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Development of Interactive Media for Learning the Pythagorean Theorem Based on Ethnomathematics in Mosque Architecture

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ABSTRACT

This study aims to develop interactive learning media for the Pythagorean Theorem based on ethnomathematics using the architecture of the Medan Grand Mosque as a learning context. This research is motivated by students' low interest and understanding in mathematics, especially in the Pythagorean Theorem material. The development method used is the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The validation results indicate that the media obtained a highly feasible category, with an average score of 92.5% from media experts and 91% from material experts. The teacher and student responses were 88% and 79.95%, respectively, based on practical criteria. The effectiveness test through N-Gain obtained an average value of 0.520 (moderate category). These results suggest that interactive media based on ethnomathematics can enhance students' understanding of mathematical concepts and provide more engaging learning experiences by connecting the material to local culture.

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1. INTRODUCTION

Education is crucial in a country because it produces quality human resources. Information and communication technology developments have impacted various aspects of life, including education. Educators are required to adapt to new technologies, while students are the primary subjects of every change [1], [2]. The aim of education, as mandated in the 2003 National Education System Law, is to enlighten the nation's life and produce people who are faithful, pious, and independent [3].

Mathematics is a very important basic science, but it is often considered difficult, frightening, and tedious. Many students experience anxiety when learning mathematics, which leads to low motivation to learn [4]. This emphasises the need for more innovative learning strategies so that students see mathematics not merely as a collection of formulas, but as a science relevant to everyday life. Therefore, mathematics learning should be delivered in a contextual and enjoyable manner to stimulate students' interest in learning. Mathematics is not only intended to make students proficient in counting, logic, or problem-solving. Mathematics also develops students' affective aspects [5]. Mathematics is a fundamental science that contributes to the development of various other sciences and technologies [6].

One approach believed to address these challenges is ethnomathematics. Ethnomathematics is a learning approach that connects mathematical concepts with the culture of a community [7], [8], [9], [10]. Through this approach, students are encouraged to discover the real relevance of mathematics lessons to their daily lives and the cultural heritage around them [11]. In this way, learning becomes more meaningful because students understand both the theory and its application within their own cultural context. Ethnomathematics presents an excellent opportunity to create a more engaging and contextually relevant learning environment.

The Independent Curriculum currently implemented in Indonesia strongly supports context-based and environmental learning. This is because education and culture are closely intertwined. Education is not only about the transfer of knowledge, but also the transmission of cultural values [12]. Thus, integrating ethnomathematics into mathematics learning is a pedagogical strategy that aims to preserve local culture while strengthening students' sense of identity as part of society.

One cultural heritage that can be used as a resource for ethnomathematics is the Al-Mashun Grand Mosque in Medan. This mosque boasts beautiful architecture with geometric shapes rich in mathematical value. For example, the shapes of triangles, squares, symmetry, and building proportions can be used as teaching materials to introduce the concept of the Pythagorean Theorem. Using the mosque's architecture as a context, students can understand that mathematics is not a standalone science, but rather an integral part of their lives and culture.

In addition to cultural approaches, the use of technology in learning is equally important. Technology-based interactive media also allows teachers to prepare teaching materials as a learning tool, Siregar et al. [13] presenting material more interestingly, combining text, images, animation, and audio so that learning is not monotonous [14], [15]. With interactive media, students can be more active in exploring concepts, making learning a more meaningful experience. Therefore, integrating ethnomathematics with interactive media is a strategic step in delivering innovation in mathematics learning.

This research aims to develop an interactive learning medium for the Pythagorean Theorem based on ethnomathematics within the architectural context of the Medan Grand Mosque. The primary objective of this research is to produce a valid, practical, and effective learning medium for enhancing students' conceptual understanding. Furthermore, this research also aims to analyse teacher and student responses to the developed medium to determine how much it assists in the mathematics learning process.

Previous research has demonstrated the success of developing ethnomathematics-based media. For example, Lutfhvia Rohmaini developed an ethnomathematics-based module using the Wingeom application. The results of this study indicate that the developed learning module meets the criteria for being feasible/valid and attractive for use as a learning resource in mathematics learning [16]. Yoseph Batkunde also said that he developed an ethnomathematics-based e-module, which was proven to show that the development of the Tanimbar Ethnomathematics-based Mathematics E-Module was very valid/very suitable for use in junior high school students learning with a percentage of 91.7% and obtained trial results in learning with an average student completion value in PB1 and PB2 of 88.5% with a very good category [17]. However, this research differs fundamentally because it develops interactive media within the architectural context of the Medan Grand Mosque. The uniqueness and novelty of the research are both significant.

Although numerous studies on ethnomathematics have been conducted, a notable gap remains, as few have integrated interactive media with local cultural objects, particularly mosque architecture. Most studies focus on simple printed or e-modules. Therefore, this study aims to address this gap by presenting interactive media that is more modern, contextual, and aligned with developments in educational technology.

This research is expected to improve students' conceptual understanding of the Pythagorean Theorem and enhance their motivation to learn, as well as their appreciation for local culture. The integration of interactive media and ethnomathematics offers a more engaging and meaningful learning experience. This is crucial for students to excel academically and develop a deeper appreciation for their cultural heritage. Based on the above description, this research is crucial for providing innovative solutions that foster contextual, enjoyable, and meaningful mathematics learning.

Based on the results of the observations carried out, it was concluded that attempts have been made to present variations in learning methods and utilise useful learning resources to support the Merdeka curriculum. In addition, the availability of the internet and technological facilities in schools opens up opportunities to further integrate technology into the learning process, increasing the effectiveness and interactivity in working on the Pythagorean theorem. Therefore, this study aims to develop interactive media for learning the Pythagorean theorem based on ethnomathematics, with a focus on the architectural structure of the Grand Mosque as a learning context using an ethnomathematics approach that links mathematics with culture, as a form of preserving existing culture, and increasing student attraction to be more motivated to learn mathematics and can also help students in understanding students' concepts on the Pythagorean theorem material.

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2. METHOD

This research uses the Research and Development (R&D) model. Research and development is a method used to produce a specific product and test its effectiveness [18]. This development research uses the ADDIE model. The ADDIE model comprises five stages: Analysis, Design, Development, Implementation, and Evaluation.

In the analysis stage (Analyse), the activities carried out are analysing observation and interviews with grade VIII mathematics teachers. The analysis carried out consists of a situation analysis, a teacher needs analysis, a student needs analysis, a basic competency analysis, and a review of Pythagorean theorem material. A situation analysis is conducted to identify and classify problems faced by teachers related to the learning media they have used so far, and then to find solutions by developing new learning media. Needs analysis is used to determine the learning media required by students to enhance the quality of learning and improve student learning achievement. Teacher and student needs analyses are used to identify problems in learning grade VIII mathematics. Basic Competency Analysis (KD) is used to develop indicators that will be included in this media.

In the design stage, the researcher undertook several work steps to initiate the initial activities. First, the researcher began designing the media product using Microsoft PowerPoint 2010 on a computer. In the second step, the researcher collected materials (teaching materials, backgrounds, images, and animations). The materials collected were teaching materials on the Pythagorean theorem obtained from various relevant sources, in accordance with the Pythagorean theorem material used in the development of learning media. The third step involved designing the appearance and instructions for using the learning media. The final step carried out in this study was designing a media feasibility assessment instrument, which consisted of an expert validation sheet and a student response questionnaire sheet.

In the Development stage, activities are carried out to develop interactive learning media according to the prepared design. The design of the learning media display is then created in Microsoft software. The user manual is packaged in book form. The media created with Microsoft PowerPoint software is packaged in a Google Drive link that can be accessed via laptop, computer, or smartphone. The media and user manual that have been packaged are then consulted with the supervising lecturer. The purpose of the lecturer's check is to review and provide feedback or suggestions on the interactive learning media that have been created. After being reviewed by the lecturer, the learning media are ready to be validated by an expert (Validator) until they are declared valid. If the interactive learning media receive an invalid category based on expert validation, then revisions are made to the learning media first. Learning media with a valid category, as approved by an expert, are ready to be tested for practicality by students.

In the Implementation stage, the researcher tested the PowerPoint learning media product. The trial in question was limited to assessing the practicality of the learning media. This trial involved 32 students from Al Ulum Terpadu Medan Islamic Middle School. Because this trial was not conducted in the school's computer laboratory, students were asked to view the learning media using an Infocus in front of the class. During the product trial, the researcher explained the contents of the media, including the hyperlink buttons on the slides and the lesson material. To see the level of practicality of the learning media developed by the author, namely by looking at the results of the questionnaire responses of mathematics teachers and students after the media was completed. The developed learning media is considered practical if the assessment criteria for the results of the questionnaire responses from mathematics teachers and students at least reach the 'good/quite practical' category.

The evaluation phase aims to assess the developed media. Based on the evaluation results, the researcher made slight revisions to the product based on feedback from students, experts, and teachers. When using the media in the ethnomathematics-based learning process through the interactive PowerPoint application, students felt enthusiastic and supported in their learning. They were happy because the PowerPoint application made it easier to understand the material presented. The difficulty lies in the network students use, as the PowerPoint file size is quite large, requiring a stable internet connection to download the PowerPoint file through the WhatsApp learning group application.

This research data consists of two types, namely qualitative data and quantitative data. Qualitative data were obtained from suggestions from validators and students regarding interactive learning media for the Pythagorean theorem material in class VIII SMP/MTs, using PowerPoint. Quantitative data were obtained from validation sheets and student response questionnaires administered to validators and students to assess the interactive learning media for the Pythagorean theorem material in class VIII SMP/MTs using PowerPoint. Validity tests on this interactive learning media consist of two types: validity by material experts and media experts, conducted by three experts. Practicality tests on this interactive learning media were conducted using student response questionnaires by 32 students from SMP Islam Al Ulum Terpadu Medan. The data analysis techniques in this study consisted of analysing interactive learning media validation sheets created using PowerPoint by experts and student response questionnaire sheets.

3. RESULTS AND DISCUSSION

3.1. Results

This study aims to develop interactive learning media for the Pythagorean theorem, based on ethnomathematics, within the architectural structure of the Grand Mosque, targeting eighth-grade junior high school students. The development model used in this study is the ADDIE development model, which consists of five stages as previously mentioned: Analysis, Design, Development, Implementation, and Evaluation. The results of developing this learning media are presented according to the stages of the ADDIE development model.

Analysis

The initial stage in the ADDIE development model is the analysis stage. This stage aims to determine why this interactive PowerPoint-based learning media is needed and for whom it is being developed. Several activities are carried out at this stage, as follows.

a. Needs Analysis

At this stage, observations and interviews were conducted with subject teachers to determine the learning media provided by the school and the students' conditions during mathematics lessons. Furthermore, the appropriateness of the software used to develop learning media tailored to students' needs was also taken into consideration. The software was used to develop interactive learning media for the Pythagorean theorem based on ethnomathematics. This activity also analysed the strengths and weaknesses of the media created using PowerPoint to ensure it could be tailored to students' needs.

b. Curriculum Analysis

This activity relates to selecting material to be presented in the developed media. In this study, the independent mathematics curriculum was used for grade VIII.

c. Student Characteristics Analysis

Characteristic analysis was conducted to determine the objectives of media development. Based on the researcher's observations during class, most students appeared uninterested in learning that only used the whiteboard as a medium. Some students appeared bored and inattentive, while most were busy taking notes in their notebooks. The teacher used a lecture method for most of the learning process, making students passive and unenthusiastic.

Additionally, researchers conducted interviews with several students. According to the interviews, almost all students already use smartphones and spend time at home playing with them. However, only a few have used applications for studying or accessed websites to support their learning activities. Students also expressed their hope that teachers would use technology-based facilities in teaching to make learning more engaging. Several other students expressed their lack of enthusiasm for reviewing material learned in school when relying only on personal notes. This is why students prefer to spend their time on less valuable activities on their smartphones.

Due to this, learning media are needed that can support the student learning process in the classroom and at home in a more interesting way, so that they can encourage students' enthusiasm for learning.

Design

In this second stage, the researcher carried out several work steps. First, the researcher began designing the media product using Microsoft PowerPoint 2010 on a computer. The second step is for the researcher to compile the material to be included in the PowerPoint learning media, which includes the subject matter to be achieved by students according to the Basic Competencies (KD) and Competency Achievement Indicators (IPK). In addition, in the final step, the researcher also designed slides using colour, animation, audio, and hyperlinks that were useful for moving between slides. The researcher also created a media validation sheet and a student response questionnaire. This PowerPoint learning media was designed for several meetings with the following explanation:

1) In the first meeting, students understand and study the general form of Pythagoras and the steps for solving the Pythagorean theorem.
2) In the second meeting, students understood and studied Pythagorean triples.
3) In the third meeting, students can model the Pythagorean theorem in everyday life.

Development

At this development stage, the researcher developed the PowerPoint learning media design. The interactive learning media display design was then created in Microsoft PowerPoint using materials collected by the researchers, including images, animations, and backgrounds. At this stage, the user manual, created in Microsoft Word, was packaged into a guidebook. The following is an example of the home page and function button page that will be compiled in Microsoft PowerPoint, as well as the material page.

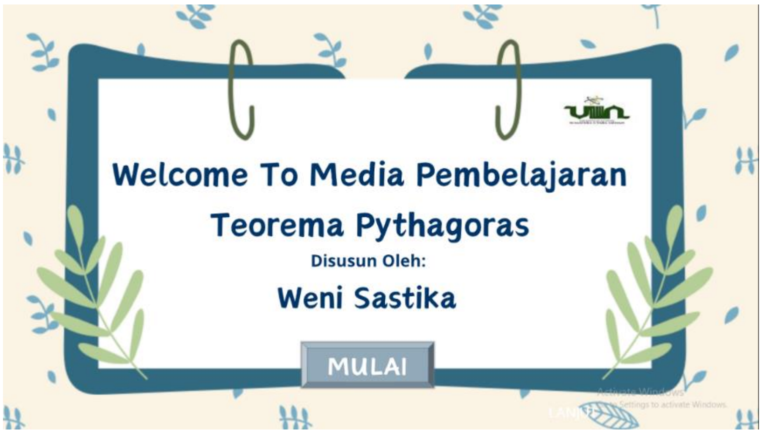


Figure 1. Home Page View

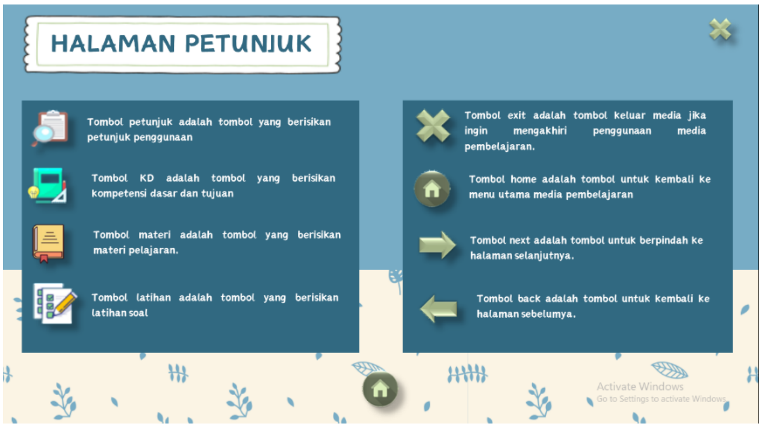


Figure 2. Display of the User Instructions Page

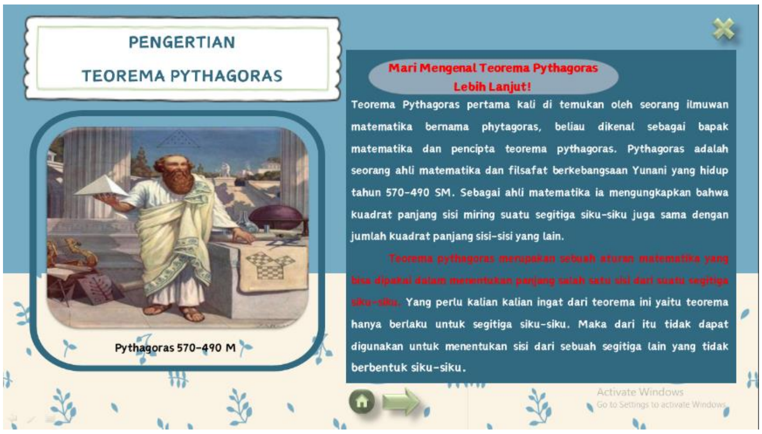


Figure 3. Display of the Pythagorean Theorem Material Page

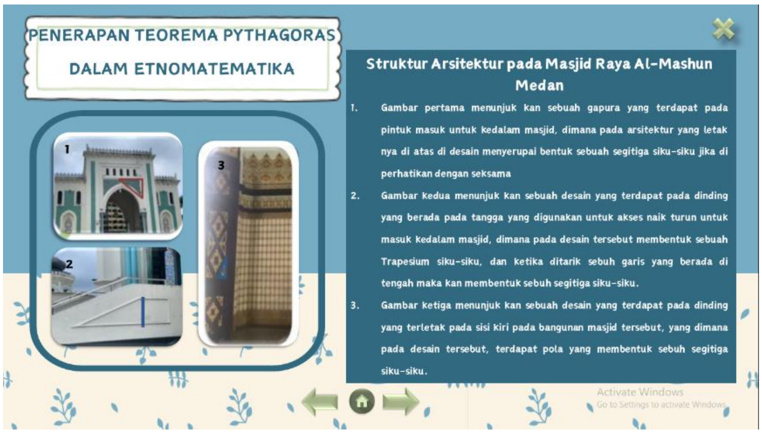
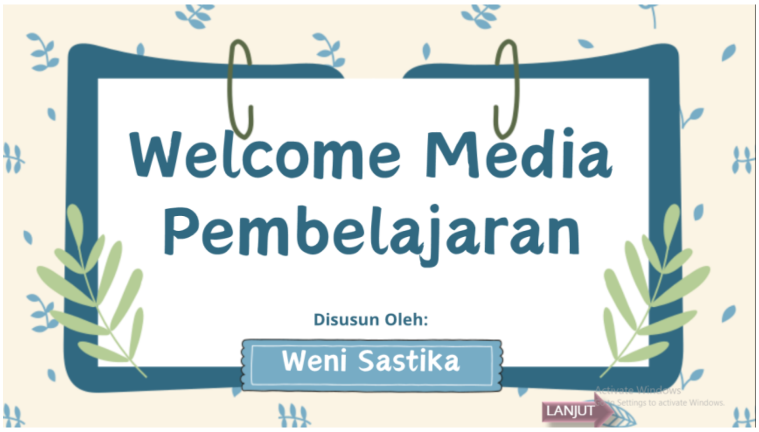
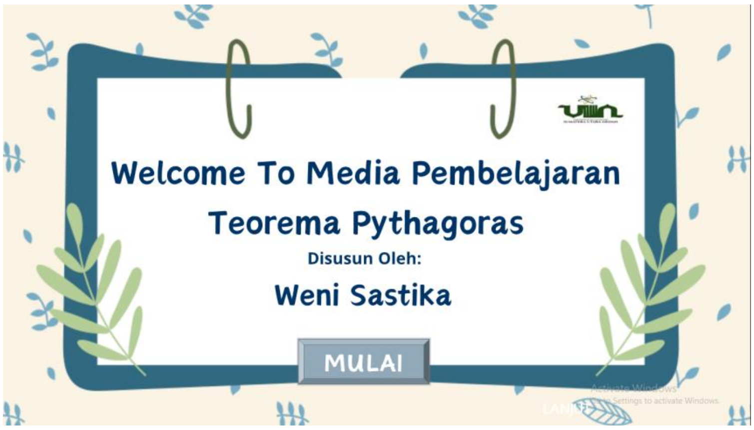
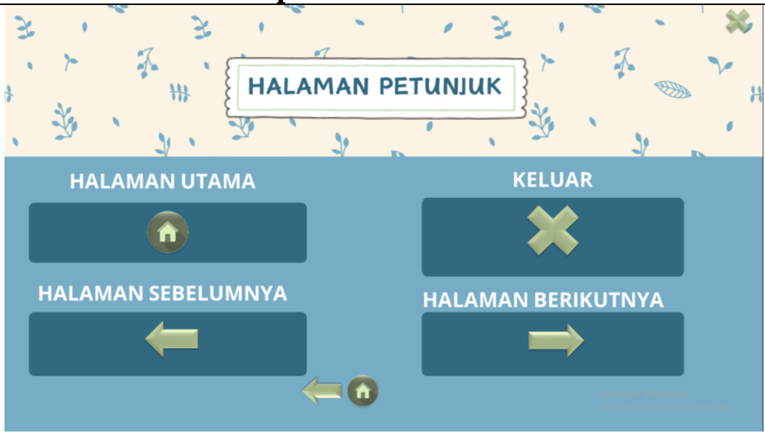
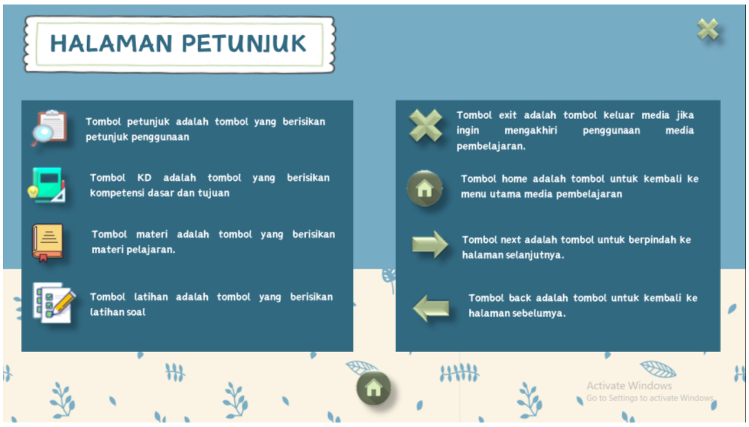
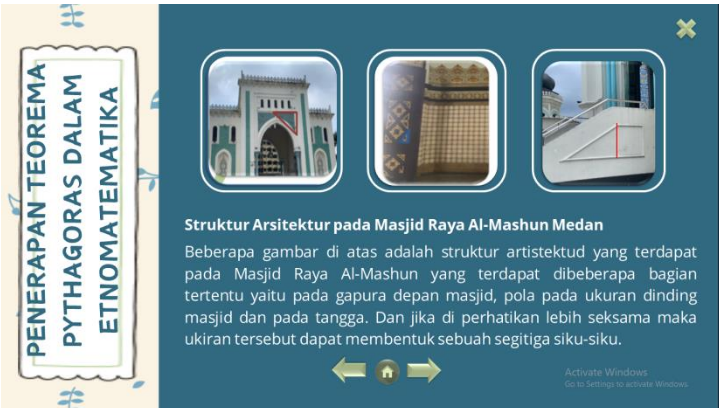


Figure 4. Display of the Material Page on the Application of the Pythagorean Theorem in Ethnomathematics

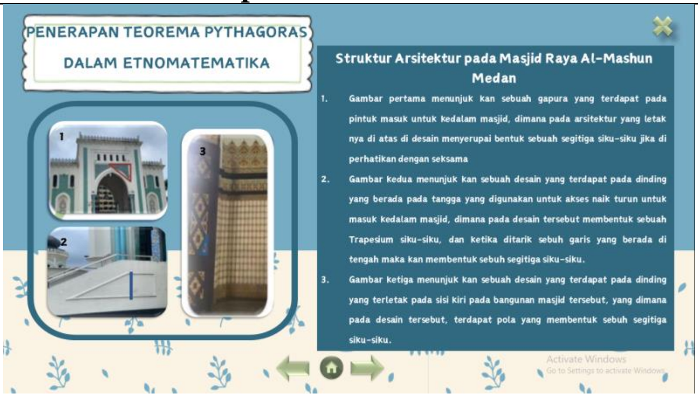
The interactive learning media developed using PowerPoint was then validated by three experts, two of whom are material experts and one media expert.

Table 1. Suggestions and Results of Improvements from Expert Validation

Suggestion	Improvement Results
The cover should contain media material and the institute logo. The "Start" button should be more eye-catching and placed in the centre.	Previously, the cover page did not contain the institute's logo and a material description.  
The instructions page must contain all the buttons in the media.	Previously, the instructions page only contained partial information about the buttons on the media.

Suggestion	Improvement Results
	 
On the material page, the design is inconsistent, and the title text is not horizontal.	Previously, a different and inconsistent design was used on the material page. 

https://doi.org/10.58421/misro.v4i3.728

Suggestion	Improvement Results
	

Implementation and *Evaluation*

This stage is a continuation of the development stage. At this stage, all media designs that have been developed are implemented after revisions to the PowerPoint-based mathematics learning media. The researcher conducted a trial of the PowerPoint learning media product. The trial in question is a limited trial to see the practicality of the learning media. This trial involved 32 students from Al Ulum Terpadu Medan Islamic Middle School. Because this trial was not conducted in the school's computer laboratory, students were asked to view the learning media using an Infocus in front of the class. During the product trial, the researcher explained the contents of the media, including the hyperlink buttons on the slides and the lesson material. To see the level of practicality of the learning media developed by the author, namely by looking at the results of the questionnaire responses of mathematics teachers and students after the media was completed. The developed learning media is considered practical if the assessment criteria for the results of the questionnaire responses from mathematics teachers and students at least reach the good to fairly practical category.

In this evaluation stage, researchers will test the normality of the pre-test and post-test data to determine whether the data obtained is normally distributed. The following are the results of the normality test:

Table 2. Analysis of Student Completion Percentage

No	Calculation	Mark	
		Pre-Test	*Post-Test*
1	Students who have completed	9	29
2	Students who do not complete	3	3
3	Percentage of completion	9.37%	90%
	Category	Enough	Very good

Based on the calculation of the percentage of calculus above, it can be seen that the number of students during the pre-test was only 59.37% with a sufficient category, while in the post-test stage, the percentage of student completion was 90%, which means it falls into the very good category. It can be concluded that the learning media produced and tested on students are effective for use in learning.

Table 3. Results of Student Learning Tests

No	Number of Students	N-Gain Score	Interpretation
1	9	$0.70 < g < 1.00$	Tall
2	16	$0.30 < g < 0.70$	Currently
3	6	$0.00 < g < 0.30$	Low
4	2	$g < 0.00$	Stable

Based on the calculation results using the Gain Normality test formula, the average obtained is 0.520. Seen from the table of interpretation categories of the effectiveness of Gain Normality, it can be concluded that the use of mathematics learning media through interactive power point applications on the Pythagorean theorem material for class VIII of SMP Islam Al Ulum Terpadu Medan with a significant increase in learning outcomes with the interpretation category of the Normalized Gain index of $0.30 < g < 0.70$ is classified as moderate.

3.2. Discussion

3.2.1. ADDIE Development Model

Research and Development (R&D) utilises the ADDIE research model, which comprises five stages: analysis, design, development, implementation, and evaluation. This research developed an educational media product in the form of an interactive PowerPoint application on the Pythagorean theorem. This analysis aimed to examine student needs and the use of media as a supporting tool for online education. The analysis revealed that eighth-grade students at SMP Islam Al Ulum Terpadu Medan struggled to master mathematics, primarily because the mathematics teacher relied solely on textbooks or modules as resources, leading to students lacking attention and enthusiasm for learning.

Based on research and questionnaires administered to eighth-grade students, it was concluded that students were very enthusiastic and enjoyed the learning process, which utilised interactive PowerPoint presentations linked to culturally engaging materials, thereby ensuring that the learning process did not seem boring. The presence of media as a supporting tool for educational learning made students increasingly interested and motivated to learn mathematics, making it easier for them to master the material. Students could also review the material at any time.

In the design or planning stage, the researcher first selects the PowerPoint design that will be used later. The learning media chosen in the study are learning materials in the form of slides, presented through an interactive PowerPoint application linked to the culture, with the material focused on the Pythagorean theorem. Next, in the development stage, the researcher develops the media according to the existing plan and design, editing it as much as possible. Experts in their respective fields then validate it. Input and suggestions from the validators will be the revisions made by the author to produce a learning media that is feasible and ready to be tested on students. The validation results from the validators yielded a percentage score of feasibility, with an average of 92.5%, indicating a very valid category or suitable learning media used in the learning process.

The implementation phase involved a large-group trial and a mathematics teacher trial, aimed at assessing the practicality of the developed educational media. The average score from the student reaction analysis questionnaire was 79.95%, categorised as good to fairly instant, and the mathematics teacher reaction questionnaire yielded an average score of 88%, categorised as very good to instant. The final assessment phase of this research reported that the developed learning media were suitable for use in the learning process.

3.2.2. Validity Level

Validity is defined as the quality of the developed learning media, which is considered suitable for use before being applied to the learning process. The results of the media validation questionnaire analysis given to the validators indicate that the criteria are very valid and suitable for testing in large group trials, with an average score of 92.5%. This questionnaire assessment was conducted before the developed learning media were tested on students and teachers. Based on the results obtained from the media validation, it can be concluded that this interactive PowerPoint-based ethnomathematics learning media is very valid and suitable for the learning process on the Pythagorean theorem material in grade VIII. Previous research conducted by Muntaha et al. [19] shows the results of media validation conducted by three lecturers at PGRI Semarang University in a journal entitled interactive media based on macromedia flash eight on the theme of my experience with an average score of 98.75% entering the criteria of "very suitable/valid", the same thing is also seen in the results of research conducted by Ernawat [20] in the journal entitled "Feasibility Test of Interactive Learning Media in Server Administration Subjects" which obtained validation of learning media from validators of 85.5% with a very feasible category. Thus, it can be concluded that interactive learning media is very effective and feasible to be used in the learning process, based on the results of media validation in several studies above, which show that the average score covers the criteria of "very feasible" for use.

3.2.3. Level of Practicality

It's considered instant if the developed learning media can help and facilitate teachers' use. This practicality is evident based on the results of questionnaires administered to mathematics teachers and students. This questionnaire was distributed after the educational media had been tested. The results of the student response questionnaire yielded an average score of 79.95%, which falls into the 'good' to 'fairly instant' category. Based on these results, student reactions to the developed educational media were positive, indicating they found it practical to use in learning about the Pythagorean theorem.

Furthermore, the analysis results obtained from mathematics teachers' responses, with an average score of 88% fall into the very good/practical category. Based on these results, the mathematics teachers' response to the developed learning media was very positive, indicating that the mathematics teachers found the learning media to be practical as a learning support tool in mathematics subjects. This is in accordance with the research results. Saputra [21], which was previously conducted in a journal entitled "Interactive Learning Media Using Macromedia Flash on Spatial Geometry Material". Based on the assessment of various media aspects, an average score of 140.9 was obtained, and the ideal percentage of 82.883% was in the very practical category. Similarly, the study "Development of Mathematics Learning Videos Assisted by the Sparkol Videoscribe

Application," conducted by Rosyita [22], shows that the average score obtained from the student response questionnaire was 75.5%, with the practical category scoring 64. Research by Mayasari [23] indicates a high level of practicality achieved through the development of KineMaster-based learning media, with a percentage score of 92%, placing it in a highly practical category. According to various research results, the use of interactive learning media in education has a positive correlation. It is practical in the learning process, as it facilitates the delivery of teaching materials by teachers and also enhances students' ability to receive them.

3.2.4. Level of Effectiveness

Media is effective if the students can obtain and achieve the predetermined objectives. In the pre-test stage, 59.7% of students completed the learning process, with a sufficient number of students who met the KKM value set by the school, which was 75. Then, in the post-test stage, there was an increase in the number of students who completed it, specifically 90% of students who achieved a very good category. This data was obtained by calculating the percentage of students with an average score of 90% who fall into the very good category. It can be concluded that the developed learning media have proven effective for use in the learning process.

Based on the results of the learning test conducted in class VIII of SMP Islam Al Ulum Terpadu Medan, 29 out of 32 students were declared to have completed the learning, with the classical completeness calculation obtained previously of 90% > 70% and with the Gain Normality test with significant results and showing criteria of $0.30 < g < 0.70$ classified as (average/moderate) these results show that the mathematics learning media through the kine master application is said to be effective. The media developed through this PowerPoint application has a positive impact on learning, and the test conducted has a significant influence on student learning outcomes, similar to the results of the study [24]. "Development of Android-Based Interactive Mathematics Learning Media for Three-Dimensional Material for Grade X Senior High School", which achieved learning completion in the large group trial, obtained a score of 82% and an average score of 54.445% which means it is included in the effective criteria. The same results were also observed in previous research conducted by Media [25], which shows the influence on student learning outcomes using interactive learning media, namely Video Scribe-based learning videos, with an average score of 3.55, meeting the very good/effective criteria. The experimental results showed an average of 76.75 with an n-gain of 0.5947, placing them in the moderate category. This shows that interactive media increases students' critical thinking skills (KBK). Therefore, it can be stated that the use of interactive learning media in the learning process can increase the effectiveness of student learning, as evidenced by the results of increased test scores.

4. CONCLUSION

Based on the research results, it can be concluded that the development of interactive geometry learning media based on ethnomathematics in the architectural structure of the Al Mashun Grand Mosque in Medan has proven valid, practical, and effective for use in mathematics learning. Expert validation results indicate a highly feasible category, while trials with students and teachers yielded positive responses, suggesting that this media can enhance student motivation and conceptual understanding. Furthermore, effectiveness tests showed significantly increased learning outcomes after using this media.

This research implies that ethnomathematics-based interactive media not only serve as a learning aid but also as a means to instil cultural values and strengthen local wisdom in the educational process. Thus, this research contributes to innovative efforts aimed at creating more contextual, engaging, and meaningful mathematics learning experiences for students.

The limitations of this study include the limited facilities and infrastructure at the school, which prevent the implementation of media in the computer lab. Furthermore, the research trial was conducted within a limited scope at one school, so the results cannot be generalised more broadly.

For further research, it is recommended that the development of ethnomathematics-based interactive media be piloted in other schools with diverse student conditions and characteristics to obtain more comprehensive results. Future researchers could also integrate the media with more advanced technologies, such as mobile-based applications or learning management systems. Thus, this research is expected to make a real contribution to the world of formal education and the general public in efforts to preserve local culture through innovative mathematics learning.

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