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Developing Android App-Based Interactive Learning Media for Mechanical Engineering Basics: Enhancing Vocational School Student Learning Outcomes

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Abstract: This study is to provide valid, practical, and effective Android application-based interactive learning media for the Basics of Mechanical Engineering subject in class X Mechanical Engineering at SMK Dhuafa Padang. This medium is intended to boost students' comprehension, motivation, and independence, allowing them to achieve better learning outcomes. The research approach employed is Research and Development (R&D), using a 4D development model (define, design, develop and disseminate). The primary data utilized in this study came from validators, teachers, and students. Data was analyzed descriptively to characterize the validity, practicality and effectiveness of the learning media developed. The validity test findings show that this learning medium, which had a media aspect score of 0,892 and a material aspect score of 0,950, was deemed valid by expert review. This media was also declared practical with a practicality score of 96,94% from teacher responses and 92,25% from student responses. In the effectiveness test, the Gain Score was 0,68, placing it in the medium category. Meanwhile, the t-test shows a Sig value (2-tailed) of 0.002 (2-tailed < 0,05) and a t_{count} value of 3,372 ($t_{count} > t_{table}$), indicating a significant difference in learning outcomes between students who use this learning media (experimental class) and those who do not use the media (control class). Thus, this Android application-based interactive learning media is declared valid, practical and effective for use in the DDTM learning process.

Keywords: Android; Interactive Learning Media; Basics of Mechanical Engineering; Learning Outcomes.

Introduction

In the era of revolution 4.0, scientific and technological advances have accelerated dramatically. As a nation confronting diverse technological changes, Indonesia must engage in the preparation of high-quality Human Resources (HR) so that it can compete in science and technology sectors (Saman et al., 2020; Tuwoso et al., 2021). Human resources are anticipated to have a balanced mix of interpersonal skills (soft skills) and technical skills (hard skills) (Pattaufi et al., 2023). Education is one approach for developing exceptional and high-quality human resources (Harliansyah & Amon, 2022). To attain educational goals, the education system should keep pace with rapid improvements in educational technology (Ajlouni & Jaradat, 2021; Xu et al., 2022). National Education seeks to serve as a reference in the implementation of education in Indonesia. All orientations of national education activities correspond to national education goals, which represent three domains of learning outcomes: affective, psychomotor, and cognitive (Prawiyogi et al., 2023).

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Vocational education is one type of education that helps Indonesia achieve national goals for improving the quality of its human resources (Rismita & Bunyamin, 2022). Vocational education strives to train human resources with both soft and hard skills who are ready to work, produce, and have competences in line with the industrial world, allowing them to live prosperously in society (Irwanto, 2021). Vocational education, particularly vocational high schools (SMK), is secondary education that primarily trains students for employment in certain sectors (Aksit et al., 2017). Vocational schools strive to train graduates who are ready to enter the workforce immediately based on the skills taught (Danardono et al., 2022; Nugraha & Wahyono, 2019).

To make it simpler for schools to meet predetermined educational goals, the government created the Independent Curriculum (Thahery, 2023; Irawati et al., 2022). The Ministry of Education, Culture, Research and Technology (Kemdikbudristek) introduced the Independent Curriculum, and instructors are required to execute it by involving students in enjoyable learning activities that promote motivation, independence, and creativity (Rahayu et al., 2022; Suryawan et al., 2023). Teachers have a key role in helping students develop their skills and abilities, including their cognitive, emotional, and psychomotor talents (Alayda et al., 2022). Students must actively participate in more student-centered learning in order to implement the independent curriculum learning process (Lutfiana, 2022; Pratiwi et al., 2023).

Learning media is one of the five primary and crucial components of the learning process (Audie, 2019). The purpose of learning media is to transfer knowledge from the source or teacher, to the recipient or student (Aurum & Surjono, 2021). According to Tafonao (2018), learning media serves as a teaching tool that helps instructors deliver teaching material, foster student creativity, and grab students' attention during the learning process. Therefore, it can be concluded that learning media play a significant role in the educational process because they support educators in their instruction, spark students' curiosity and focus, and motivate them to actively communicate and imagine in order to deliver content and speed up the learning process. Making the most of learning media can motivate students to respond actively and to follow proper procedures (Abanikannda, 2019; Nurhikmah et al., 2021). It is thus envisaged that the media employed would be interactive in order to maximize the function of the learning media (Falah & Arsana, 2023).

According to Jayanti (2023), interactive learning media aims to make learning easier while also encourage teacher creativity and innovation in designing the learning process. Furthermore, an interactive learning medium is characterized as a device that users may control, allowing them to select the next course of action they wish to pursue in their learning (Fitriani et al., 2021). Interactive learning media can also be interpreted as a type of learning media that is intended to involve users through interactive displays and is capable of carrying out two-way communication interactions with its users (Arthur et al., 2022; Sujarwo et al., 2022). There are several advantages to using interactive learning media, such as allowing students study on their own terms or in small groups based on their skills, and improving the efficiency of material delivery to give students engaging learning opportunities and can enhancing their learning outcomes (Sugiwati et al., 2023; Tamami & Dwiningsih, 2020).

According to Setyaedhi et al. (2023), learning outcomes are the result of evaluating and assessing a person's learning efforts. Learning outcomes are the degree to which students succeed in accomplishing the predetermined program objectives (Syah, 2019). Moreover, learning outcomes are also expressed as the outcome of evaluation and measurement of learning activities (Prasetyowati & Setyasto, 2023). Consequently, based on the evaluation and assessment of students' learning efforts, learning outcomes can be defined as the degree of success that students achieve in reaching the established learning goals. Benjamin S. Bloom classified the three main aspects of student learning outcomes as cognitive, affective, and psychological (M. P. Sari & Abduh, 2022). The analysis in this study focused more on the cognitive aspects of learning outcomes from learning media, as evidenced by the comparison between students who used the media and those who did not (Damopolii et al., 2021; Zhampeissova et al., 2020).

SMK Dhuafa Padang's preliminary study observations have led to the knowledge that the learning process still has a number of issues. At SMK Dhuafa Padang, a number of students still have learning outcomes in DDTM topics that are comparatively low — that is, below the minimal completion criterion. This is due to the fact that students find the content basics of mechanical engineering to be challenging because it is new and available only to those who have enrolled in vocational school. Then, the teaching and learning process activities at SMK Dhuafa Padang still use conventional learning media in the form of whiteboards, teaching modules, LCD projectors and power points. In addition to having inadequate infrastructure, schools do not make the most of technology's potential as a alternative and innovative teaching tool. This results in a lack of motivation and independence for students in the learning process so that they repeat the lessons that have been explained by the teacher (Asmianto et al.,

2022; Murdiono et al., 2020). The development of innovative and effective learning media is important to improve the quality of DDTM learning in vocational schools (Damanik et al., 2023; Novaliendry et al., 2021). Android is one technology that can be applied (Ewais et al., 2021). The creation of interactive educational materials utilizing Android applications to support the learning process becomes a new alternative that can be applied (M. P. Sari & Abduh, 2022).

Android is an operating system based on Linux that is intended for use with a variety of touch-screen mobile devices, including tablets and smartphones (Novaliendry et al., 2021). Because the Android operating system is open source (free to use) (El-Sofany et al., 2014; Pratama & Sofyan, 2020), one of its benefits is that it is simple to develop for. Students may find it simpler to study on their own with the help of this Android App-Based Interactive Learning Media (Hasyim et al., 2020). Compared to other media, like e-learning, which needs an internet connection to function, this media is more affordable and effective (Hingide et al., 2021). In the meanwhile, Android media can be accessible both online and offline via the smartphone device (Mulyana et al., 2023; Stevani & Sucahyo, 2022). Additionally, Android makes things simple to utilize by including providing features that are simple enough for students to comprehend (Riyan, 2021) The widespread adoption of Android can be attributed to its user-friendly features and reasonable cost for the ordinary population. (Rizki et al., 2023). Thus, the creation of Android application-based learning media is highly beneficial to the educational process and can aid in students' comprehension of the subject matter (Murtiningsih et al., 2022; Muskhir et al., 2023).

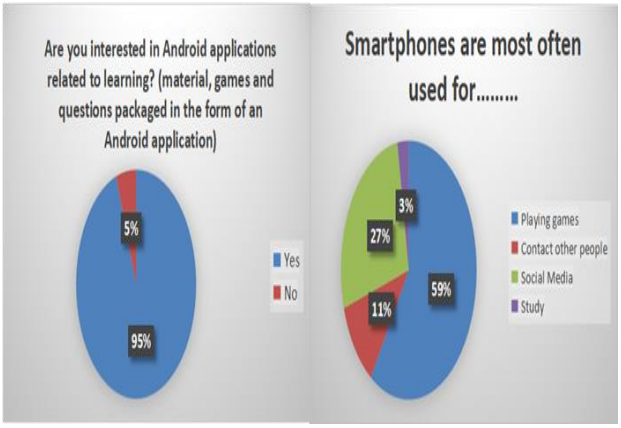

Figure 1. Data Analysis of Student Needs.

Afterwards, examining the class X Mechanical Engineering student's requirements analysis at SMK Dhuafa Padang. The findings of the research reveal that 59% of students use their cellphones for gaming, 27% for social media, 11% for communication, and only 3% for learning activities. Additionally according to this data, up to 95% of students are interested using Android applications as a learning media. It is evident from this that there is a great deal of potential for enhancing the quality of learning in class X Machining Engineering by utilizing technology in the form of Android applications as a learning tool.

Based on the aforementioned issues, the objective of this study is to develop Android app-based interactive learning for the Basics of Mechanical Engineering subject in class X Machining Engineering at SMK Dhuafa Padang that are valid, practical and effective. The fact that this school has not yet development digital technology-based instructional materials in the form of Android applications in previous research at this school was one of the primary motivations for conducting this research. Consequently, researcher aim to implement innovations that should aid students in comprehending the subject matter of Basics of Mechanical Engineering by fusing instructional materials, learning videos, quizzes and minigames into a single digital-based interactive teaching material in the form an Android application.

Method

Research and development techniques are used in this study. A research methodology known as research and development, which attempts to generate specific products and and test its validity, practicality and effectiveness of these products in their application (Mulyana et al., 2023). Thirty-seven SMK Dhuafa Padang Class X Machining Engineering students served as the research subjects. Two sets of participants were created: class X TP A, which consisted of 19 individuals, was the experimental class, and class X TP B, which consisted of 18 individuals, was the control class. Before being tested on students, the product was first assessed by two medium experts from DDTM subject instructors at SMK Dhuafa Padang and three media experts from UNP engineering department professors. The Thiagarajan 4-D development model, which comprises of the four processes of define, design, develop, and disseminate, will be used as the development model in this study (Sugiyono, 2017).

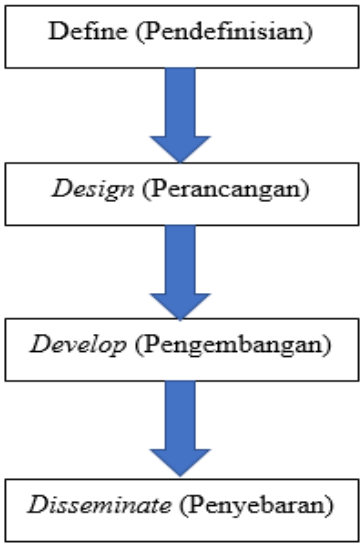

Figure 2. 4D Model.

The goal of the Define stage is to identify the fundamental issues required to create android app-based interactive learning media (Sugiwati et al., 2023). The purpose of the design stage is to create a working prototype or first model of the learning media that are being produced (Kus Eddy Sartono et al., 2022). The purpose of the third stage, Develop, is to create valid, practical and effective learning media (Setyaedhi et al., 2023). To determine whether or not the designed learning media is valid, the validity test is derived from the validation operations of media experts and content experts. To ascertain the level of practicality of the produced learning media, a practicality test is then conducted. In the meanwhile, the effectiveness test is carried out to evaluate whether the media that has been created can be used as expected to increase student participation and achievement of learning outcomes. The last step is to disseminate the interactive learning media, which are based on this Android application and may be given to other classrooms and schools that provide this subject (Tamami & Dwiningsih, 2020).

Three different methods of data collecting are used in this study to assess the validity, practicality and effectiveness of the Android application-based learning media that is being developed. Data collection techniques are conducted with a validator using the validation sheet as an instrument as part of data gathering strategies to ascertain media validity. Furthermore, teachers and students are given answer questionnaires as part of the data gathering approach to assess the practicality of the media being produced. The instrument used was a teacher and student response questionnaire. A Likert scale with five alternative answers a scale intended to evaluate attitudes, views, and perceptions of an individual or group toward an event or social phenomenon is used to examine responses to validation sheets and student response questionnaires (Sugiyono, 2017). Utilizing the Aiken's V statistical method, data analysis techniques for validity and practicality are determined. Meanwhile, the effectiveness data collecting method employs objective pretest and posttest assessments of student learning outcomes, administered to both experimental class and control class students. Use the independent sample T-test, normality test, homogeneity test, and N Gain formula (gain score) for analyzing effectiveness data.

Result and Discussion

Results

Validity of Learning Media

Home menu is the main display where menus from interactive learning media can be found.

Figure 3. Home Menu.

The indicator menu displays learning elements, learning outcomes (CP), learning objectives (TP) and learning objective flow (ATP) in the Basics of Mechanical Engineering Phase E or Class X Machining Engineering subjects.

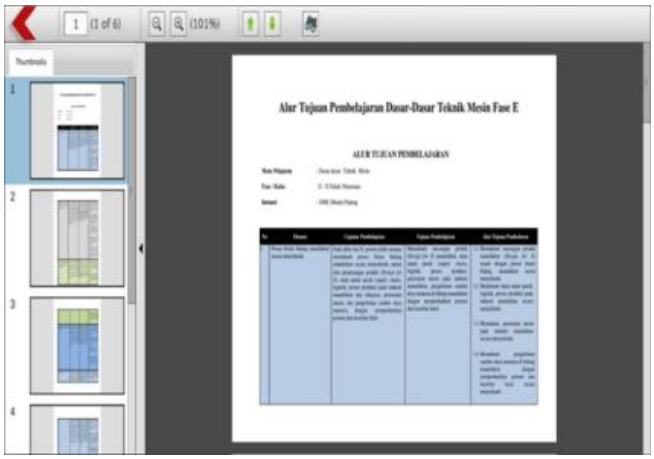

Figure 4. Indicator Menu.

The learning material menu, learning video menu, and learning miniquiz are the three menu selections that make up the displayed teaching material menu.

Figure 5. Teaching Materials Menu.

The element material menu is presented in the form of a PDF file that will be used during the research process.

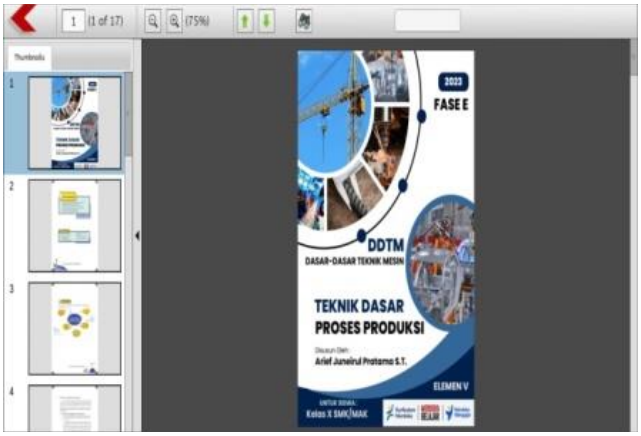

Figure 6. Element Material.

After choosing a video menu, students will be able to access and study it instantly since the learning video menu will be directly connected to the YouTube link.

Figure 7. Learning Video.

The quiz menu has many interactive evaluation questions with objective options that are used as a learning evaluation.

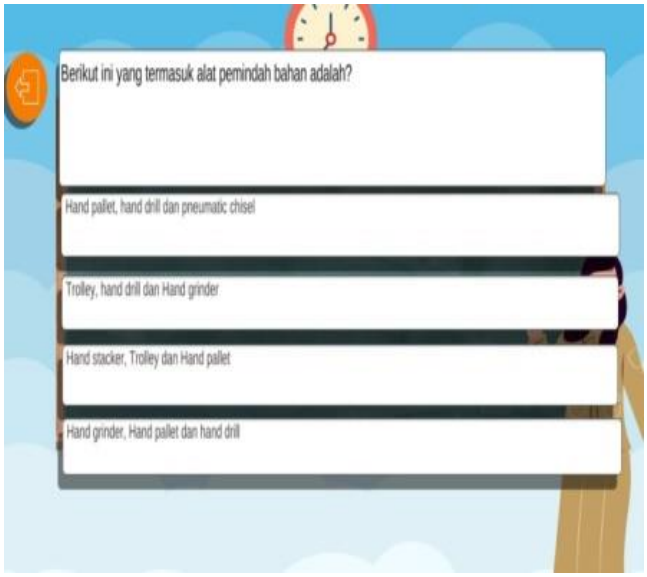

Figure 8. Quiz.

The game menu includes snakes and ladders and picture connection games that correspond to the Basics of Mechanical Engineering learning material. Measuring instruments, measuring instrument parts, and measuring instrument calculation are all covered in the picture connection games menu. This snakes and ladders game menu can be used by two students, and is equipped with questions related to the learning material.

Considering assessments from media and material experts, the validation test is used to determine if the learning materials that have been generated are appropriate. Validators who are experts in the field of media and materials complete out instruments to determine the validity assessment 's results. The study's findings show the viability of the earning media developed. The table below displays an overview of the validation findings from media specialists on several facets of learning media.

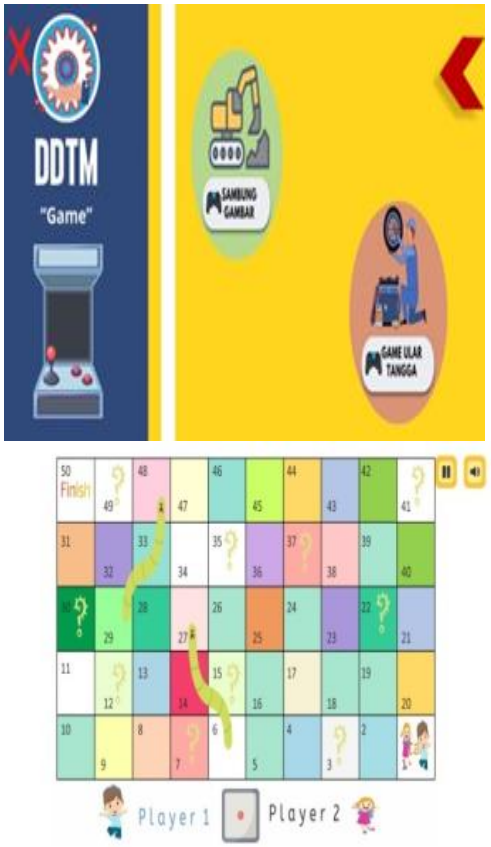

Figure 9. Game.

The assessment for each aspect of media validation is in the valid category. The average value of validity in media validation reached 0,892 which is included in the valid category. Then, a summary of the validation from the material expert is described in the following recapitulation table of the material expert's validation results:

Tabel 1. Media Expert Validation Results.

No.	Assessment Aspects	Average Validator Value	Categories
1	Visual	0.908	Valid
2	Media Design	0.900	Valid
3	Media Utilization	0.867	Valid
	Average	0.892	Valid

Tabel 2. Material Expert Validation Results.

No.	Assessment Aspects	Average Validator Value	Categories
1	Material Quality	0.911	Valid
2	Learning Quality	0.975	Valid
3	Interaction Quality	0.975	Valid
4	Display Quality	0.938	Valid
	Average	0.950	Valid

The assessment of each aspect of material validation is included in the valid category. The average value of validity in material validation reached 0,950 which is also in the valid category. Considering the assessment of media and material experts who serve as validators, this Android app-based interactive learning media is considered feasible and suitable for use in the learning process, both in class and independently.

Tabel 3. Validity Level Categories.

No	Achievement Level	Categories
1	0-0.666	Invalid
2	≥ 0.666	Valid

(Source: Irsyadunas et al., 2021)

Practicality of Learning Media

Tabel 4. Results of Practicality Data from Teacher and Student Response Questionnaires.

No.	Indicator	Percentage % Teacher Assessment	Practicality Criteria	Percentage % Student Assessment	Practicality Criteria
1	Ease of Use	98.33	Very Practical	98.33	Very Practical
2	Effectiveness of Learning Time	97.50	Very Practical	97.50	Very Practical
3	Use of Media	95.00	Very Practical	95.00	Very Practical
Average Percentage (%)		96.94	Very Practical	96.94	Very Practical

The practicality test of learning media aims to measure the practicality level of the learning media that has been developed (Purnomo & Nuryanto, 2021). Based on the practicality test, this media obtained an average practicality score of 96.94% in the very practical category on the teacher response questionnaire. In the student response questionnaire, an average practicality score of 92.25% was obtained, which is also in the very practical category. Therefore, based on responses from teachers and students regarding the use of Android applications based interactive learning media, it can be concluded that this learning media is very practical to use.

Effectiveness of Learning Media

The learning media that have been developed have gone through a validation and practical testing process. Subsequently, the effectiveness of this media was tested through the use of the gain score test and the Independent Sample T-Test to measure its success.

Gain Score

When the pretest and posttest results are compared using the N-Gain or gain score, the effectiveness of the learning media may be observed in the rise in student learning outcomes. When the Gain Score achieved by the student reaches a minimum of ≥0.3 in the medium category, the learning medium becomes effective.

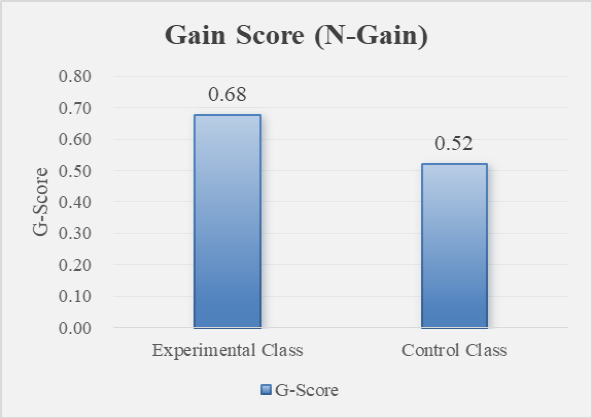

Figure 10. Effectiveness Test Analysis of the Gain Score Value.

Based on the results of the analysis, it can be shown that the gain score in the experiment group was higher than the control group, with a value of 0.68 in the medium category. Meanwhile, the control group's gain score is 0.52 in this category as well. It may be inferred from the data on the gain score on the above graph that android app-based interactive learning media can be considered effective.

Normality Test

Tabel 5. Results of *Normality Test*

	Class	Kolmogorov-Smirnov		
		Statistic	df	Sig.
Student Learning Outcomes	Experimental Class Pretest	0.166	19	0.181
	Experimental Class Posttest	0.181	19	0.101
	Control Class Pretest	0.182	18	0.119
	Control Class Posttest	0.174	18	0.159

The Kolmogorov-Smirnov normality test was used to analyze the pretest-posttest findings in the experimental and control classes. The results showed that the experimental class pretest data had a Sig value of 0.181, while the experimental class posttest data had a Sig value of 0.101. Meanwhile, for the control class pretest data, the Sig value was obtained. of 0.119, and for the control class posttest data the Sig value was obtained. of 0.159. The sample data in this case shows that Sig. value is greater than 0.05 so that the data for the two groups studied is normally distributed and can be continued with the next analysis.

Homogeneity Test

Tabel 6. Results of Homogeneity Test

		Levene Statistic	df1	df2	Sig.
Student Learning Outcomes	Based on Mean	1.071	3	70	0.367
	Based on Median	0.910	3	70	0.441
	Based on Median and with adjusted df	0.910	3	64.047	0.441
	Based on trimmed mean	1.070	3	70	0.368

Based on data analysis, the Sig value was obtained (Based on Mean) of 0.367>0.05. This indicates that the research data has homogeneously distributed variations, so it meets the requirements needed to carry out an independent sample t test.

Independent sample t-test

The Independent Sample T-Test is used to determine whether posttest learning results for students in the experimental class and control class differ significantly from one another.

Based on the results of the independent t test above, it is known that the sig value, (2-tailed) is 0,002 and the t_{count} value is 3,372. Analysis of this data obtained a sig value, (2-tailed) < 0,05 (0,002 < 0,05). Apart from that, data analysis also states that $t_{count} > t_{table}$ (3,372 > 2,03011). Thus, it may be said that there is a significant difference between the experimental group's and the control group's posttest learning outcomes. The table below displays the two groups' average learning outcomes:

Tabel 7. Independent Samples T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Student Learning Outcomes	Equal variances assumed	1.317	0.259	3.372	35	0.002	8.83	2.618	3.515	14.146
	Equal variances not assumed			3.362	34.075	0.002	8.83	2.626	3.493	14.167

Tabel 8. Group Statistics

	Class	N	Mean	Std. Deviation	Std. Error Mean
Student Learning Outcomes	PostTest Eksperimen	19	81.053	7.524	1.726
	PostTest Kontrol	18	72.222	8.399	1.980

Based on statistical analysis using the independent sample t-test method, it was determined that the average score for the experimental class was 81.053, whereas the average score for the control class was 72.222. This suggests that using android app-based interactive learning media is more effective than using conventional learning.

Discussion

The primary goal of this study is to develop android app-based interactive learning media that are valid, practical and effective by utilizing the 4D modeling approach.This learning media has proven to be very useful in increasing students' motivation and independence as well as their learning outcomes. There are several reasons that support the success of this learning media, namely: 1) Media experts and material experts evaluated the learning media's validity, finding that it falls into the valid category with respective validity scores of 0,892 and 0,950; 2) Teacher and student response questionnaires were analyzed to determine the practicality of the learning media, yielding an average practicality score of 96,94% and 92,25% (very practical criteria); 3) The researcher has evaluated the learning media and found it to be effective. The gain score test, which shows that the experimental class's N-Gain for student learning outcomes is higher than that of the control class, demonstrates this. The independent sample t-test which displays Sig value. (2-tailed) of 0,002 < 0,05 and $t_{count} > t_{table}$ (3,372 > 2,03011). In addition, the results of statistical analysis show that the average student learning outcome score in the experimental class is 81,053, while in the control class it is 72,222.

These results are consistent with previous research conducted by (Cahyo, 2021), which found that android app-based interactive learning media met the criteria for validity, practicability, and efficacy. This is further corroborated by research findings (Andrian & Maksum, 2020) that indicate this media is suitable for use in the teaching process. Below are some guidelines for using the educational media that have been developed, namely: 1) Assisting teachers in assigning learning materials; 2) Creating a two-way learning process, where learning is student-centered so that it is interactive; 3) Contribute to increasing student motivation and learning outcomes; and 4) Assist in boosting students' learning independence in repeating what they have learned at home or at school.

The use of android app-based interactive learning media in education can lead to a shift in learning that is centered on the teacher to become a student (Budiarto et al., 2021). For this reason, Android-based interactive learning media must meet the requirements of being easy to understand, interesting and appropriate so that it can motivate students to learn (Sari et al., 2022). Additionally, instructional media must be easily used in order to engage students actively in their learning and support teachers in their efficient use of time and energy (Insani & Body, 2021). Then this media also provides varied, alternative and innovative learning resources to train students' abilities, be active and motivate them and make the learning process more enjoyable.

Conclusion

The following conclusion may be drawn from the research results: Android app-based interactive learning

media has passed a validation process by experts and was declared valid and suitable for use in learning. The validity of media experts is 0,892 on average in the valid category, whereas the validity of material experts is 0,950 on average in the same category. Android app-based interactive learning media is included in the very practical criteria, with a teacher response practicality value of 96.94% and student response of 92.25%. Android app-based interactive learning media that has been developed has proven to be effective to use. The experimental class posttest had an average gain score of 0.68 in the medium category. Then the effectiveness of this learning media was also proven based on the results of the t test (Independent Sample T-test), with a value of Sig. (2-tailed) is 0.002 <0.05 and the t_{count} is 3.372 > t_{table} (2.03011). This shows that students in the control group and experimental group who used this media had significantly different posttest learning outcomes.

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Authors Contribution
The primary author, Arief Juneirul Pratama, makes contributions to product development, research design, research execution, data collection, and writing research articles. Arwizet K, second author, was a supervisor in research activities ranging from article writing, reviews, to editing. Meanwhile, the third and fourth authors played a role in reviewing the initial manuscript and providing input.

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Conflicts of Interest
The researchers declare there is no conflict of interest.

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