The Influence of Electronic Teaching Materials on Students' Mastery of Learning Mathematics and Science: Meta-Analysis

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Abstract: The use of teaching materials has an important effect on achieving learning objectives. Teaching materials for learning must be appropriate and as needed. The purpose of this study was to determine the effect of electronic teaching material models on MIPA students' mastery of learning. This type of research is meta analysis. Meta analysis is research conducted by summarizing, reviewing, and analyzing data from several studies that have been conducted. The research sample consisted of 30 nationally accredited journals with criteria according to the problem formulation. The data analysis technique used in this study is to calculate the effect size of each article. Based on the research results, it is known that the effect of electronic teaching materials on MIPA learning mastery with an average effect size of 1.97 and an average effect size of 0.09.

Keywords: Mastery Study; Meta-Analysis; Teaching Materials.

Introduction

The development of science and technology (IPTEK) is very influential in various sectors of human life, one of which is education. According to Usmeldi (2017) students are required to master science and technology, so that they are able to assess the impacts and benefits of technological development in the natural and social environment in life. With advances in information technology, teaching materials develop into digital or electronic teaching materials (Fitriani & Rohayati, 2019). The development of this technology, especially the internet, provides opportunities for the world of education to access various information in the form of text, images, simulations, and sound (Sujanem et al., 2012). Education is the key in preparing quality human resources. Various strategies in learning are carried out to prepare better human resources, one of which is the use of ICT in learning. The use of ICT according to Anori (2013) can make it easier for students to access information from various sources, such as the internet. In education, of course, there is a process of teaching and learning. According to Asrizal (2018) Learning is an effort to develop some of the potential of students. In the learning process students must be actively involved. They are actively involved in reading, seeking information, writing, investigating, solving problems, and so on. For this reason, science and technology play a very important role in learning.

According to Jazuli et al. (2017), electronic teaching materials are teaching materials that contain text, images, and animation. The use of electronic teaching materials involves students, so that in learning students will continue to be active and concentrate (Manasikana & Listiadi, 2017). Educators use technology such as computers as a media presentation to convey information to students, so that students have more opportunities to communicate and discuss with educators (Husain, 2014). Educators use technology as an effort to improve the quality of learning (Kristiawan, 2014).

According to Asrizal (2019) learning skills are skills that are demanded and need to be possessed by students in the 21st century. These skills are important to compete

in this globalization era. These skills are known as 21st century skills which include critical thinking, creative thinking, collaboration and communication skills. This is in line with the statement that the development of electronic teaching materials is believed to be able to support students to achieve competency in learning (Damanik & Hutasuhut, 2020). One of the important things in creating a teaching material is the presentation of the material. Learning material is important, so that it is easier for teachers to carry out learning activities and make it easier for students to learn (Rochmawati et al., 2019)

Based on this, learning physics cannot be separated from mastering concepts, applying them in solving physics problems, and working scientifically. However, learning physics in the current classroom tends to emphasize mastery of concepts and overrides students' physics problem solving abilities Hoellwarth et al. (2005), so that students' ability to solve problems is still relatively low (Aji, Hudha, & Rismawati, 2017). Science learning is not only limited to learning facts, concepts, principles, laws, but also learning how to obtain information, apply technology, work scientifically, and think skills.

Electronic teaching materials can be in the form of videos, interactive multimedia, e-books. E-module, and digital pocket book. According to Moody (2010) ebook is an electronic book from a traditional book with digital features that can help readers. Zucker et al. (2009) said e-books are an interesting tool for most students. In line with the opinion of Lynch (2012), there are many benefits to be gained from using e-books, one of which is multimedia which can attract students' attention. According to Bozkurt and Mujgan (2015) Interactive e-books are digital books whose users can interact and communicate reciprocally. As for making electronic teaching materials, one of them can be web-based. However, in order to be able to identify more specifically the influence of electronic learning media, an analysis of research results documents that have been published from various credible scientific journal articles is carried out. This analysis is called a meta analysis.

Meta-analysis is research that uses studies that have been carried out and used by researchers to be tested systematically and qualitatively to obtain accurate conclusions (Ridwan, at all. 2021). Meta-analysis has the advantage of being able to identify specifically the effect of electronic learning media on each variable, educational level, and various grade levels. Therefore, it is important to know the effect of electronic learning media on learning outcomes and students' understanding of concepts.

Method

Research methods used is a journal review method in the form of effect size analysis by reviewing several articles in national journals or known as meta-analysis. According to Aslikhah (2015) meta-analysis is a statistical analysis in the form of quantitative data derived from a large collection of analysis results in an individual study to integrate into a conclusion. This is in line with the opinion of Lee et al (2018) who says that data from meta-analysis is quantitative in nature because meta-analysis uses calculations in the form of many numbers from data collected to summarize the findings of two or more studies.
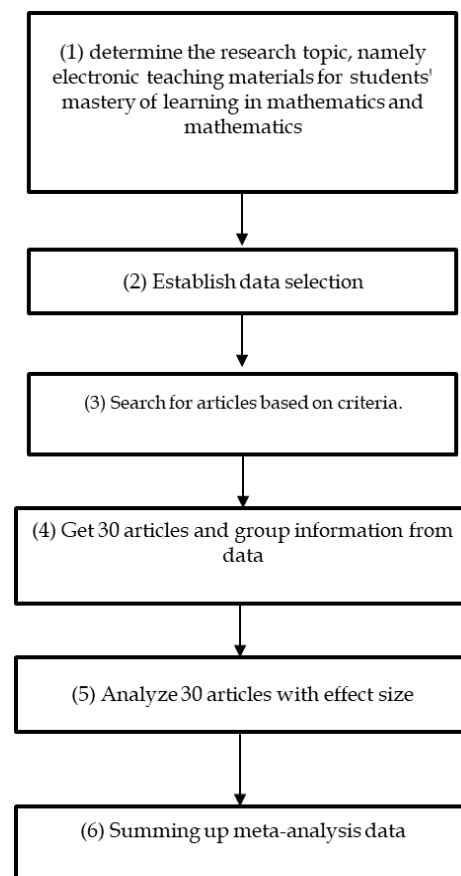

Figure 1. Meta-analysis research flow

Effect size analysis is statistical analysis in the form of quantitative data by summarizing two or more results of previous studies because effect size analysis uses calculations in the form of numbers and requires a lot of data that cannot be done with other methods. Effect size analysis can be concluded as a way of analyzing the results of previous research analyzes and summarizing them quantitatively with a large sample. Effect size analysis has steps including studying research topics and selecting them, collecting data in the form of related articles, coding and analyzing the quantitative results

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In this article, two variables are determined, namely the independent variable, namely students' mastery of learning MIPA and the dependent variable, namely the influence of electronic teaching materials. The analysis technique used is a quantitative approach. The number of articles analyzed were 30 articles.

To determine the effect size of each research data, statistical parameters can be determined in Table 1.

Table 1. Effect Size Formula

Statement	Equation
Average formula in one group	$ES = \dfrac{X_{post} - X_{pre}}{SD_{pre}}$
Average formula for each group	$ES = \dfrac{X_E - X_C}{SD_C}$
Formula ES t -count	$ES = t\sqrt{\dfrac{1}{n_E} + \dfrac{1}{n_c}}$

After the effect size is calculated from the various articles obtained, then the effect size value is seen by category based on characteristics. The characteristics of the effect size can be seen in Table 2.

Table 2. Characteristic Effect Size

ICE	Category
ES ≤ 0.15	Very low
0.15 < ES ≤ 0.40	Low
0.40 < ES ≤ 0.75	At the moment
0.75 < ES ≤ 1.10	Tall
ES > 1.45	Very high

(Dincer, 2015)

Result and Discussion

From the meta-analysis that has been carried out by determining the effect size value of the 30 articles that have been obtained about electronic teaching materials in the first article to the thirtieth article (category code) with A1 to A30 which are national articles. The distribution of electronic teaching materials can be seen in Table 3.

From Table 3 it is known that the highest effect size is in article A13 of 4.3 with a very high category while the lowest effect size is in article A29 of 0.09 with a very low category which is a type of video teaching material. According to Daryanto (2011) video teaching materials have drawbacks, namely inaccurate taking can cause doubts and misinterpretations of those who see them, requiring a projection tool to be able to display existing images. Meanwhile, the average effect size is very high at 1.97 for e-book teaching materials. In line with Rosida's statement, et al (2017) said that e-books are able to provide opportunities to train students' critical thinking skills and foster students' thinking abilities.

From Table 5 shows that the average effect size has a very high category except for electronic teaching materials, digital pocket books have an effect size of 0.76 in the high category, this means that electronic teaching materials have an effect on students' MIPA mastery.

Based on the results of the research that has been done regarding the effect of electronic teaching materials on MIPA students' mastery of learning which consists of 30 articles used can be reviewed based on the level of education and the type of electronic teaching materials. First, in terms of education level, it can be seen in table 4. The effect size is very high, namely 1.74 at the junior high school level, which is in the very high category, but at the elementary and high school levels, it also has a very high category, but the effect size is below the junior high school level. This proves that the application of electronic teaching materials has more influence on students' mastery of learning MIPA.

Second, based on the type of electronic teaching materials can be seen in Table 5. The average effect size of electronic teaching materials is very high in video teaching materials, interactive multimedia, e books and e modules but has a high category in digital pocket book teaching materials. This is supported by the opinion of Muneer (2021) which states that interactive multimedia provides several features including being interactive by providing easy feedback, freedom in determining learning topics and automatic control in the learning process.

From Table 4 it is known that the effect size is very high at the elementary, middle and high school levels but the superior value is 1.97.

Table 3. Distribution of distribution of data on the effect of electronic teaching materials on students' MIPA mastery.

Code	Electronic Learning Materials	Level of education	*Effect Size*	Category
A1	Digital Pocket Book	Senior High School	1.88	Very high
A2		Young Senior High School	0.61	At the moment
A3		Junior High School	0.47	At the moment
A4		SD Senior High School	0.8	Tall
A5		SD Senior High School	0.43	At the moment
A6		Junior High School School	0.54	At the moment
A7		Senior High School	0.58	At the moment
A8	E-Module	Senior High School	1.27	Very high
A9		Junior High School	3.87	Very high
A10		Senior High School	1.36	Very high
A11	E-Book	Junior High School	1.4	Very high
A12		Senior High School	0.1	Very low
A13		Junior High School School	4.3	Very high
A14	Interactive Multimedia	Senior High School	1.44	Very high
A15		Senior High School	0.63	At the moment
A16		Senior High School	1.23	Very high
A17		Junior High School	1.75	Very high
A18		Junior High School	0.68	At the moment
A19		SD Senior High School	3.08	Very high
A21	Videos	Senior High School	1.38	Very high
A22		Senior High School	2.09	Very high
A23		Senior High School	1.16	Very high
A24		SD Senior High School	1.49	Very high
A25		Junior High School School	0.5	At the moment
A26		Junior High School	3.32	Very high
A27		Senior High School	1.81	Very high
A28		SD Senior High School	0.98	Tall
A29		Senior High School	0.09	Very low
A30		SD Senior High School	0.52	At the moment
Average ES =			1.97	Very high

Table 4. Distribution of distribution of data on the effect of electronic teaching materials on students' MIPA mastery in terms of educational level.

Level of education	Number of Studies	Effect Size	Category
Elementary High School	6	1.22	Very high
Junior high school	10	1.74	Very high
Senior high school	14	1.51	Very high

Table 5. Distribution of the distribution of data on the effect of electronic teaching materials on students' MIPA mastery in terms of the types of electronic teaching materials.

Code	Electronic Learning Materials	Effect Size	Average Effect Size	Category
A1	Digital Pocket Book	1.88		
A2		0.61		
A3		0.47		
A4		0.8	0.76	Tall
A5		0.43		
A6		0.54		
A7		0.58		
A8	E-Module	1.27		
A9		3.87		
A10		1.36	3.45	Very high
A11		7.3		
A12	E-Book	1.4		
A13		0.1	1.93	Very high
A14		4.3		
A15	Interactive	1.44		
A16	Multimedia	0.63		
A17		1.23		
A18		1.75	2.11	Very high
A19		0.68		
A20		3.08		
A21		5.99		
A22		1.38		
A23		2.09		
A24		1.16		
A25		1.49		
A26	Videos	0.5		
A27		3.32	1.33	Very high
A28		1.81		
A29		0.98		
A30		0.09		
A31		0.52		

Conclusion

Based on the results and discussion that have been presented, it can be concluded that electronic teaching materials have a high effect on students' MIPA learning completeness. This is because electronic teaching materials are more varied and can be used repeatedly by students. The results of the data analysis showed that the combination of types of electronic teaching materials on students' mastery of learning MIPA resulted in an average effect size of 1.92 in the very high category. So, electronic teaching materials have a big influence on students' mastery of learning MIPA.

Conflicts of Interest
The authors declare no conflict of interest.

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