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Improving Motivation and Learning Outcomes of Elementary School Students with Multimedia-Based Interactive Media

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Abstract

This study addresses challenges in 21st-century education, particularly the low motivation and academic performance of elementary school students. It investigates the use of multimedia-based interactive learning tools as a solution to improve engagement and learning outcomes. Focusing on the Hydrological Cycle (Theme 8) for fifth-grade students, the research aimed to develop interactive multimedia learning materials using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Data were collected through questionnaires, interviews, and assessments, then analyzed using quantitative and qualitative descriptive methods. The findings revealed strong validity, practicality, and effectiveness of the developed materials. Material and media experts rated the tool's validity at 90%, classifying it as highly valid. Practicality tests yielded scores of 98.3% from teachers and 86.9% from students, confirming its usability in classroom settings. Most notably, the tool significantly improved learning outcomes, with average test scores rising from 48.79 (pretest) to 81.47 (post-test). These results demonstrate that interactive multimedia tools can effectively enhance student motivation and academic achievement in elementary education.

INTRODUCTION

Background of the Study

The 21st century has seen significant advancements across various sectors, including education. Aslamiah et al., (2021) highlight that this era is marked by changes in the economy, transportation,

technology, communication, and information due to globalization. These developments are evident in the widespread application of innovation to further the expansion and advancement of knowledge. Science and innovation have played a crucial role in redevelopment efforts, focusing on leveraging innovation in a constantly evolving environment (Dakhi et al., 2022). According to the National Education Standards Agency (BNSP) in 2010, the 21st century is characterized by the widespread availability of information and data, coupled with the continuous evolution of innovation.

These changes also necessitate a transformation in education, particularly in preparing students with the skills required for the 21st century. Suryani et al., (2018) noted that the goal of 21st-century learning is to produce graduates who are proficient in complex thinking, communication, and problem-solving, all of which are essential for navigating the dynamic changes in the global landscape. Erdoğan (2019) emphasized the crucial role of education in shaping the future. As a result, educators are expected to adapt and stay current with advancements, especially given the rapid developments in information and data innovation (Wahyono et al., 2020). However, to develop these competencies, student motivation plays a critical role and cannot be overlooked.

Learning motivation is a crucial factor in the success of the educational process. Ratminingsih et al., (2021) explain that high learning motivation encourages students to actively participate and engage in learning activities. When motivation is optimal, it leads to improved learning outcomes. A decline in student motivation can result in lower academic performance, highlighting the need for innovative approaches to address this issue (Nanang et al., 2017). In this regard, multimedia-based interactive media can serve as an effective solution to boost student motivation in learning.

Mastery of Information and Communication Technology (ICT) as a tool to support learning is a crucial skill for educators to navigate the challenges of the 21st century (Andrian & Rusman, 2019). Both educators and students need to master the "4Cs"—creativity (the ability to innovate), critical thinking (the ability to analyze), communication (the ability to communicate effectively), and collaboration (the ability to work together to solve problems) (Kembara et al., 2019). Therefore, learning based on the 4Cs is vital for the 21st century (Ratminingsih et al., 2021). One effective application of ICT in education is multimedia-based interactive media.

Multimedia-based interactive media has been shown to effectively enhance student motivation and learning outcomes in elementary schools. A study by Arisanti & Adnan (2021) found that using interactive multimedia like Macromedia Flash 8 boosted student motivation, with average scores rising from 65 to 95, while learning outcomes increased from 77 to 93. Additionally, Hadi Heryadi et al., (2017) discovered that students who used Adobe Flash-based multimedia exhibited higher motivation and better learning outcomes compared to those who used traditional presentation tools like PowerPoint. Nanang et al., (2017) also concluded that interactive multimedia tutorial-based learning positively impacts student motivation, leading to improved overall learning performance. Therefore, the use of multimedia-based interactive media not only fosters an engaging and interactive learning environment but also supports the achievement of 21st-century education objectives, which emphasize the development of 4C skills and the enhancement of educational quality.

Problem of The Study

The concept of 21st-century learning emphasizes a student-centered approach, where educators serve as facilitators, offering students ample opportunities to explore, solve problems, and expand their knowledge. However, according to Arianti & Pramudita (2022), the current educational system still leans towards a teacher-centered model, where students are less engaged, hindering their development in critical thinking, creativity, collaboration, and communication—key skills for 21st-century learning. Initial observations in various elementary schools indicate that teaching is often dominated by lectures, with students remaining passive and simply following the teacher's instructions. Interviews with teachers revealed that one significant challenge is the lack of engaging and interactive learning media. Teachers also noted that students often lose motivation due to

repetitive teaching methods, which leads to poor understanding of the subject matter. Previous studies suggest that multimedia-based interactive media could address this issue. Arisanti & Adnan (2021) reported that using Macromedia Flash-based interactive media boosted student motivation from an average score of 65 to 95 and improved learning outcomes from 77 to 93. Heryadi et al., (2017) also found that students using Adobe Flash-based media showed a better understanding compared to those who followed conventional methods. Furthermore, Nanang et al., (2017) emphasized that interactive multimedia-based learning tools can help students engage more actively in the learning process and enhance their academic performance. Therefore, additional research is needed to develop and implement multimedia-based interactive media that can increase student motivation, improve learning outcomes, and support a student-centered approach to 21st-century learning.

Research's State of the Art

The evolution of educational technology has led to the integration of text, images, audio, animations, and video in interactive multimedia, significantly enhancing students' learning experiences. Research indicates that multimedia-based approaches positively impact learning by increasing both motivation and outcomes (Manurung & Panggabean, 2020; Nurlaela et al., 2021; Saifudin et al., 2020) demonstrated that interactive multimedia fosters active student participation in learning. Additionally, this type of media addresses the limitations of traditional tools like textbooks and PowerPoint presentations, which often fail to engage students. Recent studies emphasize the importance of interactivity features, such as interactive quizzes, simulations, and educational games, which go beyond presenting information to actively involving students (Heryadi et al., 2017).

Key features of multimedia-based interactive media include dynamic elements customizable to user needs, intuitive navigation, and the ability to present material in an engaging and accessible manner (Gros, 2018). This media supports multimodal learning experiences by integrating visual, auditory, and kinesthetic elements, aiding students in better understanding the content. Buchori & Setyawati (2015) highlight that the success of interactive media depends on attractive user interfaces, engaging interactivity, and content relevance to educational objectives.

Learning motivation in this context refers to the internal and external factors driving students to participate actively in the learning process. It can be assessed through indicators like attention, persistence, and satisfaction (Ratminingsih et al., 2021). Meanwhile, learning outcomes pertain to students' achievement in knowledge, skills, and attitudes, measured through pretests, posttests, assignments, and observations (Rahman & Nyoman, 2020). This study evaluates these aspects to determine the effectiveness of interactive multimedia in education.

Despite its benefits, implementing interactive multimedia faces challenges. In Indonesia, for example, technical issues like limited internet access and insufficient teacher training in multimedia development and use often hinder its adoption (Wahyono et al., 2020). Moreover, the success of such media depends on its alignment with local needs and the national curriculum. The long-term potential of interactive multimedia extends beyond boosting motivation and short-term learning outcomes. It can help cultivate 21st-century skills such as critical thinking, creativity, and collaboration. By accommodating diverse learning styles, interactive multimedia promotes a more inclusive and comprehensive learning experience, equipping students to meet global challenges more effectively.

Gap Study & Objective

Previous studies have demonstrated that multimedia-based interactive media has significant potential to enhance student motivation and learning outcomes. For instance, Arisanti & Adnan (2021) found that using Macromedia Flash increased student motivation from a score of 65 to 95 and improved learning outcomes from 77 to 93. Similarly, Heryadi et al. (2017) observed that students who

used Adobe Flash-based media achieved a better understanding compared to those taught with traditional methods. Furthermore, Nanang et al. (2017) revealed that tutorial-based interactive multimedia could boost student learning motivation. Saifudin et al. (2020) reported that interactive multimedia on energy sources significantly facilitated student comprehension, while Manurung & Panggabean (2020) highlighted that problem-solving-based multimedia improved students' critical thinking in physics.

However, gaps remain in previous research. Most studies focus on specific platforms like Macromedia Flash or Adobe Flash, which have yet to be integrated with modern tools such as Android applications. Additionally, these studies often address learning outcomes or motivation separately, rather than demonstrating how interactive media can enhance both aspects concurrently. Moreover, there is a lack of research applying interactive multimedia to specific thematic materials, such as the Hydrological Cycle for grade V elementary students, in alignment with the thematic curriculum. To address these gaps, this study aims to develop Android-based interactive multimedia learning media specifically tailored for the Hydrological Cycle in theme 8 for grade V elementary students. It also seeks to evaluate the effectiveness of this media in simultaneously enhancing student motivation and learning outcomes. This research is expected to offer innovative solutions for teachers, leveraging modern, engaging, and interactive technology to meet the demands of 21st-century education.

METHOD

Type and Design

This research applied the Research and Development (R&D) methodology, which aimed to create certain products and test their effectiveness in real-world situations. According to Mustadi et al. (2022), R&D was a research method used to develop and test a product. To produce the product, the research included analyzing the needs and testing the functionality of the product in the community (Sugiyono, 2019). The products produced from this research were multipurpose, media-based interactive learning media focused on hydrological cycle material for grade V elementary school students. The sample of this study was V-grade elementary school students. The sample of this totaled 29 students. The ADDIE model was used in this approach, following the views of Suryani et al. (2018). The ADDIE model was integrated as a core component in a systems approach to developing learning, which was carried out through five stages: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation (Figure 1).

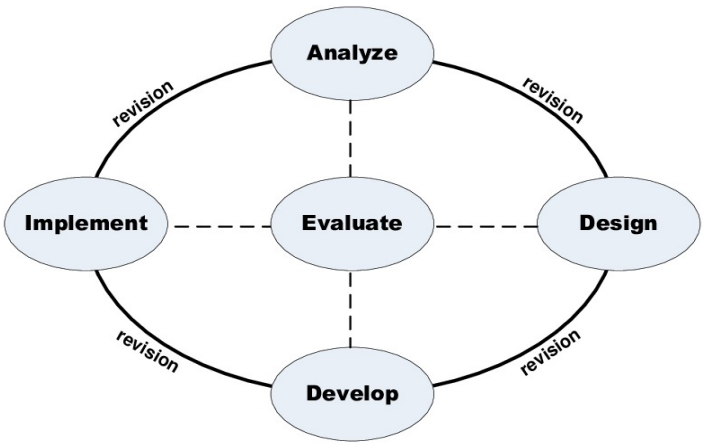

Figure 1. ADDIE Desain.

Data and Data Sources

The data in this study consisted of data used to assess the validity, practicality, and effectiveness of interactive multimedia learning media. Validity data is obtained from the assessment of material experts and media experts regarding the feasibility of material content, design, and display quality of the developed product. Practicality data comes from teacher and student feedback regarding the ease of use and attractiveness of the learning media. Meanwhile, effectiveness data is in the form of student learning outcomes collected to see the increase in understanding after using the media.

Data sources in this study include material experts, who assess the content and accuracy of the learning materials; media experts, who evaluate the design, appearance, and technical aspects of the media; teachers, who provide views on the application of the media in teaching and learning activities; and students, who provide data related to the practicality of the media and their learning outcomes after using the learning media.

Data Collection Technique

The data collection techniques in this study were designed to evaluate the validity, practicality, and effectiveness of the developed interactive multimedia learning media. To assess validity, data were gathered using validation questionnaires provided to material and media experts. These questionnaires included a range of evaluation indicators covering aspects such as content quality, design, appearance, and functionality of the learning media. The results were analyzed by calculating percentage scores to determine the validity level.

To measure practicality, data were collected through response questionnaires completed by teachers and students. These questionnaires focused on evaluating the ease of use, attractiveness, and usefulness of the media in supporting the learning process. The responses were analyzed in percentages to determine the practicality level of the media in teaching and learning activities. For effectiveness, data were obtained through pretest and posttest assessments administered to students before and after using the learning media. The differences in mean pretest and posttest scores were analyzed using statistical methods, such as the t-test, to identify the significant impact of the media on improving student learning outcomes. By employing these data collection techniques, the study thoroughly evaluates the product's validity, practicality, and effectiveness based on input from experts, teachers, and students as the primary users. The data can be seen in Table 1 below.

Table 1. Data Collection Instruments and Techniques

Data	Research Instrument	Data Collection Techniques
Analysis of Teacher Needs for Learning Video Media	Interview	Interview guidelines
Validation of Learning Video Media	Validation Questionnaire	*Judgement/Expert Review*
Teacher and Student Responses to Learning Video Media	Response Questionnaire	*Judgement/Expert Review*

Data Analysis

The data analysis in this study utilized both qualitative and quantitative descriptive techniques. The qualitative descriptive approach was employed to assess interview results and analyze feedback provided by media and material experts. On the other hand, the quantitative descriptive approach was

used to examine data from validation questionnaires completed by media experts, material experts, teachers, and students. The validity of the learning media was determined using a percentage formula to evaluate the feasibility of the developed product. The validation results were then categorized based on predetermined criteria.

This method aligns with the study by Ambaria et al. (2023), which assessed the fraction board learning media, achieving validity scores of 87.27% from media experts and 100% from material experts. Similarly, Jeneva et al. (2023) conducted research on archery-themed learning media for biography text, obtaining validity scores of 88.57% from media experts and 90% from material experts. Therefore, the use of a descriptive percentage method is deemed suitable for evaluating the validity of the learning media developed in this study. The data analysis method used to evaluate the validity of the media involves the percentage formula to calculate and determine the validity value (In Table 2):

$$P = \frac{x}{\sum x_i} \times 100\%$$

Description:

P : Percentage of feasibility

x : Total score obtained

$\sum xi$: Total ideal score

Table 2. Interpretation of Assessment

Value Criteria	Assessment Percentage	Category
4	76-100	Very good
3	51-75	Good
2	26-50	Not good
1	0-15	Not good

The score results above are then entered into the following criteria (Table 3):

Table 3. Media Validity Criteria

Present %	Qualification	Validity Criteria
81-100	Very good	Very valid, no revision is needed
61-80	Good	Valid, no revision required
41-60	Pretty good	Invalid, needs revision
21-40	Not good	Invalid, needs revision
<20	Very bad	Invalid, total revision

(Arikunto, 2018)

RESULTS

The development of learning media such as interactive multimedia follows the ADDIE development model approach which consists of a series of steps namely Analysis, Design, Development, Implementation, and Evaluation. This process ends with the creation of a product, namely an android-based learning application called the SiLogi Application (Hydrological Cycle). This application is designed to present Natural Science material, material about the hydrological cycle in theme 8 grade V at the elementary school level.

Level Analysis (Analysis)

This stage aims to identify the obstacles faced by students during the learning process. According to Syahroni & Nurfitriyanti (2018), this stage plays a significant role in gathering information that supports the development of learning media. Similarly, Kurniawan et al. 2021 stated that this stage is conducted to analyze existing problems before determining solutions. Researchers evaluate issues and the content of teaching materials through observations, interviews, and needs analysis questionnaires, involving the participation of students and teachers in the effort to develop learning media.

Observations revealed that most teachers tend to rely solely on printed books as the primary source of teaching materials. Although PowerPoint media is occasionally used, it is considered less effective. Interviews with fifth-grade students indicated that PowerPoint presentations are less engaging for them because most of the content consists only of additional text. Consequently, students' interest and motivation to learn decrease, negatively impacting their academic performance. This is supported by data from the Odd Semester Final Assessment, which showed a low average score of around 67. These findings serve as the basis for researchers to develop interactive multimedia learning media, particularly for elementary school students.

Level Design (Planning)

The next stage is the design process which plays an important role in directing the formation of a learning media framework or design that will be implemented at the next stage of development that has been designed (Syahroni & Nurfitriyanti, 2018). At this stage, researchers design research tools, including flow charts and storyboards. A flowchart is used to support the planning of learning media development by describing the general concept or flow of the program. After the flow chart is completed, the next step is to create a storyboard. The storyboard serves as a visualization or sketch of each element in the learning media, including text, usage, and navigation button functions. The storyboard can be seen in Table 2 below.

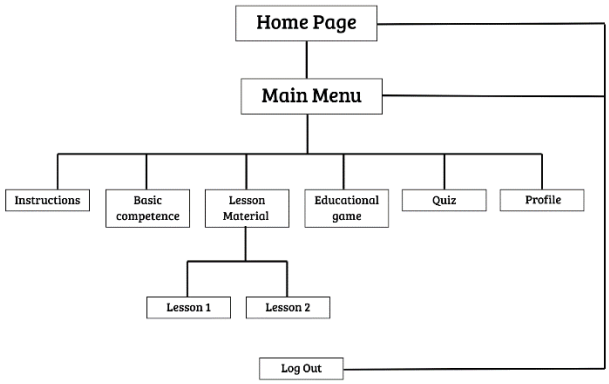

Figure 2. Flowchart

Level Development (Development)

This stage aims to develop and adapt learning media until it is ready to be tested on research subjects. At this stage, researchers design and develop learning media in accordance with the plans that have been prepared at the design stage. This development process involves the use of tools such as Microsoft PowerPoint integrated with Ispring Suite 10, resulting in HTML 5 format. This format is then converted into an application format (.apk) using web2apk software. At this stage, the learning media will be formed thoroughly and optimally, with the main focus on making applications that can be installed on Android devices. This learning application is called SiLogi (Hydrological Cycle)

Application which includes several menu displays, including guides, basic competencies, materials, educational games, quizzes, and profiles.

The process of making learning media in the form of the SiLogi (Hydrological Cycle) application begins with creating a display design for each menu. Furthermore, the next step is to create logos for existing buttons and icons, develop games with the help of a game creation platform, collect learning videos as references that will be included in the developed application, and finally compile evaluation questions and exercises using Ispring Suite 10 software. After all the components have been made, the next step is to combine all the elements that have been prepared into Microsoft PowerPoint so that they become a unified and effective learning media.

After the media creation stage is complete and approval from the supervisor, the next step is to carry out the media validation process by two material experts, one learning media expert, and two teachers or learning practitioners. The validation results from the five validators can be seen in Table 4 below.

Table 4. Validity Results from the Expert Team

Validator	Score		Percentage	Category
	Average	Max Value		
Material Expert 1	39	40	97,5%	Very Valid
Material Expert 2	34	40	85%	Very Valid
Members of the Media	42	48	87,5%	Very Valid
Average Number of Validations			90%	Very Valid

The validation results from three validators showed optimal presentation results, with the validity percentage as follows: material expert 1 reached 97.5% (very valid), material expert 2 reached 85% (very valid), and media expert reached 87.5% (very valid). This shows that the interactive multimedia learning media that has been developed has met the standards to be tested on students, although there are some suggestions and input that need to be considered. Furthermore, some display changes were made to improve certain aspects in accordance with the suggestions and input from the validators (Figure 3).

(A) (B)

Figure 3. (a) Display before citing the source; (b) display after including the source.

Initially, on the material menu display, there were no indicators displayed on the image. However, after receiving input from the validator, changes were made by adding indicators or

descriptions to each process illustrated in the image. This is so that users can better understand the meaning of each picture.

Level Implementation (Implementation)

The implementation stage has an important meaning in assessing the achievement of the objectives set in the manufacture of learning media, as well as assessing whether the media developed is able to overcome the problems identified at the validation stage(Cahyadi, 2019).

Figure 4. The sequence of product development photos for each section

Based on Figure 4 at this stage, interactive multimedia learning media was tested on a group of V-grade elementary school students. To measure the level of practicality, a questionnaire filled out by students was used as an evaluation tool. To measure the level of practicality, a questionnaire filled out by students is used as an evaluation tool. Meanwhile, the practicality survey was used to measure the extent to which this learning media fulfills the practicality aspect of the learning experience. The following are the results of the practicality questionnaire conducted by teachers and students.

Table 5. Teacher Response Results

Validator	Score		Percentage	Category
	Average	Max Value		
Teacher/ practitioner 1	58	60	96,6%	Very Practical
Teacher/ practitioner 2	60	60	100%	Very Practical
Average Number of Validations			**98,3%**	**Very Practical**

From the Table 5, the results of the practicality assessment by teacher or practitioner 1 show an average score of 96.6% (very practical), while teacher or practitioner 2 obtained an average score of 100% (very practical). From these data, it can be concluded that this interactive multimedia learning media has a very high level of practicality in the context of the learning process.

Table 6. Student Response Scale

The number of students	Maximum Score	Results Score
29	1.856	1.616
Present	86,9%	

Criteria	Very Practical

From the Table 6, the results of the trial involving 29 participants showed that the level of practicality reached a percentage of 86.9% with very practical criteria. This shows that interactive multimedia learning media has a very high level of practicality in the teaching and learning process environment.

Level Evaluation (Evaluation)

Figure 5. Documentation photos of the developed product being used in the classroom

At the evaluation stage, the final product is produced in the form of learning media in the form of applications. Furthermore, the learning media is implemented and competence is measured through the final exam. At this stage, the final exam results can be seen in Table 5.

Table 7. Data on students' pretest and posttest results

Ability Learning Outcomes	Rate-rate
Pretest	48,79
Posttest	81,47

Based on the data in Table 7, it can be stated that the average pretest score is 48.79 and the average posttest score is 81.47. This information illustrates the increase in student scores after involving interactive multimedia learning media through the SiLogi (Hydrological Cycle) application during the learning process. By using this learning media, it can be seen that there is a positive contribution to improving student learning outcomes and motivation in the learning context.

The next stage is evaluation. The purpose of the evaluation stage is to assess the quality of the product and the learning process, both before and after implementation (Wilujeng et al., 2020) in addition to assessing whether there is a significant relationship between student learning motivation and student learning outcomes with the use of interactive multimedia learning media. The normality test was conducted using the Shapiro-Wilk method because the number of respondents was below 30. The results of this test showed a significance of 0.142 (Pretest) and 0.300 (Posttest) where both exceeded the value of 0.05. Therefore, based on the decision-making process in the Shapiro-Wilk normality test, it can be concluded that in general the information can be considered normally distributed.

The next stage is to use the T-test to test the difference in the level of motivation and learning outcomes of students before and after the application of interactive multimedia learning media. This test applies the following criteria: (1) If the significance value (sig) < 0.05, then the alternative hypothesis (Ha) can be accepted, (2) If the sig value > 0.05, then the null hypothesis (Ho) will be rejected. The results of the analysis conducted using SPSS 26 software show that the paired sample

test produces a significance value (2-tailed) of 0.000. Because of the sig value. 0.000 <0.05, the conclusion is that the alternative hypothesis (Ha) is acceptable and the null hypothesis (Ho) is rejected. Thus, it can be concluded that interactive multimedia learning media based on Android applications has significant effectiveness in improving the learning experience of grade 5 elementary school students.

DISCUSSIONS

Relevant research

This study builds upon previous research on the development of interactive multimedia learning media. Saifudin et al. (2020) developed interactive multimedia for energy source material aimed at elementary school students, demonstrating its effectiveness in facilitating learning with high validity scores. Similarly, Ambaria et al. (2023) evaluated fraction board learning media, obtaining validity scores of 87.27% from media experts and 100% from material experts, emphasizing the importance of expert validation to ensure media quality before implementation. In addition, Jeneva et al. (2023) created archery-themed learning media for biography text and achieved validity scores of 88.57% from media experts and 90% from material experts, highlighting the potential of interactive media to enhance student engagement and learning outcomes. Ayuningsih (2020) applied Gregory's formula to evaluate the content validity of interactive learning media, which was declared valid based on expert reviews. This method is particularly relevant, as the present study also employs a similar validation process to ensure the accuracy and feasibility of the developed media.

While this research shares a validation approach with these studies, it differs in its focus on learning materials, specifically the hydrological cycle for fifth-grade elementary students. Furthermore, this study not only assesses media validity but also evaluates its practicality and effectiveness through teacher and student feedback as well as learning outcomes tests. This comprehensive approach provides a broader assessment of the quality of the developed interactive learning media.

Test results for the validity of interactive multimedia learning media

The validity test of interactive multimedia learning media was conducted by a team of experts, including material and media specialists. The validation results showed an average score of 90%, categorized as very valid. Assessments from material experts yielded scores of 97.5% and 85%, while media experts provided a score of 87.5%. These findings indicate that the developed learning media possess a high level of validity and are well-suited for use in the learning process. This aligns with the research by Ambaria et al. (2023), which evaluated fraction board learning media and achieved validity scores of 87.27% from media experts and 100% from material experts. Similarly, Jeneva et al. (2023) reported validity scores of 88.57% from media experts and 90% from material experts for archery-themed learning media. Both studies highlight the critical role of expert validation in ensuring the quality and effectiveness of learning media before implementation. Consequently, this study's validation results reinforce the conclusion that multimedia-based interactive media meet high validity standards.

Results of the Practicality Test of Interactive Multimedia Learning Media

The practicality test was evaluated based on teacher and student responses to the use of interactive multimedia learning media. According to the questionnaire results, teachers provided an average score of 98.3%, indicating a very practical category, while students gave a score of 86.9%, which also fell into the very practical category. These findings suggest that the developed learning media are user-friendly, engaging, and effective in supporting the teaching and learning process. This aligns with the study by Saifudin et al. (2020), which demonstrated that interactive media for energy

source material achieved high practicality levels as assessed by teachers and students. Similarly, Ayuningsih (2020) research confirmed that interactive media validated through practicality tests were highly suitable for use in educational settings. These results reinforce the conclusion that interactive multimedia learning media are a practical and effective tool for enhancing student motivation and learning outcomes in elementary education.

Results of the Effectiveness Test of Interactive Multimedia Learning Media

The effectiveness test of interactive multimedia learning media was conducted by comparing students' pretest and posttest results. The data revealed that the average pretest score before the intervention was 48.79, while the posttest average increased significantly to 81.47 after utilizing the interactive multimedia. This improvement highlights the positive impact of interactive media on student learning outcomes. Statistical analysis using a paired sample t-test yielded a significance value of 0.000, which is below 0.05, confirming that the difference between pretest and posttest scores is statistically significant. These findings demonstrate that interactive multimedia learning media has a substantial effect on enhancing student learning outcomes. This conclusion aligns with research by Saifudin et al. (2020), which reported a significant improvement in student learning outcomes on energy source material after using interactive multimedia. Similarly, studies by Arisanti & Adnan (2021), showed that integrating Macromedia Flash 8 in interactive multimedia increased scores from 77 to 93. Research by Heryadi et al. (2017) also confirmed that Adobe Flash-based multimedia significantly boosted student performance.

Therefore, this study's results strengthen existing evidence that interactive multimedia-based learning media significantly improve student learning outcomes, echoing the success of similar tools in elementary school education as reported in previous studies.

CONCLUSION

The main innovation in this research is the development of learning media that integrates multimedia elements (text, images, audio, and animation) with interactivity to increase student motivation and learning outcomes. The developed media product contributes significantly to the successful implementation of 21st-century learning, with a student-centered approach. In addition, this research provides empirical evidence that multimedia-based interactive media can improve the quality of education at the primary school level, especially in the context of thematic learning that is more interesting and fun. Although this study showed positive results, some limitations need to be considered. First, this research was only conducted in one school with a limited sample of students, so generalization of the research results needs to be done with caution. Secondly, although the results of the validity and practicality of the media showed high numbers, the media effectiveness test was conducted only for a limited period. Further research is needed to test the use of this media in the long term and various learning contexts. In addition, the development of media with new and more sophisticated features, such as integration with VR/AR (Virtual Reality/Augmented Reality) technology, could be an interesting direction for further research. Based on the results of this study, it can be concluded that interactive multimedia learning media based on Android applications are very effective in increasing student motivation and learning outcomes at elementary school. This study implies that the use of technology in learning can enrich students' learning experiences, create a more dynamic learning atmosphere, and increase students' involvement in the learning process. Therefore, it is recommended that teachers and other educators consider using multimedia-based learning media in the classroom, especially for materials that require visual and interactive explanations. This research also encourages the need for further training for teachers to maximize the use of technology in learning.

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