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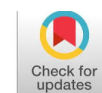
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Learning Media to Improve Mathematics Learning Outcomes Algebraic Topics and Pythagorean Theorems: A Literature Study

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ABSTRACT

Mathematics learning media is a tool that is used to convey mathematics material so as to make abstract material more concrete and easily understood by students. This article aims to find out the suitable learning media applied to the mathematics subject of Algebra and the Pythagorean theorem. This research method uses descriptive qualitative research with a literature study approach to analyze various literature sources related to mathematics learning media. Based on the results of searches that have been conducted by the author through scopus, scient direct, sinta 1 and 2 in 2020 to 2024, 10 articles are obtained that are suitable for learning media for Algebra and the Pythagorean theorem. The results showed that non-digital based learning media is very minimal in application. While learning media that are currently widely used are digital-based learning media. Digital-based learning is used by utilizing android and website. In utilizing android, there are several that are used, namely Edmodo, Algebra Adventure Media, and OBAR. On the utilization of the website there are also several that are used, namely Google Sites, Multimedia Learning, Macromedia Flash 8, Articulate Storyline, Adobe Animate CC (OPERAL), and Almath Game.



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Introduction

Mathematics education plays an important role in building logical, analytical, and problem-solving skills in students. However, learning mathematics is often considered difficult and uninteresting by students, especially on the topic of algebra and the Pythagorean theorem. This difficulty is caused by various factors, such as the abstract nature of the material, students' lack of understanding of basic concepts, and the use of learning media that does not support

students' understanding to the maximum (Dwi & Audina, 2021). In mathematics, it requires an understanding of abstract ideas, so it requires a medium that can explain these concepts more clearly (Indriyani et al., 2020). The use of appropriate learning media is important in improving mathematics learning outcomes.

The right learning media has a strategic role in increasing learning motivation, student engagement, and understanding of concepts. According to Beat (2024), interactive learning media can help students understand abstract concepts through visualization, simulation, and contextual approaches. In algebra and Pythagorean theorem materials, the use of learning media such as animated videos, technology-based applications, and physical manipulative tools has been proven to be able to increase students' interest in learning (Komariah et al., 2018). Mathematics learning media is a tool used to help convey abstract mathematics material so that it is easier for students to understand (Sudianto, 2021). Different types of media can be used, including digital media such as computers, internet, e-learning, and gaming applications (Pulungan & Rakhmawati, 2022). The use of the right media can increase students' motivation to learn, achievement, and math problem-solving ability (Sudianto, 2021). For junior high school students, interactive multimedia, edpuzzles, and GeoGebra can help concretize abstract concepts (Chairudin et al., 2023). The selection of media must be tailored to the cognitive development of students and requires careful planning to ensure the effectiveness of its use in mathematics learning (Komariah et al., 2018).

Mathematics learning media is a tool used to convey abstract mathematics material to be more concrete and easy to understand by students (Pulungan & Rakhmawati, 2022; Sudianto, 2021). Different types of media can be used, including digital media such as computers, internet, e-learning, and gaming applications (Pulungan & Rakhmawati, 2022), as well as conventional media such as props, pictures, and games (Sudianto, 2021). The use of the right media can increase students' motivation to learn, achievement, and mathematical problem-solving skills. Teachers are expected to utilize learning media to improve student learning outcomes in mathematics.

Learning media plays an important role in mathematics education, increasing student motivation and understanding. A variety of media can be utilized, including traditional games, comics, images, and digital devices such as Quizizz, GeoGebra, and augmented reality. During the COVID-19 pandemic, online platforms such as WhatsApp, Zoom, Google Classroom, and YouTube were used for elementary school math teaching (Artika et al., 2022). The development of relevant learning media in mathematics has been shown to motivate students to be more actively involved in learning and reinforce their positive character while understanding mathematical concepts (Purwandari et al., 2024). Visual learning media for math and science has also been introduced to teachers through workshops, which has resulted in increased understanding, skills in creating media, and enthusiasm for implementation (Adawiyah & Kowiyah, 2021). Overall, the use of appropriate learning media can significantly improve mathematics education outcomes.

Electronic mathematics learning media plays an important role in improving students' understanding of concepts and learning outcomes. Electronic learning media has a very high influence in improving students' learning outcomes and understanding of concepts (Herman et al., 2023). Research showing moderate improvement and positive student responses to specialized apps like Macromedia Flash can effectively improve students' understanding of math concepts (Kania & Arifin, 2020). The e-learning approach in mathematics education showed a strong correlation with academic achievement, with a correlation coefficient of 0.998 and a determination coefficient of 99.6% (Powered by Herlina & Lois, 2020). These findings underline the effectiveness of electronic mathematics learning media in improving concept understanding and academic performance.

In subjects such as the Pythagorean theorem, the depiction of three-dimensional space helps students intuitively understand the relationships between the sides of a triangle. Along with advanced technology, multimedia learning that combines text, graphics, music, and video substantially improves educational outcomes (Imron, 2019). This method uses the concept of multimedia learning, which highlights the importance of integrating visual and verbal channels to optimize cognitive processing in students. This is especially relevant in algebraic education, where animation and narrative help explain the step-by-step process of solving equations. Recent studies show that digital media can improve students' mathematical literacy and their ability to apply algebraic ideas such as Pythagorean's theorem into practical scenarios (Ummah, 2021).

However, many teachers still rely on conventional learning methods with the dominance of lectures and practice questions, which tend to be less relevant to the needs of students in the digital era. As a result, mathematics learning outcomes on these topics have not shown a significant improvement. The study of the literature on various learning media relevant to the topic of algebra and Pythagorean theorem becomes important to identify the best approach that suits the characteristics of the student and the demands of the curriculum. This study aims to examine various learning media that are relevant in improving mathematics learning outcomes, especially on the topic of algebra and Pythagorean theorem, by analyzing previous literature studies. Thus, this research is expected to provide practical recommendations for teachers to choose learning media that are effective, interesting, and support the improvement of student learning outcomes.

Method

Research Design

This research uses a literature review method because this research collects data from relevant literature, then analyzes it to achieve the article's objectives. Literature research, or often called literature study, according to Zed (2008), is a series of research activities related to the method of collecting library data, then reading and recording and processing the research material. This research is a descriptive qualitative study that adopts a literature review approach to analyze a variety of literature sources related to mathematics learning media. The descriptive qualitative method is appropriate for understanding and interpreting educational phenomena based on non-numerical data. By focusing on content from previously published scientific studies, this research seeks to explore patterns, trends, and findings regarding the use of learning media in mathematics education. The focus is specifically directed at media used in teaching algebra and the Pythagorean theorem. This method allows researchers to critically examine how these media have been designed, implemented, and evaluated in prior studies.

Instruments and Procedures

The main instrument in this research is a literature analysis protocol designed to extract and organize data from selected sources. This protocol includes a checklist and coding scheme developed to identify the type of media, subject matter focus (algebra and Pythagorean theorem), implementation context, and reported outcomes. To ensure validity, the selection of literature is based on clear inclusion and exclusion criteria, such as publication in peer-reviewed journals, relevance to the research topic, and recency (published within the last 10 years). To ensure reliability, the coding process was conducted independently by two reviewers, and discrepancies were discussed until agreement was reached. The decision to include only 10

articles was based on the application of strict selection criteria, focusing on quality and relevance rather than quantity, to allow for in-depth analysis and meaningful conclusions.

Procedure

Data sources are in the form of secondary literature such as research results from various scientific articles, literature sources and documents that are in accordance with the topic of mathematics learning media. The research process involves searching, selecting, and analyzing the types of mathematics learning media with the topic of algebra and Pythagorean theorem and their effectiveness in improving student understanding. The data collection procedure involves several systematic stages. First, identification and selection of data sources was carried out through academic databases such as Google Scholar, ERIC, and ScienceDirect, using keywords such as “mathematics learning media,” “algebra,” and “Pythagorean theorem.” Second, the collected articles were filtered based on inclusion criteria, including peer-reviewed status, relevance to the topic, and publication between 2014 and 2024. Third, the selected articles underwent a content analysis to extract relevant information about the types of learning media used, their characteristics, implementation, and outcomes. Throughout this process, careful documentation and coding were maintained to ensure transparency and traceability of data.

Data analysis

The data analysis was conducted using a qualitative content analysis technique, which involved three main stages: data reduction, data display, and conclusion drawing/verification. In the data reduction stage, irrelevant or redundant information was filtered out to focus only on aspects related to the design, application, and effectiveness of mathematics learning media. In the data display stage, key information was organized into matrices and thematic categories such as media types (e.g., digital, manipulative, visual), learning outcomes, and subject focus. Finally, in the conclusion drawing stage, patterns and trends were synthesized to identify innovative practices and areas needing further development. This analysis provided a systematic and comprehensive overview of the current state of mathematics learning media and generated recommendations for future development aligned with educational needs.

Results

Relevant mathematics learning media can improve student learning outcomes. Various types of media such as snakes and ladders, comics, games, props, and digital applications have proven to be effective in increasing motivation, achievement, and mathematical problem-solving skills (Sudianto, 2021). The development of technology-based mathematics learning media is also able to motivate students to learn more actively and understand mathematical concepts (Maharani & Putri, 2023). Systematic literature studies show that the use of learning media has a positive effect on students' mathematics learning outcomes (Dzikri et al., 2024). In particular, interactive learning media is often used to improve students' mathematical literacy skills by helping to visualize abstract concepts, improve comprehension, and encourage application in daily life (Nareswari & Arfinanti, 2023). Therefore, the use of appropriate learning media is very important in improving students' mathematics learning outcomes.

Based on the results of the search that has been carried out by the author through Scopus, scient direct, sinta 1 and 2 in 2019 to 2024, 10 articles suitable for learning Algebra and Pythagorean theorem were obtained. The table of articles can be seen in Table 1 as follows:

Table 1. List of Research about Learning Media for Algebra and the Pythagorean Theorem

No.	Research	Field	Research Methods	Research Results	Learning Media
1.	The Development of Mathematics Learning Media Using Google Sites Web Based on an Integrated Contextual Approach to Islamic Values for Junior High School Students in Riau, Indonesia (Noviarni et al., 2023)	number patterns, circles, statistics, Pythagorean theorems, and build flat-sided spaces	Research and Development of the ADDIE Model	Data analysis shows that Google Sites web-based learning media that integrates contextual approaches and Islamic values is included in the valid, practical, and effective categories, because the materials tested have higher posttest scores in the experimental class than in the control class.	Google Sites web learning media
2.	Discover the pythagorean theorem using interactive multimedia learning (Adhitama et al., 2018)	Pythagoras teal	Research and Development of the ADDIE Model	This study shows that the multimedia developed is suitable for use as a learning medium, and interactive multimedia can increase students' interest and achievement in learning mathematics.	Interactive Multimedia
3.	Development of Pythagorean Theorem Learning Tools with Computer-Aided Media (Ayda & Widjajanti, 2014)	Pythagoras teal	4-D Mode Research and Development	Research shows that the learning tools developed are valid, practical, and effective based on students' achievement and their math self-efficacy scores.	Computer-Aided Media
4.	Development of Interactive Media with Articulate Storyline, Based on the Rater Test, Using the PPE Model on the Phytagoras Theorem (Nurhayati et al., 2024)	Pythagoras teal	Research and Development of PPE Models	This study shows that the development of interactive learning media with Articulate Storyline for Pythagorean theorem material has met the standard of good validity and practicality.	Interactive Media With Articulate Storyline
5.	Development of Edmodo-Based E-Learning Media on Pythagorean Theorem Material (Farman & Chairuddin, 2020)	Pythagoras teal	Research and Development of the ADDIE Model	Based on expert assessments and trials, Edmodo-based e-learning media for Pythagorean theorem material meets the criteria of validity, practicality, and effectiveness, and can increase interest and support interactive	Media E-Learning Berbasis Edmodo

				learning for Grade VIII junior high school students.	
6.	Development of Learning Media Using Android Based Articulate Storyline Software for Teaching Algebra in Junior High School (Nissa et al., 2021)	Algebraic Forms	Model Research and Development Borg and Gall	The validation results show that the Android-based OBAR learning media with Articulate Storyline is feasible to use, with the validity of media and material experts is very good, and the students' responses show that the category is very feasible.	a learning medium called OBAR using Android-based Articulate Storyline software
7.	Development of Math Comic Learning Media on The Subject of Algebraic Expressions for Seventh Grade of Junior High School Students (Hidayah, 2019)	Algebraic Expressions	4-D Model Research and Development	This study produced two main findings: 1) The comic learning media developed is valid, practical, and effective. 2) Mathematics comic learning media with valid algebraic expression topics.	Learning media in the form of comics
8.	Almath Learning Media Powerpoint-Based Game on Algebraic Form Material (Noerhasmalina et al., 2024)	Algebra	ADDIE Model Research and Development	This study concluded that Almath Game learning media is very feasible to use based on expert assessment (93%) and is effective judging from student responses (83.33%). In addition, 81.8% of students achieved KKM, showing an increase of 51.5% compared to the initial condition.	Almath Game learning media
9.	Educational Game-Based Algebra Adventure Media for Junior High School Students (Sarji & Mampouw, 2022)	Algebraic Forms	ADDIE Model Research and Development	The results of the study show that Algebra Adventure media can improve student learning outcomes on Algebraic Forms material.	Algebra Adventure Media Android and Windows based
10.	Development of "OPERAL" Algebraic Form Operation Media Based on Adobe Animate CC (Shalikhah, 2022)	Algebraic form operations	ADDIE Model Research and Development	This study shows that the learning medium "OPERAL" is valid, practical, and effective in algebraic form operation materials, with a very good category.	learning media "OPERAL"

Discussion

From the data found from the table above, there are a total of 10 articles that have been collected to see the learning media that are suitable for learning on algebra and Pythagorean theorem material. Based on the table above, it is found that there is a grouping of media types that are suitable for use in learning Algebra and Pythagorean theorem, which are described in the following [Figure 1](#)

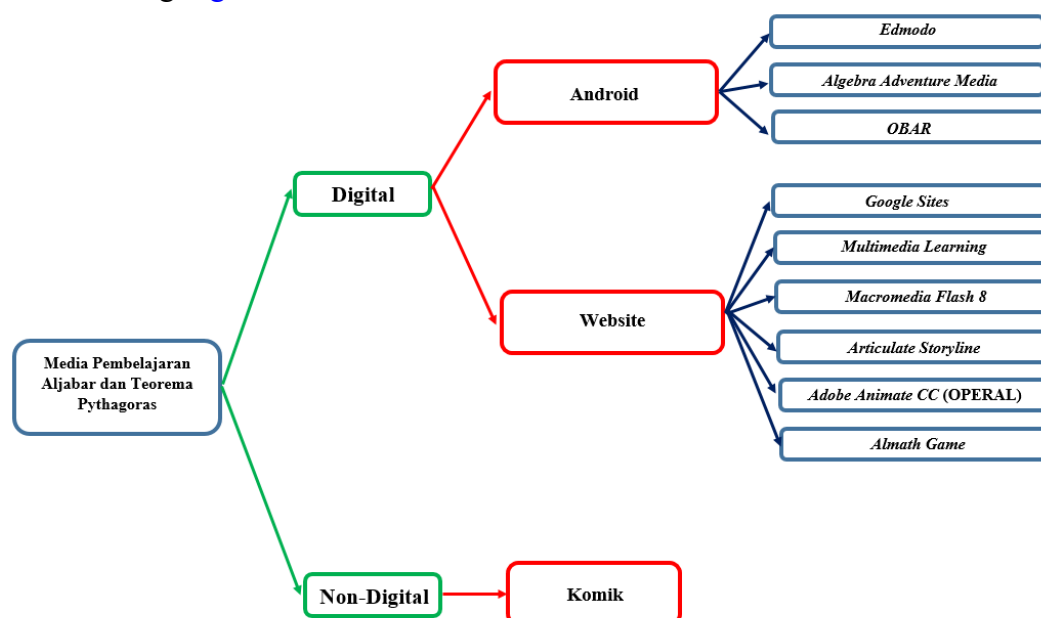


Figure 1. Learning Media for Algebra and the Pythagorean Theorem

Based on the flow chart, it can be seen that non-digital-based learning media is very minimally applied. Meanwhile, the learning media that is currently widely used is digital-based learning media. Digital-based learning is used by utilizing androids and websites. In the use of android, there are several that are used, namely *Edmodo*, *Algebra Adventure Media* and *OBAR*. In *Edmodo*, e-learning-based mathematics learning was developed as an alternative medium in increasing interest and learning outcomes in Pythagorean material. In *Algebra Adventure Media*, an android-based interactive educational game media was developed to improve students' learning outcomes in Algebra Forms material. Meanwhile, in *OBAR*, Android-based learning media was developed using the *Articulate Storyline 3* application software.

The use of the website uses several features, namely *google sites*, *multimedia learning*, *Macromedia Flash 8*, and *Articulate Storyline*. In *google sites* learning media, web learning is based on a contextual approach that is integrated with Islamic values. In the multimedia learning media of mathematics on the Pythagorean Theorem material using DL in the 2013 curriculum and packaged in the form of a CD assisted by Adobe Flash Pro CS6 learning software. *Macromedia Flash 8* develops learning rankings including Syllabus, RPP, Student Activity Sheets, and Learning Media. In *Articulate Storyline*, we developed web-based interactive learning media on the Pythagoras theorem material. Learning media made using *Articulate Storyline* is in the form of web-based media (html5) or in the form of application files. *Almath Game* aims to develop learning media in the form of interactive PowerPoint-based games. The purpose of making *the Almath Game* is to increase students' enthusiasm and motivation to learn, especially in understanding algebraic form material. Meanwhile, in *OPERAL*, a learning media based on *Adobe Animate Cc* was developed to help students learn algebraic form operations.

Android-based and web-based learning media have different impacts on student motivation, conceptual understanding, and learning outcomes. Android-based media tends to be more practical because it can be accessed via mobile devices anytime and anywhere, thus providing flexibility and increasing student motivation through a more personalized and interactive learning experience. Meanwhile, web-based media usually offers richer features, including integration with online learning resources, discussion forums, and more complex visual displays, which can strengthen students' conceptual understanding of materials such as algebra and the Pythagorean theorem. In terms of learning outcomes, Android media is more effective in supporting independent practice and individual engagement, while web-based media is superior in building collaboration, in-depth concept exploration, and developing critical thinking skills through broader access to materials. Thus, both have their respective advantages that can be selected according to learning objectives and student needs.

The findings of this literature study on relevant learning media for algebra and the Pythagorean theorem align with various previous studies and theories in mathematics education. For example, Piaget's and Vygotsky's constructivist theories emphasize that understanding of mathematical concepts is formed through active learning experiences and interactions with appropriate environments and media. This is supported by research by [Hwang & Wu \(2014\)](#), which shows that mobile learning-based media can increase students' motivation and independence in learning by providing opportunities for independent exploration of concepts. Furthermore, [Arsyad \(2016\)](#) research on the use of digital learning media confirms that interactive visualizations can strengthen students' conceptual understanding of abstract topics such as algebra. Furthermore, these findings are consistent with the Cognitive Load [Sweller \(1988\)](#) theory, which explains that the use of appropriate media can reduce students' cognitive load, allowing them to focus more on understanding core concepts. Therefore, the results of this study reinforce the belief that selecting appropriate learning media, whether Android-based or web-based, not only supports learning outcomes but also aligns with mathematics learning theories that emphasize active engagement, conceptual understanding, and student motivation.

The significance of these findings provides important implications for teachers, researchers, and media developers. For teachers, the results of this study can serve as a reference in selecting and utilizing learning media that are more relevant and in accordance with the characteristics of algebra and the Pythagorean theorem material, so that learning is more interesting, interactive, and able to improve student learning outcomes. For researchers, these findings open opportunities to develop further research related to the effectiveness of certain learning media, both through experiments and the development of innovative models oriented to student needs. Meanwhile, for media developers, the results of this literature study provide a basis for designing learning media that are not only creative, but also contextual, technology-based, and aligned with the curriculum, so that the resulting products are truly able to address problems in mathematics learning in schools.

Conclusion

Based on the results of the review that has been carried out, it can be concluded that the use of digital-based learning media, especially those that utilize Android applications and websites, shows greater effectiveness in teaching mathematics material, especially in this study, namely Algebra and Pythagorean Theorem material. Although non-digital learning media is still used, the advantages of digital media in making abstract material more concrete and easy to understand by students are very visible. Various digital platforms used in this learning include Edmodo, Algebra Adventure Media, OBAR, as well as several websites such as Google Sites, Multimedia Learning, Macromedia Flash 8, Articulate Storyline, and Almath Game. The

study also found that digital-based media facilitates interaction and increases student engagement in the learning process, which was previously difficult to achieve with non-digital media. However, the challenge that is still faced is the limited access to the applications that have been developed, which makes it not fully applicable in all learning contexts. Therefore, it is recommended for researchers and developers to continue to innovate in integrating technology in education, so that this digital media can be more optimally used in both face-to-face and online learning, and provide greater benefits for students in understanding mathematics material.

This literature research shows that relevant learning media, both Android-based and web-based, significantly contribute to improving mathematics learning outcomes in the topics of algebra and the Pythagorean theorem. Android-based media is superior in providing flexibility and supporting students' independent learning through practical, interactive, and ubiquitous experiences. Meanwhile, web-based media is more effective in strengthening conceptual understanding, facilitating collaboration, and providing broader learning resources. These findings emphasize that the selection of learning media must be tailored to learning needs, material characteristics, and student profiles to optimize learning outcomes. For media developers, innovation is needed in designing products that integrate the advantages of both, for example by creating hybrid media that can be accessed via Android while also connecting to a web platform. This will help provide learning media that is more contextual, flexible, and tailored to student needs and the curriculum.

Conflict of Interest

The authors declare that there is no conflict of interest.

Authors' Contributions

D.D.M. contributed to topic selection and framework design, data collection and analysis, as well as manuscript writing and revision. D.N.H. provided academic supervision, content evaluation, and final manuscript refinement. J and W.S. assisted with technical guidance, validation, and review, as well as the completion of the thesis. The overall contribution percentages for conceptualization, preparation, and review are as follows: D.D.M.: 55%, D.N.H.: 15%, J.: 15% and W.S.: 15%.

Data Availability Statement

The authors declare that the data supporting the findings of this study will be made available by the corresponding author, [D.D.M.], upon reasonable request.

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