A Systematic Review : Interactive Media in Mathematics learning, What do we get?

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Abstract
The use of learning media is now essential for the success of learning. Developments in learning media continue to be carried out today to produce interactive media that requires students to interact with teachers, friends, and learning media. This is common in mathematics learning. This research aims to find data regarding the learning media that are most frequently used in the world, the countries that use interactive learning media the most in mathematics learning, and the mathematics materials that are most widely used in using interactive learning media. The method used is a systematic review using the PRISMA method. From the initial results, there were 381,837 articles, which were then filtered according to predetermined criteria, and the final results were 8 articles for further research. The results of this research found that Interactive Media is widely used in mathematics lessons throughout the world such as Digital Books, Geogebra, Geometer's Sketchpad, ChatGPT, and Instructional Video. Of the various interactive media, digital books are the ones most used in learning because digital books can stimulate the skills needed for learning in the 21st century. The results of this research also found that Ethiopia and Germany are the most users of interactive media. Geometry material is material that is considered difficult so it is most widely used in interactive media in various countries.

Keywords : Interactive Media, Mathematics, Systematics Review.

INTRODUCTION

Global demands require the world of education to consistently and continually adapt technological developments to efforts to improve the quality of education, especially adapting its use to the world of education, especially in the learning process. According to Budiman, (2017) the trend of change and innovation in the world of education will continue to occur and develop as we enter the 21st century. All aspects of life have technology that makes them more accessible, including the educational aspect (Cahyono & Ludwig, 2018). These changes include making it easier to find learning resources, more choices for using and utilizing ICT, and the increasing role of media and multimedia in learning activities.

The use of appropriate learning media can increase students' understanding (Neneng Aminah et al., 2023). Learning media, which used to only be a complement to learning, has now become fundamental in the learning process. This learning media is also inseparable from technological innovation (Neneng Aminah et al., 2020), which used to only be in simple physical form, now many learning media are in digital form (Morales-Belando et al., 2021). Digital learning media is a medium for learning that is based on digital technology, in the form of applications or websites that are useful for supporting the learning process. In digital learning media, files in the form of images, videos, animations, and music can be added, which aims to increase students' enthusiasm for learning.

The development of learning media continues, and further innovation in learning media continues to be carried out (N. Aminah & Wahyuni, 2018; Neneng Aminah et al., 2021). Currently, the use of interactive learning media in learning is becoming widespread. With this interactive learning media, students not only pay attention to the teacher who is teaching, but students can also actively participate in the learning process so that there is two-way communication between the teacher and students and students and other students (Hannaway &

Steyn, 2017; Hokanson & Gibbons, 2014; Kamarudin et al., 2022; Niess, 2005). The most essential characteristic of interactive learning media is that students do not only pay attention to the presentation or objects but are required to interact during the lesson (Tarigan & Siagian, 2015). So that the active learning process can run well, educators, as drivers of student learning, are required to use and master active learning strategies (Syaparuddin et al., 2020). In line with research conducted by Harsiwi & Arini, (2020) stated the conclusion from the results of their research that the use of interactive learning media is able to motivate students so that student learning achievement increases and students also provide a positive response to the use of interactive learning media. According to Pramuditya (2020) uses of Schoology which is an LMS that can provide new learning experiences so that learning does not feel boring and at the same time makes good use of technology.

Some people feel that mathematics lessons are difficult to understand, so learning media are needed (Aminah et al., 2020) to help students understand the material being taught. This is in line with research conducted by Wahyudin (2021) that the use of digital-based interactive media, such as mobile apps and blended learning approaches, has proven effective in improving mathematics learning outcomes for elementary to middle school students. With the support of appropriate interactive media, it is hoped that learning mathematics will become more enjoyable and students' understanding of mathematics will increase (Neneng Aminah et al., 2022; Aminah & Wahyuni, 2019; Feriatna, 2017). According to Wulandari (2020) Characteristics of interactive learning media are as follows: 1)Have more from one convergent medium, for example combines audio and visual elements. 2)Characteristic interactive, in the sense of having the ability to accommodate user responses. 3)Characteristic independent, in the sense of providing convenience and the completeness of the content is such that the user can use without guidance from others. The use of learning media in the process of teaching and learning mathematics can foster students' motivation and interest in learning independently, and is proven to have a positive response from students(Wardani & Subekti, 2022).

RESEARCH METHODS

The review protocol is carried out using the Prisma Method
Thematic Reviews and Meta-analyses or commonly called PRISMA, this method is carried out systematically by following the correct research stages or protocols. A systematic review is a method that uses reviews, research, structured evaluation, classification, and categorization of previously produced evidence-based data. The steps in carrying out a systematic review are very planned and structured, so this method is very different from methods that convey literature studies. Researchers widely use systematic reviews to map areas that are still uncertain, identify research that has been conducted, and explore new studies that are needed (Hadi et al., 2020). In (Subramaniam et al., 2022), there are 4 steps in the Literature Review procedure, namely (1) identification, (2) screening, (3) eligibility, and (4) inclusion.

Systematic search strategy
To examine previous articles, researchers used four systematic procedures (identification, screening, eligibility, and inclusion). By using this strategy, the authors were able to thoroughly discover and synthesize this research, resulting in a transparent and well-organized systematic literature review.

Identification
In this research, researchers used the Dimensions website to search for data. Dimensions itself is a platform that can be used to find and analyze research data easily. To find data related

to interactive learning media in mathematics learning, researchers entered keywords in English, namely *interactive mathematics learning media.*

Filtering

The next step is data filtering. The aim of this stage is to select data that fits the criteria, as shown in Table 1. Here, the first step includes selecting research in the form of articles; apart from that, it is eliminated. Then, the publication limit for articles can only be in the period 2019 to 2024; articles published before 2019 are eliminated by considering the concept of maturity of the research field (Kraus et al., 2020).

Table 1. Eligibility and exclusion criteria

Criteria	Appropriateness	Exception
Literary type	Journal (research article)	Books, conferences, book series, and chapters.
Language	English	Not English
Time	2019 to 2024	Before 2019
Fill	Interactive media and mathematical materials	Does not contain interactive media or mathematical material

At the start of entering keywords into *Dimension,* researchers got 381,837 articles, and then only 159,576 articles were published in the period 2019 to 2024. Next, it was filtered again by the research category, namely education, totaling 36,567 articles. Moreover, filtered again in the form of articles totaling 23,518 articles. Next, the researcher filtered the data again by searching for mathematics education journals indexed by Erih Plus and obtained three international journals, which were ultimately used as the object of his research. These international journals include ZDM-Mathematics Education with 85 articles, then Educational Studies in Mathematics with 51 articles, and Eurasia Journal of Mathematics Sciences and Technology Education with 82 articles. Then, from the three international journals above, the researcher filtered them again with titles that were relevant to the current research topic, resulting in ZDM-Mathematics Education with the results of 11 articles, Educational Studies in Mathematics with the results of 7 articles, and the Eurasia Journal of Mathematics Sciences and Technology Education with the results 12 articles. Then, the researchers analyzed these articles so that only articles that contained learning media were taken, including ZDM-Mathematics Education with the final result of 2 articles, Educational Studies in Mathematics with the final result of 1 article, and Eurasia Journal of Mathematics Sciences and Technology Education with the final result being 5 articles. So overall, in this study, the researcher analyzed 8 articles that were relevant to the required data.

Eligibility

The eligibility procedure follows the screening method. From the resulting data, there are 2 from ZDM-Mathematics Education, 1 from Educational Studies in Mathematics, and 5 from the Eurasia Journal of Mathematics Sciences and Technology Education, making a total of 8 articles which we will examine in more depth.

Inclusion

Interactive learning media used in mathematics learning is the main focus of this research. Because the aim of this research is to find out which interactive media are the most popular in the world, which countries use interactive media the most in the world and what mathematical materials are often used in interactive media.
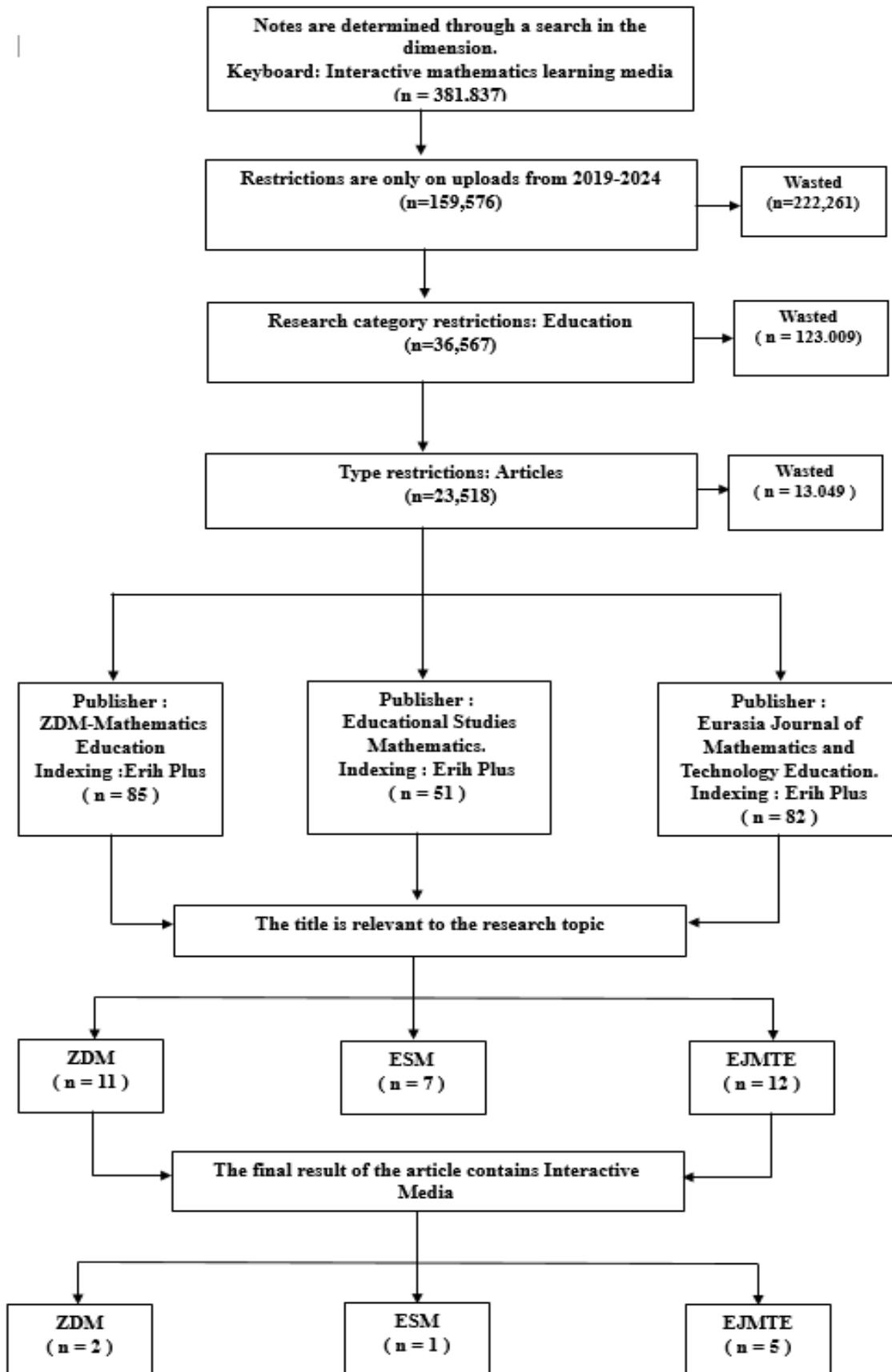
Figure 1. Systematic Overview of PRISMA

RESULT AND DISCUSSION

Results

This research has explored articles related to interactive learning media in mathematics learning, using the keyword *"Interactive Mathematics Learning Media"* on the *Dimensions website,* resulting in 381,837 articles. Then, it filtered and produced eight articles that were in accordance with the research questions.

Table 2. Articles related to interactive media

No	Publisher	author	country	subject	Media used
1.	Eurasian Journal of Mathematics Sciences and Technology Education	Agnita Siska Pramasdyahsari	Indonesia	Middle school students	Interactive digital book
2.	Eurasian Journal of Mathematics Sciences and Technology Education	Sirak Tsegaye Yimer	Ethiopia	Student	GeoGebra
3.	Eurasian Journal of Mathematics Sciences and Technology Education	Abera Kotu	Ethiopia	Middle school students	Geometer's Sketchpad
4.	Eurasian Journal of Mathematics Sciences and Technology Education	Yusuf Wardat	United Arab Emirates	Teacher and student	Chat GPT
5.	Educational Studies in Mathematics	Anna Baccaglini-Frank	Italy	High school student	GeoGebra
6.	Eurasian Journal of Mathematics Sciences and Technology Education	Elena V. Soboleva	Russia	Middle school students	Interactive Novels
7.	ZDM-mathematics education	Laura Wirth	German	High school student	instructional videos
8.	ZDM-mathematics education	Sebastian Rezat	German	Elementary students	Digital textbook

In this research, researchers found several types of interactive learning media used in various countries. These include Instructional Video (Wirth & Greefrath, 2024), Chat GPT (Wardat et al., 2023), Geometer's Sketchpad (Kotu & Weldeyesus, 2022), Geogebra (Baccaglini-Frank, 2021; Yimer, 2020), and Digital Books (Pramasdyahsari et al., 2023; Rezat, 2021; Soboleva et al., 2022) .
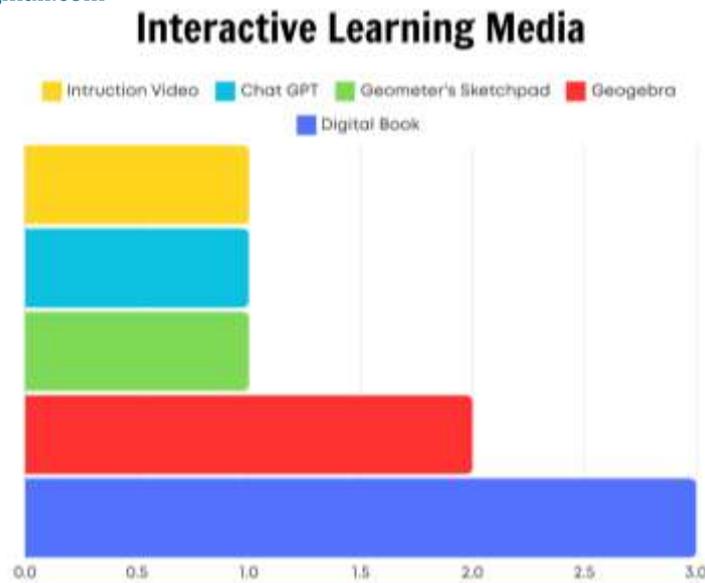
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Figure 2. Learning media that are widely used

The data in Figure 2 shows that digital books are used more widely than other interactive media. This is because digital books can stimulate the skills needed for learning in the 21st century, such as creative thinking, collaboration, and communication (Pramasdyahsari et al., 2023) . The results of research (Pramasdyahsari et al., 2023) also show that 76.2% of students indicated that digital books could encourage them to play an active role in learning and experimenting. Learning using enhanced electronic textbooks implies that students may have access to additional supporting resources that can engage them more actively in their interactions with mathematics (Naftaliev & Yerushalmy, 2013) . Compared with traditional mathematics textbooks, digital mathematics textbooks increasingly offer additional features, such as interactive diagrams, feedback, and formative assessments, and provide teachers and students with the possibility of personalization and individualization (Choppin et al., 2014; Usiskin, 2018; Rezat , 2020; Yerushalmy, 2005) .

Various countries use interactive media in their learning to improve the results and quality of their education. In this research, researchers found several countries that use interactive media in mathematics learning, including Indonesia (Pramasdyahsari et al., 2023), Ethiopia (Kotu & Weldeyesus, 2022; Yimer, 2020), United Arab Emirates (Wardat et al., 2023), Italy (Baccaglini-Frank, 2021) , Russia (Soboleva et al., 2022), and Germany (Rezat, 2021; Wirth & Greefrath, 2024).
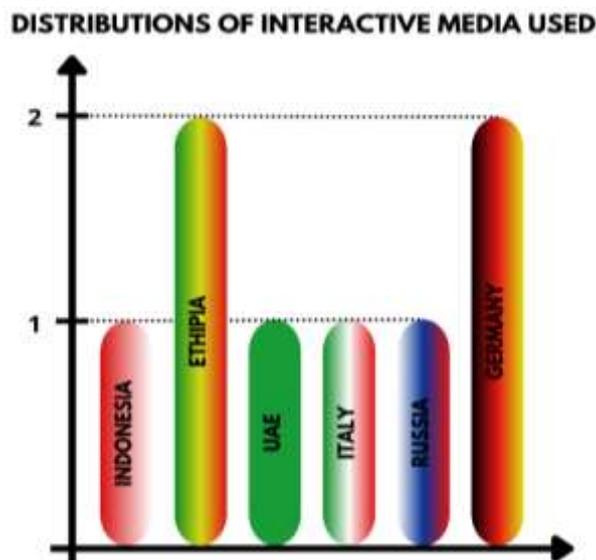
Figure 3. Distributions of Interactive Media Used

From the data in Figure 3 , it shows that Ethiopia and Germany have the same frequency. Where these two countries have more interactive media users compared to other countries in this research. Both countries also have a variety of interactive media. These include Digital Books, Geogebra, Geometer's Sketchpad, and instructional videos.

Researchers found several mathematical materials used in interactive media. These mathematical materials include number patterns (Pramasdyahsari et al., 2023), calculus (Yimer, 2020), arithmetic (Soboleva et al., 2022), geometry (Kotu & Weldeyesus, 2022; Wardat et al., 2023), function (Baccaglini-Frank, 2021), mathematical modeling (Wirth & Greefrath, 2024), and probability (Rezat, 2021).
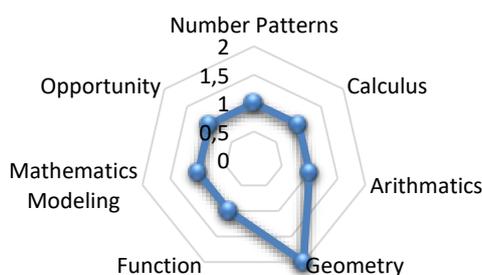
Mathematics Material

Figure 3. Frequently used mathematics material

In this study, researchers found that geometry material had a higher frequency of research compared to others. Geometry is one of the materials that is considered important in mathematics (Safrina & Ahmad, nd) . Usiskin (1982) gives reasons why geometry needs to be taught, namely first, geometry is the only field of mathematics that can link mathematics to the physical forms of the real world. Second, geometry is the only one that can allow mathematical ideas to be visualized, and third, geometry can provide non-single examples of mathematical systems. Geometry is mathematical material where in learning a person will go through hierarchical levels of thinking. The point is that when studying geometry material, a person will be guided to think

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in increasingly higher stages. Geometry is also material that is difficult to understand and tends to be avoided by students. This is the background to the large number of interactive media that highlight geometric material. Mathematics material that is considered difficult and feared by students in mathematics lessons is geometry material (Adolphus, 2011).

Discussion

In this research, researchers obtained eight articles that met previously determined criteria. The initial data, which reached 381,837 articles, were then filtered, and the final result was eight articles to be discussed and researched more deeply. These 8 articles contain learning media and mathematics material, and these two factors are the main ones in this research.

Fostering student's mathematical critical thinking skills on number patterns through digital book STEM PjBL researched by (Pramasdyahsari et al., 2023)

Current learning models and teaching materials need to be revised to meet the educational needs of the 21st century. Therefore, to accommodate students' needs in the learning process, it is necessary to provide learning models and teaching materials that support 21st-century learning. This research was used for research and development (R&D), followed by quantitative research methods. The quantitative method uses a pre-experimental design and one group pretest post-test design (Creswell, 2014; Sugiyono, 2010, 2014). The research subjects were 21 students consisting of men and women. The use of digital books based on STEM-PjBL can improve students' critical mathematical thinking. Considering that students' initial abilities are below average, this will be a long learning experience for them. Through STEM project-based learning, students gain experience in collaboration and communication. Apart from that, they are used to solving problems in stages and have the opportunity to express their arguments in group discussions. The findings show that the STEM PjBL digital book is valid and significant in developing students' critical thinking skills and has a positive impact on other 21st century learning skills. Furthermore, the data shows that students are satisfied and interested in learning through active teaching and learning methods that combine ICT tools and STEM-PjBL aspects. Well-designed interactive e-books are believed to be able to contribute significantly to the learning process in an effective and efficient manner (Bozkurt & Bozkaya, 2015). This is also in line with Albert et al. (2021), Martins (2012), and Suarsana (2021) that students are satisfied with the use of textbooks. The use of digital tools encourages student engagement in learning activities (Moundy et al., 2021; Moundy et al., 2022).

Stimulating Content Knowledge Learning of Intermediate Calculus through Active Technology-Based Learning Strategy researched by (Yimer, 2020)

Most of the research literature states that instructors and students place more emphasis on procedure-based teaching and almost ignore concept-based teaching. This situation will be considered one of the reasons why learning calculus becomes more challenging for students. This problem largely originates from the way educators present their learning, which usually uses the lecture method at the tertiary level. However, researchers share the view that concept-based teaching should be more encouraged in the learning/teaching environment. Quantitative methods are used in quasi-experimental designs. Population: all new undergraduate mathematics and science students at two Ethiopian state universities. Sample: 16 students and 14 students to take the calculus diagnostic test, 30 students and 45 students as the comparison group and 50 students and 25 students as the experimental group. Findings revealed that the use of an active learning intervention that borrowed heavily and utilized technology substantially stimulated the experimental group (EG) to increase their CK attainment compared to PK development. COK understanding also improved significantly because EG learners performed better than CK. Thus, the contribution of JCLGS as educational technology to the development of students' CK and COK is outstanding and can be used as a main finding. Research (Wondo et al., 2020) also concluded that students' interest in learning increased, so student learning outcomes also

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increased when learning geometry using Geogebra media. The results of this research are in line with the opinion expressed by (Oktaria et al., 2016) that with Geogebra media, there is an increase of 0.651 in students' mathematical representation abilities. The results of other research also conducted by (Siswanto & Kusumah, 2017) showed that there was an increase in the spatial geometry abilities of students who received guided inquiry learning assisted by GeoGebra which was better than students who received conventional learning.

Instructional use of Geometer's Sketchpad and students' geometry learning motivation and problem-solving ability researched by (Kotu & Weldeyesus, 2022)

Several factors can be cited for this problem, but teaching methods, absence or inappropriate use of technology, problems related to curriculum design, and textbook preparation are some of them. Among them, teaching must be given priority because it has a direct and significant impact on students' motivation and PSA. This research uses quantitative methods using cross-sectional data of the quasi-experimental type. There are 769 students in class IX of Chancho Abageda Secondary and Preparatory School, consisting of 422 male students and 347 female students. The results of this study showed that there were statistically significant differences between the intervention and comparison groups, as well as the level of achievement after treatment in terms of motivation and PSA, and there was a high correlation between motivation and problem solving. The motivation component has a significant effect on motivation and PSA. The use of GSP-supported learning is recommended to increase students' motivation and problem-solving abilities. This is also in line with research (Hartono, 2020) , which reveals that the use of GSP-supported learning is recommended to increase students' motivation and problem-solving abilities . According to Meng, (2009) by using GSP, students' level of van Hiele geometric thinking about cubes can increase from level 0 to level 2.

Chatgpt, a Revolutionary Tool for Teaching and Learning Mathematics researched by (Wardat et al., 2023)

ChatGPT can improve education and student learning, it is essential to use it as a complementary tool alongside human teachers and educators. Educators can use ChatGPT to produce personalized content, assess student learning, and provide feedback to students. However, it is essential to understand its limitations and use it in a sound and ethical manner. This research adopts a qualitative case study approach consisting of two stages: interview content analysis and user experience investigation. The 30 interviewees were selected for this study based on their public blogs discussing the use of ChatGPT in mathematics. The interviewer had been using ChatGPT for at least one month and had a lot of experience with chatbots in mathematics teaching. The results of this research are that ChatGPT does not understand geometry in depth and cannot correct misunderstandings effectively. The accuracy and effectiveness of ChatGPT solutions may depend on the complexity of the equations, input data, and instructions provided to ChatGPT. This study found that ChatGPT is a valuable educational tool, but caution is needed when using it, and safe use guidelines should be developed. ChatGPT is expected to become more efficient in solving increasingly complex mathematical problems. This is in line with research (Zafrullah et al., 2023) that the presence of ChatGPT, which provides significant benefits in accessing information and learning assistance, also has a negative impact in the form of potential student dependence on this technology so that it can ignore the vital role of teaching staff. This increases learning motivation when using learning media that is able to attract students' attention so that they can achieve learning goals more effectively (Apriyani, 2017) .

To Tell A Story, You Need A Protagonist: How Dynamic Interactive Mediators Can Fulfill This Role And Roster Explorative Participation To Mathematical Discourse researched by (Baccaglini-Frank, 2021)

This research aims to understand differences in the development of mathematical discourse between low-achieving students and high-achieving students, as well as to explore DIM mechanisms that support the learning of students with different needs in the context of mathematics learning. The method used is an in-depth analysis of students' computer-mediated mathematical discourse. The research was conducted by analyzing student responses to the mathematics interview questions given, as well as student interactions with GeoGebra. The subjects chosen for this research were two students from two classes. An interesting finding from this research is that the integration of GeoGebra in mathematics learning can provide benefits for low-achieving students. The analysis shows that digital mediation mechanisms used in technological environments can shape students' mathematical discourse and influence their learning processes. This research is in line with research conducted by Syafitri et al. (2018), which explains that the role of GeoGebra interactive media can improve the learning outcomes of Class VII Junior High School (SMP) students. Even though the two research results have differences in terms of the results obtained, this difference is influenced by the treatment given by the teacher as a facilitator who develops mathematical discourse (Pamungkas et al., 2023). Thus, the learning process by developing mathematical discourse using interactive media can be carried out using various innovations that use digital technology. Digital technology using GeoGebra devices can improve students' understanding of mathematical representation and concept depiction. Based on research by Maryono et al., (2021), understanding the representation and depiction of concepts when conveying information from teachers to students is very important in the problem solving process. Representative understanding is understanding that encourages the process of deciphering answers and the process of formulating strategies to finding solutions (Nalim et al., 2022) .

Developing a Personalized Learning Model Based on Interactive Novels to Improve the Quality of Mathematics Education was researched by (Soboleva et al., 2022)

This research aims to develop a personalized mathematics learning model through interactive novels with the aim of improving the quality of mathematics education and student academic achievement. The subjects of this research were 121 schoolchildren from Russian and Uzbek schools. The problem identified in the research is the need for a sufficiently developed methodological foundation before graduation which has a detrimental impact on the mathematical competence of future experts required by the modern economy. The methods used in this research include theoretical analysis and generalization of scientific literature, the use of digital technology to personalize learning, and the use of visual interactive literature as a type of computer game. Statistical processing of research results was carried out using Fisher's Test. The strength of this research lies in the use of interactive inquiry methods, which can improve students' academic performance in mathematics and contribute to the personalization of learning. The results of this research show an increase in student learning outcomes in mathematics learning using interactive novel media which prioritizes the development of students' needs and the demands of current developments. This research is in line with research presented by Purwanti et al., (2021), where it can be seen that the application of interactive media with interactive reading materials can increase mathematical connections and student learning achievement meets valid criteria with a result of 89.17%. Student connection ability is an ability that influences the amount of information that students are able to absorb in understanding and reading data presented in the form of questions. Interactive learning media with the packaging of teaching materials can improve students' learning achievement, and this is shown by an increase between classes that are part of the control sample and again from the experimental

sample with the results of the presentation of the average score of the experimental group is 74.88, while the average score The control group mean was 64.32 (Nurmawati et al., 2020) .

Working With An Instructional Video On Mathematical Modeling: Upper-Secondary Students Perceived Advantages And Challenges researched by (Wirth & Greefrath, 2024)

Learning videos in mathematics education targets knowledge of procedures and algorithms. How can students play an essential role in the involvement of learning resources? This research was used to determine the benefits and challenges that students felt when they worked with instructional videos about mathematical modeling and solved subsequent modeling-related problems. This research was conducted in a secondary school with a total of 28 students divided into 14 pairs (17 female students and 11 male students). The advantage that students feel from using this instructional video is that the prepared step-by-step explanations are constructive in planning and monitoring the solution process. Apart from that, advantages also refer to how students describe certain features for independent learning. The perceived challenge is that students find it difficult to transfer what they have seen to related problems. Apart from that, the length of the video was a challenge. However, for the most part there is a positive perception of the video being developed. Therefore, studying the effect of using this video format on students' learning about modeling is the next step that should be taken. This research is in line with research presented by Guru et al., (2009) regarding mathematical modeling.

How Automated Feedback From A Digital Mathematics Textbook Affects Primary Students Conceptual Development: Two Case Studies researched by (Rezat, 2021)

The researcher aims to find out more deeply about the responses given by students to the information provided by the teacher, especially towards e-books compared to printed books. Most previous research was less able to address student responses in depth but was more based on other variables, such as student responses to understanding concepts and implementing learning, such as research that has been conducted by (Martin et al., 2015; Patri & Heswari, 2021; Sukestiyarno et al., 2021; Watson & Thompson, 2021; Yaniawati et al., 2021). This research uses a quantitative method based on the Rabardel instrument and concepts developed by Vergnaud. The research subjects chosen were two elementary school students who were given German e-books. The results of this research indicate that students' responses to the e-book provided had little influence on students' understanding of the material. This research is very different from that carried out by (Aminah et al., 2024), where learning media in the form of interactive modules can increase students' responses to the entrepreneurial character. The problem experienced by the subjects of this research was that they needed help completing the individual assignments provided in the e-book. So, further research is needed to develop an appropriate design that can improve the results expected by researchers.

CONCLUSION

The results of this research found that Interactive Media is widely used in mathematics lessons throughout the world. Interactive media found include Digital Books, Geogebra, Geometer's Sketchpad, ChatGPT, and Instructional Video. Of the various interactive media, digital books are the ones most used in learning. The results of this research also found that Ethiopia and Germany use interactive media more frequently than Indonesia, the United Arab Emirates, Italy, and Russia. Geometry material is the material most widely used in interactive media in various countries. It is hoped that this research will be helpful in finding interactive media that is suitable for learning. Researchers are aware that there are still areas for improvement in this research, so that other, more detailed and varied research is needed to obtain maximum research results.

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