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Development of Android-Based Learning Media Using App Inventor to Improve Student's Learning Outcomes for Dynamic Fluid Materials

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Abstract. Technology plays a great role in education, particularly in facilitating creative and innovative approaches to physics learning. This study focuses on developing Android-based learning media using App Inventor for dynamic fluid materials. This Research and Development (R&D) was based on the Jan Van Den Akker model. The development stages covered preliminary research, needs analysis, prototyping, summative evaluation, and reflection and documentation. Data on the effectiveness and practicality of the developed media were obtained from questionnaires distributed to experts, teachers, and students. Data were analyzed using N-Gain tests and obtained a score of 0.63 which is in the moderate category. The developed learning media has a high level of effectiveness in improving students' understanding of dynamic fluid materials. The results of this study indicate the potential to expand the application of technology in learning to improve quality and sustainable innovation in physics learning.

Keywords: technology, app inventor, android, dynamic fluid

1. Introduction

Technology plays a great role in education, especially in physics learning to support innovative and creative learning [1]. Students consider dynamic fluid materials difficult to understand due to a lack of understanding and involvement during learning [2]. Interactive learning media can help students better understand the material and make it easier for educators to direct activities and involve students in learning [1]. The development of android-based learning media using the app inventor can be a solution to address those problems and bring innovations in learning dynamic fluid materials [3].

The researcher conducted preliminary research in South Tangerang and South Jakarta. The results showed that students experienced difficulties in understanding basic concepts and mathematical analysis in physics learning. Some of them felt less helped by the media used in the classroom such as PowerPoint, audiovisuals, and websites. Besides, physics teachers stated that the concept of dynamic fluids is difficult for students to understand. Therefore, appropriate learning media are needed to achieve the desired learning objectives [4], for example, android-based learning media for interactive physics learning [5].

App Inventor is an open web facilitator providing application creation, which was initially managed by Google and then by MIT (Massachusetts Institute of Technology). This cloud-based app inventor can be accessed via the internet and uses a puzzle block system that can be arranged and assembled into a code [6].

The use of learning media in dynamic fluid materials has been proven effective in improving student learning outcomes [7]. Android-based learning media are effective in supporting the learning process [8]. In static fluid materials, App Inventor media shows "very good" results and is suitable to support learning [9].

Android-based learning media have been developed but some still have limitations, especially for dynamic fluid materials. Many previous studies focused on the use of e-modules and computer-based media for other materials. However, the development of Android-based applications that are more interactive and easily accessible to students is still limited.

Considering the benefits of learning media on learning physics materials, teachers need to improve their learning method and media in order to increase the student's learning outcomes. This research aims to develop Android-based learning media using AppInventor for fluid dynamics materials.

2. Methods

This research and development aims to create or develop a product and test its effectiveness [10]. The development model in this study followed Jan Van Den Akker's model covering four stages, namely, preliminary research, prototype stage, summative evaluation, and systematic reflection and documentation [11].

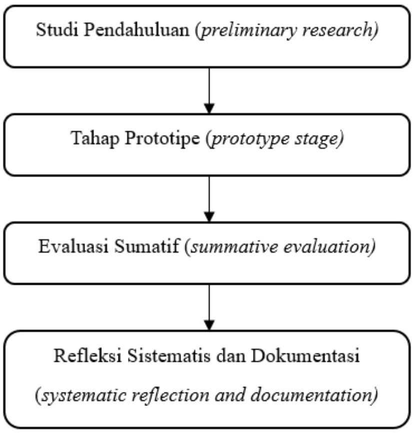

Figure 1. Research development model based on jan van den akker's model.

This research was conducted at State Senior High School 87 Jakarta and Senior High School Muhammadiyah 8 Ciputat. The subjects were students in grades XI and XII and physics teachers. The data collection techniques covered observations, interviews, questionnaires, and tests. The pretest-posttest question grid is presented in the following table:

Table 1. Pre-test and post-test question grid.

Question	Cognitive domain	Description
1	C1	Remembering
2	C1	Remembering
3	C2	Understanding
4	C3	Applying
5	C4	Analyzing
6	C2	Understanding
7	C4	Analyzing
8	C3	Applying
9	C6	Creating
10	C3	Applying

To identify students' needs during learning, the researcher distributed questionnaires and observed the teaching and learning process. The effectiveness of the developed media was based on tests and questionnaires distributed to experts, students, and teachers. Data were analyzed using the following formula.

$$TCR = \frac{\sum respondent\ score}{\sum maximum\ score} x\ 100\% \quad (1)$$

Table 2 shows the classification of respondent's achievement levels [10].

Table 2. Classification of respondent's achievement levels.

No.	Percentage	Category
1	81.26%-100%	Excellent
2	62.51%-81.25%	Good
3	43.76%-62.50%	Quite Good
4	25.01%-43.75%	Poor

The effectiveness of the developed media was tested using the Normality Gain test (N-Gain). N-Gain is the difference between the initial test score and the final test score. A post-test score that is higher than the pre-test score indicates the effectiveness of the media in improving students' mastery of concepts [12]. The N-gain formula used is as follows:

$$N - Gain = \frac{Posttest\ score - pretest\ score}{ideal\ score - pretest\ score} \quad (2)$$

N-Gain score classifications are presented in Table 3 below.

Table 3. N-Gain classification.

N-Gain	Conclusion
$g \geq 0.7$	High
$0.7 > g \geq 0.3$	Moderate
$g < 0.3$	Low

3. Result and Discussion

The developed media in this research was in the form of an android-based application for dynamic fluid materials to improve students' learning outcomes. The development of the learning media used App Inventor. The development model followed Jan Van den Akker's model covering preliminary research, prototype stage, summative evaluation, and systematic reflection and documentation.

3.1. *Preliminary Research*

Initially, the researcher conducted a need analysis for product development to meet user needs. The analysis was based on literature studies and preliminary research. In the preliminary research, the researcher conducted observations and interviews at Senior High school Muhammadiyah 8 Ciputat. The results showed that students considered physics learning difficult due to the unavailability of interactive learning media for the teaching and learning process. They need learning media to help them understand physics material including practicums, material summaries, and LKPD [13].

3.2. *Prototype Stage*

In the next stage, the researcher designed learning media that were in line with the results of the need analysis, the literature study, and preliminary research. This stage began with the selection of software to create media such as Canva, Google Form, Phet Colorado, YouTube, and App Inventor. The researcher designed an android-based learning media using the App Inventor with the initial design covering Cover, Menu, Attendance, Materials, Learning Videos, Practicum, and Exercises. The display of the learning media can be seen below:

Figure 2. Welcome screen.

Figure 3. Menu display with links to each title.

Figure 4. Attendance display and media guideline.

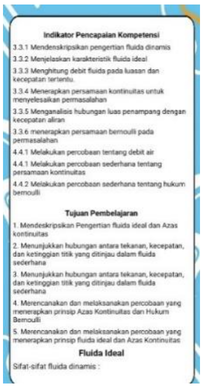

Figure 5. Explanation display.

Figure 6. Learning video display.

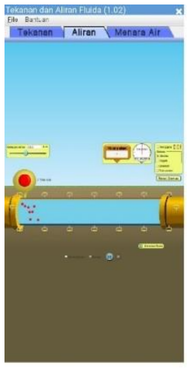

Figure 7. Practicum simulation display.

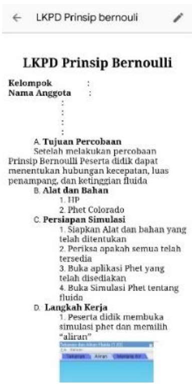

Figure 8. LKPD display.

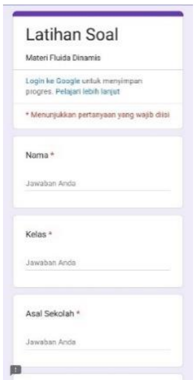

Figure 9. Exercise display.

The welcome screen contains the name of the media and information about the developer of the media as well as a button to go to the next page. This page is also an intermediary display to the next display. The menu displays buttons to change topics such as attendance and guidelines, materials, learning videos, practicums LKPD, exercises, initial menu, and exit. This menu display makes it easier for students to access media during learning and helps them interact directly with the media used [14]. On the attendance display, there are guidelines and an attendance button that goes to the Google form. The material display consists of an explanation of learning indicators, learning objectives, dynamic fluid material completed with a general discussion for each sub-chapter, formulas, and learning videos on dynamic fluid phenomena in everyday life. This video acts as contextual learning so that students can learn the application of dynamic fluid material in everyday life. The learning video display has some buttons to go to learning videos such as dynamic fluid material, Bernoulli and Torricelli practicum steps, and problem-solving. The simulation display of the practicum contains a simulation of Phet media that can be used for practicum. On the topic of fluid pressure and flow, students can simulate Bernoulli and Torricelli's practicums. This practicum is important for students to better understand the application of dynamic fluids in real life through a virtual lab. In the LKPD display, there are 2 student worksheets on the Bernoulli and Torricelli sub-materials interrelated with the simulation practicum. The LKPD structure includes objectives, practicum tools and materials, simulation preparation, practicum work steps, practicum data, data processing, questions, and conclusions. The exercise display contains physics questions on the dynamic fluid materials as a form of practice to examine to what extent students understand the materials after using the media.

The next stage is the formative evaluation involving 2 types of validators, namely media experts and material experts to measure the validity and effectiveness of this media. Besides, teacher responses to this learning media were measured using a tiered scale below.

Table 4. Validation results by media experts.

Aspect	Score	Max score	TCR (%)	Category
Use of media	39	45	86.67	Very good
Learning strategy	54	60	90	Very good
Feasibility of media	73	90	81.11	Good
Total	166	195	85.93	Very good

Table 5. Validation results by material experts.

Aspect	Score	Max score	TCR (%)	Category
Material	116	120	96.67	Very good

Table 6. Results of teacher response.

Aspect	Score	Max score	TCR (%)	Category
Use of media	25	30	83,33	Very good
Media operation	48	50	96	Very good
Media flexibility	20	20	100	Very good
Total	93	100	93	Very good

After the media was validated by experts, the researcher conducted a trial for 3 groups, namely: one-on-one test, small group test, and field test. The results of the questionnaire for students are as follows:

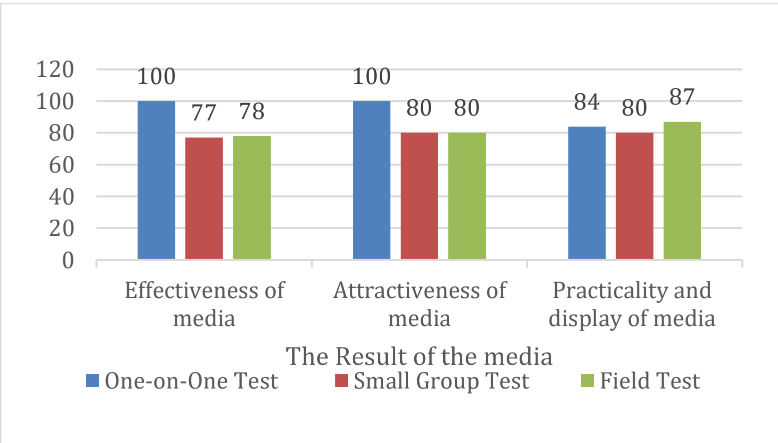

Figure 10. Graph of pre-test and post-test results.

The results of the media testing can be seen in the following tables:

Table 7. One-on-one test results.

Aspect	Score	Max score	TCR (%)	Category
Effectiveness of media	45	45	100	Very good
Attractiveness of media	30	30	100	Very good
Practicality and display of media	89	105	84.76	Very good
Total	164	180	91.11	Very good

Table 8. Small group test results.

Aspect	Score	Max score	TCR (%)	Category
Effectiveness of media	175	225	77.78	Good
Attractiveness of media	121	150	80.67	Good
Practicality and display of media	422	525	80.38	Good
Total	718	900	79.78	Baik

Table 9. Field test results.

Aspect	Score	Max score	TCR (%)	Category
Effectiveness of media	365	465	78.49	Good
Attractiveness of media	250	310	80.65	Good
Practicality and display of media	946	1085	87.19	Very good
Total	1561	1860	83.92	Very good

3.3. *Summative Evaluation*

In the summative evaluation stage, the researcher evaluated the activities that had been carried out to measure the effectiveness and practicality of the developed media based on the pre-test and post-test scores to identify the increase in students' learning outcomes in fluid dynamic materials. The results are presented in the following table.

Table 10. Pre-test post-test results.

Result	Meana	N-Gain	Category
Pre-tes	31.5	0.63	Moderate
Post-tes	75		

3.4. *Systematic Reflection and Documentation*

At this stage, the researcher reflected on the activities that had been carried out and documented the activities as evidence. The documentation of the activities can be seen below:

Figure 11. One-on-one test.

The one-on-one test involved 3 respondents.

Figure 12. Small group test.

The small group test involved 15 respondents.

Figure 13. Field test.

The field test involved 32 respondents.

Figure 14. Summative evaluation.

Summative evaluation involved 32 respondents to take the pre-test and post-test.

The use of the developed Android-based learning media becomes an effective solution to measure the improvement of student learning outcomes in fluid dynamic materials and encourage students to be more active in learning. In other words, interactive learning media is highly needed in learning [15]. Students who use Android-based learning media experience an increase in their learning outcomes [16]. This research used the development model proposed by Jan Van den Akker covering four stages, namely preliminary research, prototype stage, summative evaluation, and systematic reflection and documentation.

The use of the developed android-based media is considered practical and valid according to experts with the achievement (TCR) category of"very good". Besides, the one-on-one test and field test obtained a "very good" category. However, in the small group test, it has a ‘good’ category. This indicates a high level of effectiveness. This finding is in line with a previous study by Syamsurijal that android-based learning media has a high level of validity, effectiveness, and practicality [17]. Meanwhile, at the summative evaluation stage to measure the improvement of student learning outcomes, the N-Gain value has a"moderate" category meaning that the developed media can help students learn difficult-to-understand material.

The findings of this study indicate that the N-Gain value for the developed media has a high level of effectiveness. This is in line with a previous study [18]. This android-based learning media helps students to learn difficult-to-understand material and determine their level of cognitive ability [19]. App Inventor media also increases students’ interest in learning and helps them understand the material [20]. Interactive learning media can help the learning process and improve student learning outcomes [21].

The use of android-based learning media shows a positive result with an increase in learning outcomes and students’ independence in the learning process [22]. However, this study has limitations in the number of samples and scopes.

4. Conclusion

The development of android-based media for fluid dynamic material using the App Inventor followed Jan Van den Akker’s model which covers preliminary research, prototype stage, summative evaluation, and systematic reflection and documentation. The developed media is considered valid and practical with a "very good" category for validity and practicality. The developed media also helps improve student learning outcomes with a "moderate" category. The feasibility of the developed media is considered feasible. Future studies need to see the long-term impact of the use of Android-based learning media on students’ knowledge.

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