The Impact of Using Audio-Visual Interactive Media in Learning Mathematics

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Abstrak

Proses pembelajaran matematika terdapat berbagai permasalahan yaitu diantaranya adalah latar belakang siswa, minat belajar, motivasi dan sikap. Berdasarkan hal tersebut maka penelitian ini bertujuan untuk mengkaji pengaruh pengunaan media interaktif audio visual terhadap pemahaman konsep pembelajan matematika. Jenis penelitian yang digunakan adalah penelitian Meta-analisis. Subjek penelitian ini mulai pada jenjang SD, SMP, SMA. Sumber data adalah hasil penelitian terdahulu yang relevan dengan topik penelitian yang memenuhi keiteria ingklusi dan eksklusi. Dari pengindeks Google Scholar, DOAJ, dan Scopus. Alur penelitian ini meliputi penentuan topik penelitian; mengembangkan dan memvalidasi review protokol; mencari literatur; analisis; menarik Kesimpulan; dan tahap terakhir pelaporan hasil. Hasil penelusuran ditemukan sebanyak 47 data yang memenuhi syarat dengan jumlah siswa (N), nilai F-hitung, nilai t-hitung, dan nilai r-hitung. Data dianalisis menggunakan software JASP dengan menginput nilai Effect Size (ES) dan Standar Eror (SE). Hasil analisis uji variable moderator pembelajaran berbasis media audio visual pada siswa dengan nilai P-regression sebesar -1.041 lebih besar dari 0.298 artinya hipotesis Ha Accepted dan nilai summary effect sebesar 70% dengan katagori tinggi. Adapun hasil analisis data yang diperoleh dari simulasi software JASP menunjukkan bahwa pengaruh yang signifikan terhadap media pembelajaran matematika salah satunya berbasis media Adobe Flash yakni pada jenjang SMA Berdasarkan hasil n summary effect sebesar 85% dengan kategori tinggi.

Kata kunci: Media Pembelajaran, Audio Visual Interaktif, Pembelajaran Matematika

Abstract

In the process of learning mathematics, there are various problems, including student background, learning interest, motivation, and attitude. Based on this, this study aims to examine the effect of using audio-visual interactive media on understanding the concept of mathematics learning. The type of research used is Meta-analysis research. The research subjects are at the elementary, junior high, and high school levels. The data source is the results of previous research relevant to the research topic that meets the criteria of inclusion and exclusion. From Google Scholar, DOAJ, and Scopus indexers. The research flow are determining the research topic; developing and validating the review protocol; searching for literature; analysis; drawing conclusions; and the last stage of reporting the results. The search results found 47 eligible data with the number of students (N), F-count value, t-count value, and r-count value. The data were analyzed using JASP software by inputting the Effect Size (ES) and Standard Error (SE) values. The results of the analysis of the moderator variable test of audio-visual media-based learning for students with a P-regression value of -1.041 are greater than 0.298, meaning that the Ha Accepted hypothesis and the summary effect value are 70% with a high category. There are also the results of data analysis obtained from JASP software simulations showing a significant effect on mathematics learning media, one of which is based on Adobe Flash media at the high school level based on the results of the summary effect of 85% with a high category.

Keywords: Learning Media; Audio Visual Interactive, Math Learning

1. INTRODUCTION

Along with the times, science and technology have also experienced the development of science and technology to become increasingly sophisticated, directly or indirectly having a considerable influence on several aspects of human life. One aspect of the development of science and technology is education (Fitriyani, 2019; Zubaidah, 2019). Therefore, for education not to lag behind the development of science, adjustments are needed. Existing technology must be utilized to assist the learning process in education in schools. One of the

audio-Visual (Fitriyani, 2019; Manshur & Ramdlani, 2020). Education is something that is very important for humans in living life in the world because with education people can know what is not yet known and with education people can also achieve what is desired. Education is a conscious and planned effort to create a learning atmosphere and learning process so that students are active. Through education children can develop aspects of knowledge (Abdillah, Pramita Dewi, 2018; Pamungkas & D, 2021). Today's education requires the application of technology in learning, especially in mathematics. Mathematics is one of the subjects studied at all levels of education at the primary and secondary education levels. So informally it can also be referred to as the science of numbers and numbers (Mahsup, Abdillah, 2019; Nur'aini et al., 2017). A universal science that underlies the development of the modern world today, mathematics also has a fairly central role in various disciplines and can also advance human thinking. Therefore, media is very important in math learning. Mathematics as one of the basic sciences, both in the aspect of reasoning, which has an important role in efforts to master science and technology (Pramita & Rusmayadi, 2018; Prasetia, 2016). Mathematics including the use of technology has been advocated for several years by teachers who use materials to enhance their classes such as computers, calculators, and other technology. Therefore, the correct mathematics learning process must be able to attract student learning outcomes so that it is easier to accept the knowledge given (Capuno et al., 2019; Mahmudah, 2022; Stit et al., 2020). One of the media used in the teaching process so that students can more easily understand learning is using audio-visual media assistance.

Learning media includes tools that are physically used to convey the content of teaching materials which include books, tape recorders, cassettes, video cameras, video recorders, films, slides, photos, pictures, graphics, television and computers. Audio visual media is media that contains elements of sound that also contains elements of visible images such as video recordings, various sizes of films, pictures, sound slides and others (Jusmiana et al., 2020; Saragih, 2019). In line with that states that audio-visual media is media that can make students able to gain knowledge, skills, or attitudes, animation accompanied by images, videos, text, charts, and sound (Susilo, 2020). Meanwhile, according to previous study stated that the advantages of audio-visual media can create interest in learning in students, save time because the explanation of ideas is easy and precise, help and focus students' attention in learning lessons (Raisa et al., 2018). Audio visual can make it easier for students to learn and understand learning material, so that students can reach the target (Angreini et al., 2020; Tairu Idris, 2018). Audio visual is very necessary in stimulating students' thoughts, feelings, attention, interest and motivation to learn so that the teaching and learning process can run smoothly.

Adobe Flash according to previous study stated that adobeflash is an application program that is able to create interesting interactive multimedia with the display of animations, images, movies, presentations, games, quizzes, and electronic cards (Oktafiani, 2020). Geogebra is a software that has animation and motion facilities that can provide clearer visualization for students (Evi & Andy, 2012; Hartanto, 2013; Pramestika, 2020). Microsoft power point is one of the software tools operated through computer devices that are used to present material with learning media in which there are elements of text, sound, video, and images. Microsoft power point can also help create interesting learning media so that it will provide convenience and encourage students to learn actively and independently (Al Subaiei & Jarboui, 2022; Asriningsih et al., 2021; Fitriana et al., 2022). On the other hand, PowerPoint is one of the simple programs that is close to teachers and students and provides facilities for making videos or PowerPoint learning animations. Powerpoint is a presentation processing software that contains text objects, graphics, video, sound, and objects positioned on several pages or called "slides". The advantages of the Canva application are that it has a variety of attractive designs, able to increase the creativity of

teachers and students in designing learning media. (Rizanta & Arsanti, 2022; Zulfadewina et al., 2020).

Canva learning is expected to have a positive influence on teachers and students. As for students, it is expected to increase participation in participating in learning and increase student learning outcomes (Rusdiana et al., 2021; Tanjung & Faiza, 2019). Kahoot educational game is one of the online game platforms that can be used for teaching and learning activities in the classroom both offline and online classes. Previous study shows that the Kahoot application is very feasible to use as an evaluation tool (Sartika & Octafianti, 2019). Because the Kahoot application really helps learning to be more interesting, not boring, and further enhance student creativity and activeness (Alfiani et al., 2021; Demirkan, 2019). Previous stusy shows the same results from his research, namely the use of Kahoot media is interesting and fun for students so that it has an impact on increasing student activeness in the learning process (Erfan & Archi Maulyda, 2020). Lectora inspire is an e-learning development software that is relatively easy to apply or implement because it does not require an understanding of sophisticated programming languages (Shalikhah, 2017; Sulistiyawati et al., 2021). Lectora inspire is a technology product that can be used to develop engaging and interactive multimedia learning.

So that learning media is important in supporting the teaching process in the classroom and students are not alien to technology, as for problems in learning mathematics as in research (Awalia et al., 2019; Hardyanti.T et al., 2021; Waskitoningtyas, 2016). Explained that student difficulties that are often encountered are lack of understanding of basic mathematical concepts, lack of ability to remember formulas and solve existing problems because they require detailed explanations full of concentration and practice (Anjarsari et al., 2020; Buchori & Cintang, 2018; Olivia et al., 2023). So the need for learning media that can support teachers in explaining learning materials with various limitations owned by school facilities and teacher teaching methods in the classroom. The benefits of audio visual media in learning are that it increases mutual attention and sympathy, produces significant behavioral changes in students and shows the relationship between students and teachers (Hastuti & Budianti, 2014; Lestari, 2013; Masykur et al., 2017).

Based on the explanation above, the novelty of this study is focus on the impact of this type of audio visual interactive math learning media. Aiming to analyze the level of effectiveness or quality of audio visuals in android-based mathematics learning, including at the elementary, junior high, high school and college levels, and we can find out the effectiveness of audiovisual-based learning media in learning mathematics.

2. METHODS

Meta analysis is a form of quantitative research because it uses numbers and statistical methods from several research results to organize and explore as much information as possible from the data obtained so that it approaches comprehensiveness. This type of research is meta-analysis research. Meta analysis is research conducted by researchers by collecting research data, summarizing, reviewing, researchers by searching for articles contained in online journals, thesis results or journals, using google scholar, entering the keywords "interactive audio visual learning mathematics" (hartati et al., 2021).

The research subjects were self-efficacy and math learning outcomes and the research was conducted at the elementary, junior high, and high school education levels. This study uses the meta-analysis method. to add to the research hypothesis, according to previous study states that meta-analysis is a study conducted by researchers by summarizing research data, reviewing and analyzing research data from several pre-existing research results (Mandailina

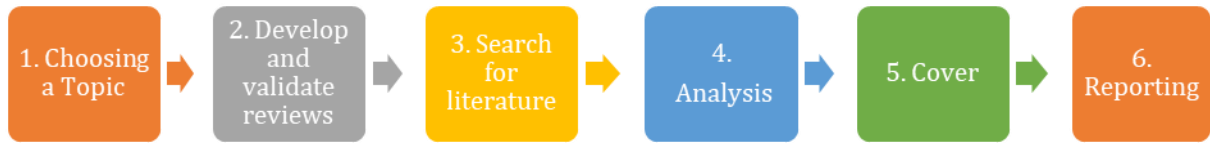et al., 2021). research results that have existed before. the stages in this study according to Figure 1.

Figure 1. Chart of Research Stages

Based on Figure 1 a multi-stage topic selection is done through the preparation of a research framework by collecting preliminary sketches of the topic. Topic selection is done by searching for articles on the google scholar indexing database with the words used in the article search. (1) Consultation related to the research title and its variables, audio-visual media in math learning (2) the dependent variable of audio-visual math learning and (3) next, we developed and validated the selected review articles according to the criteria, then analyzed the data in several stages, namely. (a) labeling or numbering their articles, (b) writing fisher test values (F), student test (t), correlation test (r), and the number of research subjects (N), (c) convert the F and t values to the R-values, (d) calculate the effect size (ES) and standard error (SE) values, (e) interpret the results of data analysis or output from JASP software, (f) analyze the results found from the articles that become reference data, (g) draw conclusions from the research results.

Conduct data analysis using JASP software; interpret the results of data analysis or output from JASP software. The final stage of reporting, reporting the results of the study by drawing conclusions from the results of the study, the category of impact level is determined by the value of the Effect size (ES) and Standard Error (SE). The research subjects were self-efficacy and math learning outcomes and the research was conducted at the elementary, junior high, and high school education levels. The effect size criteria is show in Table 1.

Table 1. Effect Size Criteria

Effect Size (ES)	Category
ES ≤ 0.15	Negligible effect
0.15 < ES ≤ 0.40	Small effect
0.40 < ES ≤ 0.75	Medium effect
0.75 < ES ≤ 1.10	High effect
1.10 < ES ≤ 1.45	very high effect
ES > 1.45	High influence

3. RESULTS AND DISCUSSION

Results

From the search results shown in the database indexing database, 139 relevant studies were obtained. However, after selection 45 data met the complete criteria. And 94 data that did not meet the criteria. Of the 45 complete data, there are 15 Adobeflash data, 4 Geogebra data, Google Clasroom 4 data, Lectora Inspire 4 data, Powerpoint 2 data, Powtoon 6 data, and 10 combined data. And the collected in this study are the value of the fisher test (F), student test (t), correlation test (r) and the amount of research data (N). While learning methods, and levels can be processed or analyzed further data with certain conditions. From the data collected that there are F and t values, the two values must be converted into r

values, as well as ES and SE values. In the first stage, a heterogeneity test is conducted to see the category of data whether using fixed or random effects. The results are as per Table 2.

Table 2. Fixed and Random Effects

	Q	Df	P
Omnibus Test of Model Coefficient	266.782	1	<0.001
Residual Heterogeneity Test	104.289	43	<0.001

Note. p -values are approximate.

From Table 3 show JASP output obtained about audiovisual learning media for mathematics learning that has been analyzed, it can be seen that the data is heterogeneous with a large Q = 104.289 and a p-value <0.001. Furthermore, the estimation of the card-based learning method in mathematics learning is shown in Table 4.

Table 4. JASP Coefficients Output

Coefficients			
Estimate	**Standard Error**	**Z**	**P**
Intercept	0.747	0.046	16.333	< 0.001

Note. Wald test.

In Table 4 about coefficients, we can see the z value of 0.046 16.333 and the p-value of .001 which means it is smaller than the significance value of 0.01. This means that the hypothesis is accepted, in this case, the true effect size is not equal to 0, in other words, the overall audio-visual-based learning method has an impact on learning mathematics by 75%. In Table 4 about coefficients, we can see the z value of 0.046 16.333 and the p-value of .001 which means it is smaller than the significance value of 0.01. This means that the hypothesis is accepted, in this case, the true effect size is not equal to 0, in other words, the overall audio-visual-based learning method has an impact on learning mathematics by 75%. The rank correlation is show in Table 5.

Table 5. Rank Correlation

Rank correlation test for Funnel plot asymmetry		
	Kendall's τ	**P**
Rank test	-0.148	0.167

Base on Table 5, regarding Rank correlation related to the large Kendall's value of -0.148 which shows the large correlation coefficient between effect size and variance. Then the P-value of >0.167 is greater than the value of 0.05 which indicates that the H0 hypothesis is rejected, in other words, there is no indication of publication bias. Regression test is show in Table 6.

Table 6. Regression test

Regression test for Funnel plot asymmetry ("Egger's test")		
	Z	**P**
Sei	0.079	0.937

Base on Table 6 regarding the z value, which is the magnitude of the coefficient >0.079, it is greater than 0.05, which indicates that the H0 hypothesis is rejected, in other words, there is no indication of publication bias 0.05. The funnel plot is show in Figure 2.
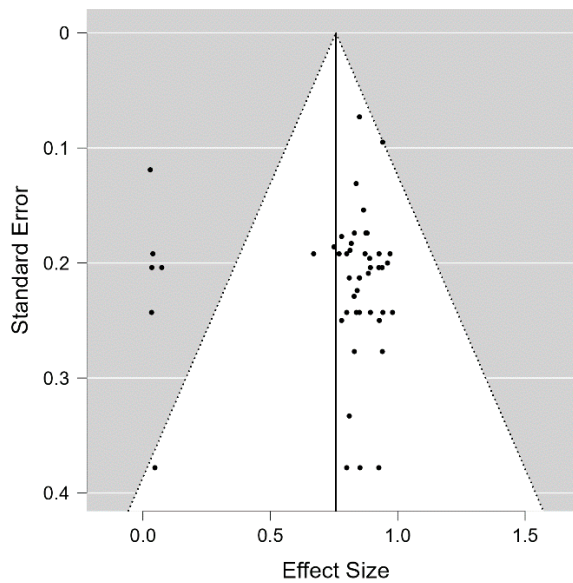

Figure 2. Funnel Plot

Based on Figure 2, the plotting results in the figure above, it can be seen that there are no missing studies marked by open circles, all open circles all closed circles. Next, the author conducted a test based on media to see the difference in the impact of each media on learning mathematics. The results are as per Table 7.

Table 7. JASP Output Hypothesis Test by Media

Media	N	Q_R	Forest Plot	Category	p-Reg. Test	Hypothesis
Adobe Flash	7	43.115	0.63 [0.31, 0.94]	Medium	0.206	Medium
GeoGebra	4	8.466	0.62 [0.23, 1.01]	Medium	-0.667	Medium
Lectora Inspire	3	0.048	0.87 [0.61, 1.14]	Medium	0.333	Medium
Google Classroom	4	0.876	0.83 [072., 0.95]	Medium	-0.333	Medium
Pow toon	6	15.132	0.73 [0.44, 1.87]	Medium	-0.552	Medium
PowerPoint	5	0.255	0.89 [0.66, 1.11]	Medium	-0.183	Medium
Macromedia Flash	4	15.495	0.68 [0.24, 1.12]	Medium	-0333	Medium
Combined data	12	104.289	0.75[0.660, 084]	Medium	-0.148	Medium

Based on Table 7, the hypothesis H_a being accepted implies that all methods have an impact on mathematical learning. For the GeoGebra media, the value of QR for the 4 data points is 8.466, which falls into the strong category with a significant level of 1%, thus H_a is accepted and the data variation is also accepted (heterogeneous). The regression test p-value is 0.006 > 0.0995, which means H_0 is rejected and H_a is accepted, or it can be concluded that the GeoGebra media has the smallest impact on mathematical learning with an effect size of 62% in the moderate category. PowerPoint has the most significant impact on mathematical learning with an effect size of 89% in the high category.

At this stage, the author analyzes the data to determine the level of influence of card-based learning methods when viewed based on variables, materials, education levels, years of publication, and the amount of data. This is presented in Table 8.

Table 8. Moderator Variable

Variable		N	Q_R	Forest Plot	Category	p-Reg. Test	Hypothesis
Variables	Learning Outcomes	14	37.896	0.67[0.34, 28.01]	Small	-0.011	Ha Accepted
	Development	12	2137.083	0.70[0.78, 50.62]	Small	-0.090	Ha Accepted
	Other Variables	16	23.746	0.23 [0.13, 0.33]	Small	0.109	Ha Accepted
Level	SD	18	31.686	0.79 [0.66, 0.90]	Medium	-0189	Ha Accepted
	SMP	14	51.159	0.57 [0.48, 0.89]	Small	-0125	Ha Accepted
	SMA	16	1.578	0.83 [0.75, 091]	Medium	-0288	Ha Accepted
Year	2012-2020	44	202.275	0.68 [0.59, 0.77]	Medium	0.012	Ha Accepted
Published	2020-2022	24	55.556	0.69 [0.58, 0.80]	Medium	0.007	Ha Accepted

In Table 8, based on the variables of hypothesis testing results and publication bias tests conducted, it can be seen that audiovisual learning media affects student learning motivation, with the highest impact found in the Development media with a significance value of 0.70 or 70%. Based on educational levels, the highest impact is seen in high school (SMA) with a value of 0.83 or 83%. Furthermore, based on the year of publication, the highest impact is seen in the years 2020-2022 with a value of 0.69 or 69%.

Discussion

The impact of Adobe Flash in mathematics learning Adobe Flash, which is included in the strong category, shows that this media provides a significant contribution in improving students' ability to understand mathematical concepts. The use of interactive media such as Adobe Flash is able to present visualizations of abstract mathematical concepts to be more concrete and easy for students to understand (Jais & Amri, 2021; Syafriatma & Amini, 2021). Previous research has shown that animation-based interactive media, such as Adobe Flash, increases students' learning motivation because it provides a more engaging and immersive learning experience (Cahyanti & Dra. Sumarsih, 2017). In addition, other studies have found that the use of Adobe Flash in mathematics learning significantly improves student learning outcomes, especially in geometry and algebra, where visualization is essential (Fathimah & Ishartiwi, 2018).

GeoGebra which is also included in the strong category and varied data (heterogeneous) indicates that this media is very effective in providing a deeper understanding of mathematical concepts, especially in geometry and algebra topics. GeoGebra allows students to explore various mathematical models visually, which strengthens their understanding of the relationship between variables (Pakaya & Machmud, 2021). Other studies have shown that GeoGebra improves students' critical thinking skills by providing them with opportunities to perform visual manipulation and interactive experiments on mathematical objects (Kholid et al., 2022). The heterogeneous data variation also shows that this media can be used at various levels of student ability, from low to high achievers, thus supporting differentiation in teaching.

Lectora Inspire has a positive impact although in the moderate category. This indicates that although Lectora Inspire is effective in helping students understand

mathematical concepts, its effectiveness may not be as strong as GeoGebra or Adobe Flash (Bulut et al., 2016; Syafitri et al., 2018). However, previous research shows that Lectora Inspire helps in delivering more structured and systematic material, making it suitable for topics that require procedural understanding (Lukman et al., 2022). This media also allows for multimedia integration that can improve student understanding through text, images, and animations.

Google Classroom, which is categorized as strong, shows that this platform is also effective in supporting mathematics learning, especially in terms of classroom management and assignments. Research by previous study shows that the use of Google Classroom increases the effectiveness of the learning process because students can access learning materials and assignments more flexibly (Woodrich & Fan, 2017). In addition, flashcards used in Google Classroom have also been shown to improve students' memory of important mathematical concepts. The results of this study are supported by other study which shows that the flashcard method helps students understand concepts gradually and repeatedly, which increases long-term retention (Maronta et al., 2023; Sari et al., 2018).

In powtoon media included in the strong category with a significant level of 1% so that Ha is accepted and data variation can also be accepted (heterogeneous), the p-regression test concluded that another portion has an impact in learning mathematics with a summary effect value with a moderate category. In PowerPoint media have an impact in learning mathematics with a moderate category (Crew et al., 2022; Mertasari & Ganing, 2021). Other media have an impact in learning mathematics with a summary effect value with a moderate category. Learning mathematics with a summary effect with a moderate category. From these results it can be concluded that PowerPoint media has the most significant impact in learning mathematics with a summary effect value of 89% with a high category (Isro et al., 2021; Listiawati & Qomariah, 2020).

Future research could focus on exploring the specific aspects of audio-visual media that contribute most to its effectiveness in mathematics learning. Additionally, investigating the optimal ways to integrate these media into different educational levels and contexts could further enhance their impact on learning outcomes.

4. CONCLUSION

Based on the results of the hypothesis testing and publication bias tests, it can be concluded that audio-visual learning media has a significant impact on student motivation with a summary effect value of 70% in the high category. Adobe Flash-based learning media is widely applied and has a significant impact with a summary effect of 72%. The high school level shows the highest impact at 83%, and the years 2020-2022 have a summary effect of 69%. For studies with participants greater than 50, the summary effect is 76% in the moderate category. In conclusion, this research demonstrates that audio-visual interactive media positively impacts mathematics learning, with different media types showing varying levels of effectiveness. PowerPoint media stands out as having the most significant impact, with an 89% summary effect in the high category. These findings suggest that incorporating audio-visual interactive media into mathematics education can enhance learning outcomes and student motivation.

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