app. The control class follows traditional teaching approaches like lectures and question-and-answer sessions.

Table 3. Middle Scores and Pre-Test Frequencies in Experimental Classes

Value Range	Middle Value	Frequency
20 – 29	24.5	3
30 – 39	34.5	5
40 – 49	44.5	8
50 – 59	54.5	3
60 – 69	64.5	5
70 – 79	74.5	10
80 – 89	84.5	2
Total		36

Tables 4 and 5 contain information on the outcomes of the distribution of post-test frequencies for the experimental class and the control class. Table 4 below shows the distribution of intermediate grades and the frequency of students who left the class after learning.

Table 4. Middle Value and Post-Test Frequencies in Control Class

Value Range	Middle Value	Frequency
35 – 45	40	1
46 – 56	51	0
57 – 67	62	13
68 – 78	73	7
79 – 89	84	8
90 - 100	95	7
Total		36

The distribution of middle grades and the frequency of students after learning in the experimental class can be seen in Table 5 below.

Table 5. Middle Scores and Post-Test Frequencies in Experimental Classes

Value Range	Middle Value	Frequency
66 - 70	68	13
71 - 75	73	0
76 - 80	78	11
81 - 85	83	0
86 - 90	88	7
91 - 95	93	0
96 - 100	98	5
Total		36

The data analyzed in this study were seen from the scores of pretests and posttests of student physics learning independence and student physics learning outcomes, calculated the N-Gain (normalized gain), with the equation:

$$N_{Gain} = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \quad (1)$$

With categories are shown in Table 6.

Table 6. Categories of N-Gain value

N-Gain Values	Categories
N-Gain > 0.70	High
0.3 ≤ N-Gain ≤ 0.70	Middle
N-Gain ≤ 0.3	Low

The data from the study on the control class, resulted in the N-Gain classification data presented in Table 7. Based on Table 7, it is known that the N-Gain value in the control class is most found in the "Middle" classification, namely at intervals of 0.30 ≤ N-Gain ≤ 0.70 with 22 students with a percentage of 61%. In the "High" classification control class, namely at the N-Gain interval > 0.70 with 6 students or 17%, while for the "Low" classification, namely at the N-Gain ≤ 0.3 as many as 8 people or 22%. The average N-Gain obtained in the control class is 0.42 with a middle category. This means that student's learning outcome in control class is classified as moderate.

Table 7. Frequency Distribution List and Classification of Normalized Gain in Student Physics Learning Outcomes in Control Classes

Normalized Gain	Classification	F	Relative Frequency (%)
N-Gain ≤ 0.3	Low	8	22
0.3 ≤ N-Gain ≤ 0.70	Middle	22	61
N-Gain > 0.70	High	6	17
Total		36	100

Furthermore, the result of the research in the experimental class resulted in the N-Gain classification data presented in Table 8.

Table 8. Frequency Distribution List and Classification of Normalized Gain in Student Physics Learning Outcomes in Experimental Classes

Normalized Gain	Classification	F	Relative Frequency (%)
N-Gain ≤ 0.3	Low	-	0
0.3 ≤ N-Gain ≤ 0.70	Middle	22	61
N-Gain > 0.70	High	14	39
Total		36	100

Based on Table 8, it is known that the value of N-Gain in the experimental class is most commonly found in the "Middle" classification, namely at intervals of 0.30 ≤ N-Gain ≤ 0.70 with 22 students and a percentage of 61%. In the "High" classification class, namely the N-Gain > 0.70, there are 14 students, or 39%, while for the "Low" classification, namely the N-Gain ≤ 0.3, there are none. The experimental class's average N-gain with a middle category was 0.42. This indicates that the learning outcome for the experimental class's students is middle category.

A pretest was administered to the control class before the start of the learning activities to evaluate the students' starting knowledge. The next step is learning. Lectures and question-and-answer sessions are used to teach. The textbook material is explained by the teacher. Following the teacher's explanation, there was a question-and-answer session. Assignments are given to students at the end of the semester.

In the next meeting, learning was carried out using the lecture and question-and-answer method. At the end of the lesson, a posttest was carried out to see the success of student learning. Furthermore, the results of the posttest were compared with the results of the pretest. It turned out that the change in results was not very significant. From the results of the pretest and posttest, it can be concluded that the use of the lecture and question-and-answer method does not show an even distribution of learning success. A significant increase in learning outcomes is only obtained by students who really pay attention and actively participate in learning. While most of the students did not take part in active learning, their learning outcomes did not experience major changes.

In the experimental class, at the beginning of learning activities, a pretest was carried out to see students' initial abilities. Students are introduced to an Android application called *Rumah Fisika*. Then it explains how to install the application. With the guidance of the teacher, students install the application. The following describes the menus contained in the application. Also explained is how to use the application. During the introduction and explanation of the use of the application, the students seemed very enthusiastic. This can be seen from the activeness of students and the questions raised by students.

Then, learning is continued by explaining the material in the application and supplemented with material from other sources, including textbooks, PowerPoint media, and the internet. At the end of the lesson, students are motivated to review the material and questions contained in the application without being limited by time or place because the application has been installed on the student's Android, which is always carried by the student.

In the next meeting, learning is carried out using applications and other relevant sources. At the end of the lesson, a posttest was carried out to see the success of student learning. Furthermore, the results of the posttest were compared with the results of the pretest. It turns out that there was a significant change in results. From the results of the pretest and posttest, it can be concluded that the use of Android-based applications can improve student achievement. Students hope that further lessons can also use Android-based applications. Because students can learn more independently without having to bother carrying books, learning can be done anytime and anywhere.

According to the data analysis's findings, the experimental class's pre-test average was 51.11, while the control class was 51.67 on average. It is evident from the experimental class's average pre-test score, which is lower than that of the control group. After the treatment and learning were carried out in both classes, the experimental class used learning resources using *Rumah Fisika* mobile app based on Android, while the control class learned without using it. However, both experimental and control classes benefit when learning is carried out online using Zoom meetings. According to the data analysis's findings, the experimental class's average post-test score was 81.11, compared to the control class's average post-test score of 72.22.

From Table 7 above, it can be seen that in the "Low" classification control class there were 8 students, or 22% of the total number of students. However, in the experimental class, there was no "Low" classification at all, or zero percent. This shows that even though both experimental and control classes, after calculating the average N-gain, are classified as "Middle," if seen per individual in the control class, there are still those who are classified as low, while in the experimental class there were no students who are in the low classification.

Based on the data analysis above, it can be seen that learning using Rumah Fisika mobile app is effective in increasing learning outcomes and increasing the enthusiasm and activeness of students. The results of this study are in accordance with previous studies that examined STEM-based learning media that can improve student learning outcomes in physics subjects (Fathurohman et al., 2021; Fitria & Asrizal, 2021; Devi & Subali, 2021; Musdalifa et al., 2021; Syarah et al., 2021; Izzah et al., 2021; Aryanta, 2020; Ananingtyas, 2020).

Conclusion

Based on the results of the research and discussion, can be conclued that the significant increase in student learning outcomes in classes where learning uses *Rumah Fisika* mobile app, with an increase of 0.613, so that it has a middle classification with an average post-test score of 81.1. While the significant increase in student learning outcomes in classes where learning is carried out conventionally with lectures and questions and answers, with an increase of 0.425, so that it has a middle classification with an average post-test score of 72.22. The learning *Rumah Fisika* mobile app is effective in increasing learning outcomes and increasing the enthusiasm and activeness of students.

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