



Interactive Learning Multimedia Based *Discovery Learning* Mathematics Subject for Grade 4 Elementary School

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Abstract

This study was motivated by the low academic performance of fourth-grade elementary students in mathematics. The objectives were to: (1) design and develop interactive multimedia based on discovery learning, (2) evaluate the validity of the developed multimedia, and (3) assess its effectiveness in improving student learning outcomes. This research employed a Research and Development (R&D) approach using the ADDIE model, which includes analysis, design, development, implementation, and evaluation phases. Data were collected through questionnaires and tests. Validity was assessed using a 4-point Likert scale and qualitative descriptive analysis of expert feedback on content, design, and media, as well as student responses through individual trials (3 students) and small group trials (9 students divided into 3 groups). Effectiveness was tested using a pretest-posttest design involving 20 fourth-grade students, analyzed with a t-test. Results indicated the multimedia was valid according to experts (85.93%–95%) and received positive responses from students (87.38%–87.73%). The t-test showed significant improvement in learning outcomes. The findings imply that discovery learning-based interactive multimedia is effective in enhancing students' mathematical understanding

Keywords: Development, Interactive Multimedia, Discovery Learning Approach, Mathematics,

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1. Introduction

Mathematics is one of the essential disciplines in developing logical, analytical and systematic thinking skills. (Kusumawati et al., 2021; Yang et al., 2022) In the context of primary and secondary education, mathematics is positioned as the foundation for mastering other disciplines, particularly in science and technology. However, the reality on the ground shows that students' achievement of mathematical competence remains at an alarming level. Survey results from *Programme for International Student Assessment* (PISA) consistently ranks Indonesia at the bottom

in terms of mathematical literacy, reflecting students' weak ability to understand, interpret, and solve numerical-based problems in real contexts.(Erayani & Jampel, 2022; Harahap et al., 2022; Zulqadri & Nurgiyantoro, 2023)This condition indicates a gap between the ideals of mathematics learning, which are expected to produce individuals who are numerically competent and think critically, and empirical facts in the field that indicate students' weak mastery of mathematical concepts.

One of the main causes of this gap is the learning approach which is still conventional, teacher-centered, and has minimal active student involvement in the concept discovery process.(Andilah et al., 2025; Nurmallasari, 2023). Learning that is not contextual and does not stimulate students' curiosity makes mathematics a difficult and boring subject. However, pedagogically, a meaningful learning process will be more optimal when students are actively involved in discovering concepts themselves through direct experience, as emphasized in the learning approach.*discovery learning* (Purnomo et al., 2022; Wardana & Djamaluddin, 2021). This is where the urgency of learning innovation lies, particularly through the use of interactive multimedia that can provide a dynamic, visual, and structured learning experience. The use of multimedia not only facilitates conceptual understanding but also encourages active student participation in the learning process. This research is crucial in response to the need to bridge the gap between the idealism of participatory, discovery-based mathematics education and the reality of stagnant learning.

As a follow-up to common problems in mathematics learning, direct field observations and interviews with classroom teachers responsible for mathematics instruction were conducted. These observations identified a number of issues indicating a weak learning process. Mathematics is considered the most difficult subject for students to understand, particularly in certain topics such as angle measurement, where many students struggle to accurately determine angle sizes. The learning process remains conventional, dominated by lectures and the use of inadequate teaching aids. This situation results in low student participation during the learning process. This learning environment does not provide space for students to explore concepts independently and hinders in-depth conceptual understanding.

Furthermore, the dominant role of teachers in learning causes students to be passive and lack motivation to actively participate in learning activities. Low student interest in mathematics contributes to suboptimal learning outcomes. One factor contributing to weak learning motivation is the limited use of engaging learning media that are appropriate to student characteristics. Currently available media mostly consist of textbooks and visual aids that are no longer representative and unable to provide a visual, interactive, and flexibly accessible learning experience. In this context, the development of interactive learning multimedia is highly relevant. This media can facilitate learning that involves the senses of sight and hearing simultaneously, supports the presentation of material in a visual and engaging manner, and allows students to access the material repeatedly. Thus, the development of interactive multimedia based on*discovery learning*is considered as a potential solution to overcome these problems and improve the quality of mathematics learning as a whole.

Interactive learning multimedia is a form of learning innovation that integrates various media elements such as text, images, audio, animation, and video into a material delivery system that allows for direct interaction between students and learning materials.(Batubara et al., 2023; (Sesriyani et al., 2021)Interactive multimedia can increase the effectiveness of learning because it involves two main channels in human cognition, namely the visual and auditory channels, thus facilitating a deeper and more meaningful information processing process.(Irwansyah et al., 2025; Lindner et al., 2021). Interactivity in multimedia allows students to control the pace of learning, repeat certain sections as needed, and provide immediate feedback, which is crucial in building

conceptual understanding independently.(Nurmawati et al., 2022; Saputra & Salim, 2021). The use of interactive multimedia is also in line with the principles of learning theory, which emphasizes the importance of active student involvement in the process of building knowledge through concrete and contextual learning experiences. In the context of problems encountered in the field, interactive learning multimedia is the right choice because it is not only able to replace conventional media that are no longer effective, but can also provide interesting visual stimuli, increase motivation, and create a more lively and meaningful learning experience for students. By utilizing the potential of multimedia, students are expected to no longer be passive objects in learning, but rather become active subjects who independently explore and build their understanding of the mathematical concepts they are learning.

In line with the use of interactive learning multimedia, the approach *discovery learning* was chosen as the pedagogical basis in this study because it is able to support an active, constructive, and student-centered learning process. *Discovery learning* is a learning approach that emphasizes the process of searching and discovering concepts by students through independent exploration, observation, and problem solving.(Andilah et al., 2025; Purnomo et al., 2022) Learning will be more effective when students discover information or concepts themselves through direct experience, rather than simply passively receiving knowledge.(Purnomo et al., 2022; Wardana & Djamaluddin, 2021) This approach is highly relevant to the characteristics of interactive multimedia, where the visual, engaging, and interactive presentation of material can stimulate students to observe, ask questions, experiment, and draw conclusions about the concepts being studied. In the context of mathematics learning, *discovery learning* encourages students to understand concepts through visual representation and object manipulation, thereby improving conceptual understanding and reasoning power. Thus, the combination of interactive learning multimedia and the learning approach *discovery learning* It is believed to be able to create a learning environment that is not only fun, but also encourages students to be actively and independently involved in building their knowledge, especially in understanding mathematical materials that have been considered difficult and abstract.

In line with the discovery learning approach and the use of interactive multimedia, mathematics learning as a basic discipline has its own characteristics that require the application of appropriate learning strategies. Effective mathematics learning must encompass conceptual understanding, procedural skills, real-life applications, and logical reasoning.(Kusumawati et al., 2021; Nasution & Ritonga, 2023) Mathematics not only functions as a collection of formulas and calculations, but also as a means to develop critical, systematic, and reflective thinking skills.(Nasution & Ritonga, 2023; Rahmawati & Hidayati, 2022). Mathematics learning should not be mechanistic and memorization-oriented, but rather prioritize the process of understanding the meaning of concepts in depth.(Dewi et al., 2023; Nasution & Ritonga, 2023). In this context, the presentation of mathematical material through interactive multimedia can help students understand the relationship between concepts visually and concretely, while the discovery learning approach allows students to experience the mathematical thinking process themselves through discovery and problem solving. By combining mathematical learning theories that emphasize conceptual understanding and students' cognitive engagement, this study aims to create a learning model that not only conveys material informatively, but also builds students' mathematical thinking skills actively and meaningfully.

The material adopted was about angle measurement, on the grounds that the students who were the subjects of the research had never received such material, so as not to damage the effectiveness research conducted. As part of the scope of geometry, the material on angle measurement is one of the important basic competencies that must be mastered by elementary school students, especially in grade IV. This material includes an understanding of the types of

angles, the unit of angle measurement (degrees), the use of angle measuring tools such as protractors, and the ability to determine the size of angles in various contexts.(Hobri et al., 2022; Toshio, 2021b). The stages of understanding geometry in children develop gradually, starting from the recognition of visual forms, observing the properties of shapes, until finally achieving deductive reasoning abilities.(Hobri et al., 2022; Toshio, 2021b). In elementary school, especially fourth grade, students are generally still at the initial visualization and analysis stage, so the learning approach must be concrete, contextual, and visual. Presenting angle measurement material through interactive multimedia is very relevant because it can present dynamic visual illustrations, allow direct manipulation of angles, and provide digital simulations of the use of measuring tools. This approach will make it easier for students to understand abstract concepts such as angle size and measurement in a more realistic and applicable way. Thus, mastery of angle measurement material will be easier to achieve if presented through active, visual, and discovery-based learning experiences, in accordance with the characteristics of the cognitive development of fourth grade elementary school students.

Development of interactive multimedia based on *discovery learning* which focuses specifically on the material "measuring angles" in grade IV elementary school, a topic that is conceptually quite abstract and has not been widely developed in the context of scientific-based mathematical multimedia. Previous studies have focused more on the use of other approaches and platforms that have not specifically reached the material and level examined in this study. The use of different models in the development of interactive multimedia for the secondary level, the use of the Genially platform in thematic learning, and the development of media using Adobe Flash for arithmetic series are some examples of media development with different approaches and different learning objectives.(Fakhruddin et al., 2024; Mulyoto et al., 2023; Septianingsih et al., 2023). In addition, several studies have focused on the development of multimedia based on project-based learning, its use in community service activities, and media for independent learning during the pandemic.(Kristiana & Putriani, 2022; Pratiwi et al., 2023; (Rulyansah et al., 2022)There is also the development of Android-based interactive media for geometry materials and mobile applications with the integration of the latest programming technology, which contributes to the realm of platform-based media development, but has not yet touched on the substance of discovery-based mathematical learning at the elementary level.(Kusumawati et al., 2021; Putri et al., 2023).

Novelty This research is based on the development of interactive multimedia based on *discovery learning* for the material "measuring angles" which aims to encourage active student involvement in building conceptual understanding through exploration, an approach that has not been widely applied at the elementary school level for visual and abstract material. In addition to assessing the validity of the media through the involvement of content, design, and media experts, this study comprehensively measures the effectiveness of learning through a pretest-posttest design and statistical analysis using the t-test to determine the empirical impact on improving student learning outcomes.(Khoirunisa et al., 2023; Umar et al., 2023). Thus, this study presents an original contribution that not only presents a valid and engaging interactive multimedia product, but is also methodologically sound because it combines a scientific approach based on active discovery and quantitative effectiveness testing in basic mathematics.(Fakhruddin et al., 2024; Christiana & Putriani, 2022; Mulyoto et al., 2023; Putri et al., 2023).

This study aims to develop valid and effective interactive learning multimedia based on discovery learning to improve students' mathematics learning outcomes in the topic of angle measurement. The main objective of this development is to provide learning media that is not only visually appealing, but also able to facilitate an active, exploratory, and meaningful learning process in accordance with the cognitive characteristics of elementary school students. Specifically, this study aims to: (1) design and build interactive learning multimedia based on discovery learning that

suits the material needs and characteristics of students; (2) test the level of validity of the developed media through expert assessments of content, design, and media; and (3) test the effectiveness of the media in improving student learning outcomes through pretest-posttest analysis. It is hoped that the results of this study will not only produce feasible and attractive multimedia products, but also provide empirical evidence that the use of the discovery learning approach is effective. *discovery learning* in interactive media can significantly improve the understanding of mathematical concepts, especially in abstract material such as measuring angles, as well as enriching innovative and applicable learning alternatives in elementary schools.

2. Method

This research uses an approach *Research and Development* (R&D) with the ADDIE development model which consists of five main stages, namely *Analysis, Design, Development, Implementation, And Evaluation* (Mesra et al., 2023; (Spatioti et al., 2022) This model was chosen because it provides a systematic structure for designing, developing, and evaluating learning media that are tailored to the needs and characteristics of students. In the analysis stage, learning needs and gaps in students' understanding of angle measurement material are identified. Next, the media design is based on the following principles: *discovery learning* to encourage active student engagement. The development phase includes the process of creating interactive multimedia, which is then implemented in fourth-grade elementary school classrooms. Evaluation is conducted in the form of validity and effectiveness tests to assess the media's feasibility and impact on student learning outcomes.

Data collection was conducted through two main techniques: questionnaires and tests. The questionnaire was used to measure the validity of the media, which was assessed by content experts, design experts, and media experts using a 4-point Likert scale. Individual and small group tests were also conducted to obtain student responses. Data from the questionnaire were then analyzed descriptively and qualitatively, taking into account the percentage of eligibility and the input provided. Meanwhile, the effectiveness of the media was tested through implementation. *pretest* And *posttest* to 20 fourth-grade students to determine improvements in learning outcomes after using the media. Quantitative data from the test were analyzed using a t-test to determine the significance of differences before and after treatment. This approach allowed researchers to comprehensively assess the appropriateness of the media, both in terms of substance, appearance, and its impact on students' conceptual understanding in mathematics learning. The data collection instrument outline is shown in Table 1, Table 2, Table 3, Table 4, And Table 5. The percentage of findings from the validity test results using the instrument is then transformed referring to the guidelines on Table 6.

Table 1. Learning Content Expert Instrument Grid

No	Aspect	Indicator	Item No.	Number of Grains
1.	Curriculum	Suitability of the learning topic. Appropriateness of learning outcomes. Suitability of learning objectives.	1-3	3
2.	Material	According to the cognitive level of students. According to the concept and definition of the material. The examples are presented clearly. The urgency of the content of the material being conveyed. According to the reality of student life. The material is easy to understand. The exercises are balanced with the material provided.	4-13	10

No	Aspect	Indicator	Item No.	Number of Grains
3.	Evaluation	The difficulty of the questions is according to competency.	14-15	2
		Increase students' independence and learning motivation.		
		Able to increase students' knowledge and understanding.		
3.	Evaluation	In accordance with the rules in mathematics learning media.	14-15	2
		According to students' language development.		

Modified from: (Batubara et al., 2023; Hendra et al., 2023)

Table 2. Learning Design Expert Instrument Grid

No	Aspect	Indicator	Item No.	Number of Grains
1.	Appearance	Attractive display for students.	1-3	3
		Accuracy <i>font</i> , text, and animations displayed.		
		Color matching on media.		
2.	Learning	The material is in accordance with learning objectives.	4-5	2
		Objectives are consistent with materials and evaluation.		
3.	Material	Suitability of material to student characteristics.	6-9	4
		Examples are presented clearly.		
		Material according to cognitive level.		
4.	Strategy	The material is presented in an interesting way.	10-12	3
		Able to help students remember the material.		
		Supporting independence and motivation to learn.		
5.	Evaluation	Improve students' knowledge.	13-16	4
		Evaluation is given appropriately.		
		Appropriate and effective number of pages.		
		Instructions for working on the questions are presented clearly.		
		Practice can support understanding of concepts.		

Modified from: (Batubara et al., 2023; Hendra et al., 2023)

Table 3. Learning Media Expert Instrument Grid

No	Aspect	Indicator	Item No.	Number of Grains
1.	Appearance	The learning display is attractive to students.	1-12	12
		The design display is in accordance with student characteristics.		
		Narration according to the material.		
		Accuracy <i>font</i> , so it's easy to read.		
		The attractiveness of size and <i>font</i> .		
		The right composition of colors and fonts.		
		Music according to student proportions.		
		The text is clear, so it is easy to understand.		
		The image can be seen clearly.		
		The right and attractive colors.		
		Interesting animation for students.		
		Audio can be played clearly.		
2.	Technical	The right navigation buttons	13-15	3

No	Aspect	Indicator	Item No.	Number of Grains
		The number of pages is appropriate and effective. Ease of use in operation.		

Modified from: (Batubara et al., 2023; Hendra et al., 2023)

Table 4. Individual and Small Group Test Instrument Grid

No	Aspect	Indicator	Item No.	Number of Grains
1.	Appearance	The appeal of media design. The writing is clear and easy to read. The attractiveness of the animation used. The attractiveness and clarity of the videos uploaded. Navigation buttons that can be used.	1-5	5
2.	Language	The material is explained clearly and is easy to understand. The language is clear and easy to understand.	6-7	2
3.	Strategy	The media is interesting and increases learning motivation. Can increase knowledge.	8-9	2
4.	Learning	Can be used as a learning resource other than books.	10	1
5.	Evaluation	The questions are in accordance with the material so they can be worked on. Creative and innovative quizzes add enthusiasm. Questions according to students' learning abilities. Audio does not disturb concentration. Can be used easily.	11-15	5

Modified from: (Batubara et al., 2023; Hendra et al., 2023)

Table 5. Which Instruments Are Available Pretest-Posttest Student

No	Aspect	Indicator	Item No.	Cognitive Level
1.	Understand the concept of angles and their units of measurement.	a) Explain the meaning of angle. b) Mention the types of angles. c) Explains the unit of measurement of angles (degrees).	1-2 3-4 5	C1 C1 C1
2.	Identifying angles in everyday life.	a) Observe and identify types of angles. b) Grouping angles based on their size.	6-8 9-10	C2 C2
3.	Using an angle measuring tool (protractor).	a) Explain the function of a protractor. b) Measuring the size of an angle with a protractor. c) Reading the angle of the measurement results.	11 12-14 15-16	C1 C3 C2
4.	Solve problems related to angle measurement.	a) Determine the size of the angle of the image. b) Solve story problems on measuring angles.	17-18 19-20	C3 C3

Modified from: (Hobri et al., 2022; Tosho, 2021b, 2021a)

Table 6. Conversion of Achievement Level Scale 4

Achievement Level %	Qualification	Information
76 - 100	Very good	No need to revise
51 - 75	Good	A little revision
26 - 50	Not enough	Many things were revised
0 - 25	Very less	Repeatedly make the product

Sourced from: (Gustina & Dewi, 2021; Milala et al., 2021)

3. Findings

The results of this research are discussed in stages according to the ADDIE model. The first stage in the development of this interactive multimedia is Analysis, which includes an analysis of needs, student characteristics, and the availability of facilities at the school. Through interviews and observations, it was found that teachers have never developed innovative digital media and have

limitations in the use of learning technology. The learning process is still conventional and makes students less motivated, especially in understanding abstract mathematical materials such as angle measurement. In addition, the results of observations of students showed low interest in learning due to monotonous lecture methods, as well as the need for more interesting media that supports concept visualization. Although facilities such as projectors, speakers, laptops, and internet connections are available, their use has not been optimized in learning. Based on the results of this analysis, it is deemed necessary to develop learning media that can address the challenges of mathematics learning in grade IV elementary school by utilizing the discovery learning approach in the form of interactive multimedia.

Entering the second stage, namely Design, development begins with systematic planning of the structure and content of multimedia. The main software used is *Smart Apps Creator 3*, with support *CanvaPro* for visual design as well *CapCut* for audio and video processing. The design starts from the compilation *flowchart* to describe the media flow, followed by the creation *storyboard*. It includes a visual display of each section of the media, from the initial menu, learning objectives, materials, videos, evaluations, and developer profiles. This design is designed to support a flexible, engaging, and user-friendly learning process. Furthermore, assessment instruments are developed in the form of questionnaires for validation by content, design, and media experts, as well as question instruments for evaluating effectiveness.

The third stage, Development, is done by integrating all elements such as text, images, audio, and video into a single, interactive multimedia product. This media allows students to explore the material independently and contextually. The media display is designed to be intuitive and support active learning activities, with clear navigation and automatic evaluation features that provide feedback. The developed media is then tested for validity by experts and revised based on the suggestions given to ensure product quality before being implemented in the classroom. The display of the development results is shown in [Figure 1](#)



Figure 1. Media Development Results Display

The implementation stage is carried out by testing interactive learning multimedia based on *discovery learning*. The fourth-grade elementary school students were used as research subjects. This

implementation aimed to determine the extent to which the developed media could be used effectively in the learning process and to observe student responses and engagement during media use. Implementation activities were carried out directly in mathematics lessons on angle measurement. The teacher acted as a facilitator, while students were guided to learn actively through exploring the media's features, such as interactive materials, explanatory videos, and game-based evaluations. During this process, students demonstrated increased learning motivation and enthusiasm in participating in the learning process, as reflected in their involvement in answering questions and trying out various available menus. This implementation also provided an opportunity to observe the suitability of the media design with student characteristics and the learning environment, thus providing an initial overview of the media's effectiveness before entering the evaluation stage. Entering the evaluation stage, the results of the analysis at this stage are listed in Table 7.

Table 7. Results of the validity and effectiveness test of the media

No	Subject	Results	Qualification
Validity Test Results			
1.	Test the Learning Content Member	95,00%	Very good
2.	Learning Design Expert Test	85,93%	Very good
3.	Test the Learning Media Member	93,33%	Very good
4.	Individual Student Trial	87,73%	Very good
5.	Small Group Student Trial	87,38%	Very good
Effectiveness Test Results			
1.	<i>Pre-test And Post-test</i>	Say. $0.00 < 0.05$	Significant

4. Discussions

Validation test by content experts on interactive learning multimedia based on discovery learning. The results show that substantially, this media has been in accordance with the characteristics of the material "measuring angles" which requires conceptual understanding and spatial thinking skills that are quite complex for elementary school students. Experts assessed that the content presented has reflected basic competencies, learning indicators, and objectives relevant to the curriculum, and is able to accommodate a discovery approach in its presentation structure. This assessment indicates that the media has successfully combined conceptual and visual aspects in an integrated manner, which is important in facilitating students' cognitive processes on abstract material. This finding is in line with constructivist learning theory which emphasizes the importance of active and exploratory learning experiences in building understanding, and supports the principled discovery learning which allows students to construct meaning through direct interaction with the material. In the context of previous research, this approach has not been widely found at the elementary school level, especially in the material on angle measurement, which is mostly still delivered conventionally or through a general thematic approach. While previous studies have developed many platform-based media such as Genially, Adobe Flash, and Android applications with a focus on different materials or levels, not many have systematically integrated the active discovery approach in the context of elementary mathematics learning. (Fakhrudin et al., 2024; Mulyoto et al., 2023; Septianingsih et al., 2023). Content validation in this study not only confirms the suitability of the material substance with curriculum standards, but also confirms that this media design has filled a gap in the development of interactive multimedia for complex visual materials at the elementary education level. (Kristiana & Putriani, 2022; Pratiwi et al., 2023).

Validation by design experts on interactive learning multimedia based on discovery learning shows that the media design has met the principles of good learning design, particularly in terms of navigation clarity, layout consistency, text readability, and the balance between visual elements, audio, and interactivity. Design experts stated that the interface structure was designed systematically and intuitively, making it easier for students to access and explore learning content

independently. The alignment between visual design and instructional functions was also considered successful in creating a conducive and engaging learning atmosphere, particularly in the material "angle measurement" which requires spatial understanding and visual processing. A design approach that prioritizes user experience at this basic level it is also in line with the principles of discovery learning, which positions students as active subjects in the process of discovering and constructing knowledge. These validation results support the findings of several previous studies that emphasize the importance of interactive and aesthetic design in optimizing the effectiveness of learning media, but differ from several previous studies that focused more on specific platforms or technologies without emphasizing the integration of scientific-based and exploratory instructional design. (Fakhruddin et al., 2024; Septianingsih et al., 2023). Some media developed in previous studies, such as based project-based learning or development for independent learning, has not explicitly prioritized design to facilitate the discovery of mathematical concepts in visually complex materials, such as angle measurement. (Alyusfitri et al., 2023; Kristiana & Putriani, 2022). The design validation in this study strengthens the methodological and pedagogical contributions of the media developed, namely combining aesthetics, functionality, and instructional direction in one adaptive interactive multimedia design for elementary school students. (Mulyoto et al., 2023; Umar et al., 2023).

Validation by media experts on interactive multimedia based on discovery learning. The results of a study on the topic of "measuring angles" for fourth-grade elementary school students indicate that this media meets the technical and functional principles of good digital learning media. Aspects such as the integration of visual, audio, and navigation elements, the quality of the interface, and the clarity of instructions are considered to support active student engagement in the learning process. Media experts also assessed that the selection of software and media formats is appropriate for the characteristics of elementary school-aged students and provides a responsive and accessible learning experience. Another advantage lies in the media's ability to display visual representations of abstract mathematical concepts such as angles through engaging animations and interactivity, which strengthens students' absorption of the material being taught. This aligns with multimedia learning theory, which states that the success of media is determined not only by the content but also by how that content is packaged and presented in a communicative and meaningful manner. These findings support previous results highlighting the importance of technical and aesthetic quality in interactive learning media, although the approaches used in previous studies were more diverse and did not specifically address the topic of measuring angles and the approach of discovery learning (Lindner et al., 2021; Sulistianti & Tegeh, 2022). Some studies have developed project-based multimedia, mobile learning, or thematic learning, but has not yet reached the visual and functional integration designed to support exploratory discovery of concepts in basic mathematics topics. (Kusumawati et al., 2021; Sulistianti & Tegeh, 2022). Validation from media experts in this study strengthens the original contribution that focuses not only on content innovation, but also on the technical functionality of the media to facilitate deep and meaningful learning experiences. (Putri et al., 2023; Umar et al., 2023).

Individual validation tests on students were conducted to determine students' initial responses to the use of interactive multimedia based on discovery learning on the topic of "measuring angles," which is conceptually abstract and often difficult to understand. Validation results show that students can interact effectively with the developed media and understand the navigation flow and learning content well. Student responses indicate that the attractive visual display, easy menu access, and presentation of material accompanied by animations and interactive exercises can increase their interest and engagement in learning. This indicates that a scientific approach combined with interactive visual elements can be a solution to the problem of material abstraction in basic mathematics learning. This finding aligns with constructivist theory in mathematics

learning, where conceptual understanding can be built through students' active involvement in independent exploration assisted by media designed contextually and communicatively. Compared with previous research, most studies only emphasize the feasibility of media from the perspective of experts or teachers, without directly examining the user experience of individual students.(Septianingsih et al., 2023; Sulistianti & Tegeh, 2022). In addition, previous research has focused on different levels of education and materials, such as the use of Adobe Flash for arithmetic series or the use of the Android platform in geometry materials.(Mulyoto et al., 2023; Putri et al., 2023; (Rulyansah et al., 2022), so the results of the individual validation in this study provide a new contribution in seeing the extent to which students are directly able to utilize media to build exploratory conceptual understanding. Thus, this individual test strengthens the finding that the developed media is not only valid in terms of content and design, but also feasible and effective from the perspective of students' direct learning experiences.(Kristiana & Putriani, 2022; Umar et al., 2023).

The results of the validation test through small groups on interactive multimedia based on discovery learningThe results showed that the developed media was able to create a more collaborative, active, and enjoyable learning atmosphere for fourth-grade elementary school students in studying the material "angle measurement." Overall student responses indicated that the attractive visual display, clear audio narration, easy navigation, and the gradual presentation of the material made it easier for them to understand the abstract concept of angles. Small group activities in accessing and discussing media content also strengthened the process of discovering concepts independently and with peers, which is a key principle in the learning approach.discovery learningThis confirms that a scientific approach through guided exploration is highly relevant for conceptual elementary mathematics learning. This finding is consistent with several previous studies that highlight the importance of interactive media in increasing student engagement, although most previous studies developed media for other levels or materials, such as the Missouri Mathematics Project model for secondary level, Genially in thematic learning, or Adobe Flash for arithmetic sequences.(Mulyoto et al., 2023; Septianingsih et al., 2023). Similarly, other studies that develop project-based media or Android applications for geometric materials have not explicitly integrated the principle of active discovery in basic mathematical learning.(Kusumawati et al., 2021; Pratiwi et al., 2023; Putri et al., 2023). Small group testing in this study provides contextual evidence that interactive multimedia with a discovery approach can facilitate collaboration, increase learning engagement, and deepen student understanding.

The effectiveness test conducted through a pretest and posttest design showed that the use of interactive multimedia based on discovery learninghad a positive impact on improving student learning outcomes on the topic "angle measurement" in fourth grade elementary school. Learning that was initially passive and lecture-dominated changed to more active and student-centered, enabling them to build conceptual understanding through independent exploration and discovery. The increase in posttest scores compared to the pretest indicates that the developed multimedia is not only visually appealing but also able to convey the substance of the material effectively. This effectiveness is supported by visual elements, animation, and interactivity that are able to bridge abstract concepts into more concrete and easily understood by elementary-aged students. This finding is in line with constructivism theory, which states that learning will be more meaningful if students are directly involved in the process of constructing their own knowledge. The results of this study are also in line with previous findings that indicate that interactive media can improve student understanding and learning outcomes, although the focus and approach are different. For example, development with other platforms for learning on different materials has shown positive results, but has not yet accommodated discovery-based mathematical learning at the elementary school level.(Gumelar et al., 2021; Lindner et al., 2021). Other studies that use project approaches,

media during the pandemic, or Android applications for geometry materials have also not reached the exploratory conceptual aspects of abstract materials such as angle measurement.(Kusumawati et al., 2021; Rohmah & Tegeh, 2022; Sangian et al., 2024). Original contribution in the context of the effectiveness of learning media based on discovery learning on basic mathematical material that has not previously been touched upon in depth.

The novelty of this research lies in the development of interactive multimedia based on discovery learning which specifically focuses on the topic of "measuring angles" in fourth grade elementary school—a topic that is conceptually abstract and has not been widely explored in studies of the development of scientific-based mathematical multimedia at the elementary level. Previous research has emphasized different approaches and platforms, such as at different levels, the use of Genially for thematic learning, or the use of Adobe Flash for arithmetic series material.(Fakhrudin et al., 2024; Mulyoto et al., 2023; Septianingsih et al., 2023) Meanwhile, the development of interactive multimedia in the context of elementary education is more often associated with project-based learning models, community service activities, and independent learning media during the pandemic, which have not yet targeted mathematical materials that require exploratory visual understanding, such as measuring angles.(Kristiana & Putriani, 2022; Pratiwi et al., 2023; Rulyansah et al., 2022). The use of Android-based technology and modern programming has also been developed for geometry materials and educational mobile applications, but has not yet integrated the approach in depth. discovery learning which prioritizes active student participation in the process of constructing mathematical meaning(Kusumawati et al., 2021; Putri et al., 2023) This research not only presents multimedia products that are developed contextually and scientifically, but also validated by content, design, and media experts, and its effectiveness is tested quantitatively with a pretest-posttest design and t-test analysis to obtain empirical evidence of significant improvements in student learning outcomes.(Khoirunisa et al., 2023; Christiana & Putriani, 2022; Mulyoto et al., 2023; Putri et al., 2023; Umar et al., 2023).

The findings of this study have significant implications for the development of educational science, particularly in the field of mathematics learning technology at the elementary school level. The use of interactive multimedia based on...discovery learning proven to be able to bridge the gap between the abstract nature of mathematical material and the cognitive abilities of elementary school students who are still developing. The main contribution of this research lies in the presentation of a learning model that systematically integrates scientific principles, interactive visualization, and exploratory learning in one multimedia device that has been proven valid and effective. Thus, this research broadens the scientific horizon in the development of digital learning media based on a constructivist approach, as well as providing methodological and pedagogical references for researchers, developers, and educators in creating learning innovations that are adaptive to the characteristics and learning needs of students.

This study has several limitations that need to be considered in its further application and development. One limitation is the scope of the trial subjects, which was still limited to one group of students in one elementary school, so generalizing the research results to a broader context requires caution. Furthermore, the effectiveness testing only focused on one learning material, namely angle measurement, so it does not yet reflect the media's functionality in other mathematics topics. Recommendations that can be given based on these limitations are the need for replication and further testing of the developed learning media, both at different grade levels and on other mathematics materials, to test the stability of its effectiveness. Furthermore, future research is recommended to involve a larger and more diverse number of subjects, and integrate other aspects such as increasing students' motivation and critical thinking skills to strengthen the scientific and practical contributions of the development of multimedia-based learning. discovery learning This.

5. Conclusion and Suggestion

This study concludes that the development of interactive multimedia based on discovery learning is an effective conceptual solution to address problems in elementary school mathematics learning, particularly in abstract materials such as angle measurement. The integration of a scientific approach in the form of visuals, audio, and interactivity encourages students to actively explore concepts, build understanding independently, and increase engagement in the learning process. Validation by experts and testing on students shows that this media is not only suitable for use but also able to optimize learning outcomes meaningfully. Thus, these findings reinforce the importance of developing learning media that are not only adaptive to the characteristics of the material but also able to respond to students' learning needs constructively and contextually in elementary mathematics learning.

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