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# Comparison Effectiveness of Concrete and Digital Mathematics Learning Media: Systematic Literature Review on Industrial Revolution 4.0 Era

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## Abstract

Industrial Revolution 4. 0. Technological developments affect all aspects of human life, as well as education. Therefore, innovation is needed to achieve learning objectives. The goal is to produce a competitive workforce equipped with skills known as the 4Cs *(communication, collaboration, critical thinking and problem solving, creativity and innovation)*. Reforms in the field of mathematics education to achieve the intended expectations include the use of tangible digital educational media. Researchers conducted research using systematic literature review methods to find out the latest facts about concrete and digital mathematics learning media in the era of the Industrial Revolution 4. 0. We interpret a total of 30 articles from various databases and make an overview of the use, advantages and disadvantages of digital and real mathematics educational media in the era of the Industrial Revolution 4. 0. The benefits of real educational media include improving students' problem-solving, creative and thinking skills, and visual reasoning. The advantages of digital learning media include efficiency and efficiency when learning mathematics, allowing for face-to-face (distance) learning, and eliminating the need for certain treatments. The shortcomings of concrete learning media require more consideration so that it takes a long time.

**Keywords:** Concrete learning media, Digital Learning Media, Industrial Revolution 4.0.

## Introduction

In 2011, the era has developed in the industrial phase familiar with the term Industrial Revolution 4. 0. The revolution is marked by the increasing development of new technology, scientific data, and the ability to perform (artificial) engineering, as well as the increasingly recognized use of the internet in various fields (Ghufron, 2018). The Industrial Revolution 4.0 will have a direct or indirect influence on various aspects of human life, including the world of

education. In the last decade, the purpose of education has shifted from providing formal/traditional materials to an interactive environment, with observers of the world of education using virtual learning media methods and *augmented reality* to provide educational materials where teachers as facilitators of group learning as a form of learning style. Real case studies (Cotet, Carutasu, &; Chiscop, 2020). These various transports are intended to ensure that students are ready to face the changes and challenges of the times in the era of the Industrial Revolution 4.0, which focuses on what is called the term skill or skill / abbreviated as 4C (*Communication*, *colaboration*, and *critical thinking* and *problem solving*/critical thinking and problem solving *and innovation*). As demands and expectations for performance increase, it becomes increasingly important to find innovations that drive the effectiveness and efficiency of the learning process. Various options that can be utilized by teachers in achieving learning outcomes are by using learning media methods.

This method has actually existed and been known for a long time before the emergence of the Industrial Revolution 4.0, and in 1800 there was a concrete mathematical educational media, or learning media intended to describe abstract mathematical concepts explicitly and concretely and physical objects (Moyer, 2001). In 1990, the use of educational media received considerable attention (Tennyson, 2010). At that time, educational media was increasing, educators believed that the media had a significant impact on students, so the educational media model also varied from time to time. Currently, educational media is not just a tangible educational media, but along with technological innovations that are growing rapidly, digital / virtual educational media is a web-based virtual image that is used to represent an attractive, easy display and provide easy understanding of mathematics (D'Angelo &; Iliev, 2012).

Teachers as facilitators are expected to have qualified abilities in educational innovations in the form of special digital educational media to increase the effectiveness and efficiency of mathematics learning. Therefore, research is needed that considers the strengths and weaknesses of each mathematical educational media and its application in the era of the Industrial Revolution 4. 0. The alternative choice is to conduct *research* using *the Systematic Literature Review* (SLR) technique. This option is used because SLR is carried out through studying, evaluating, and combining theory and *research* findings to produce sources or current fact information. In particular, *this research* will conduct research on the current phenomenon of media, education, concrete, and digital mathematics, the revolutionary period of Industry 4. 0.

Based on previous research on concrete and digital educational media conducted using a mixed method by Hunt, Nipper, and Nash (2011). In this *research*, Hunt et al. (2011) conducted specific *research* and investigated the effectiveness of digital educational media. However, considering that *this research* was carried out before the Industrial Revolution 4.0, there is a need for *research* that supports the latest facts about concrete and digital mathematics education media in the era of the Industrial Revolution 4.0. According to *the Systematic Literature Review* (SLR), it is necessary to provide guidance to teachers / teachers about the strengths and weaknesses of certain educational media and digital educational media. In addition, this research can be a reference or guideline in determining the choice of suitable learning media in helping students master mathematical concepts.

## Literature Review

Concrete learning media refers to physical aids that students can hold, move, and manipulate to help understand mathematical concepts. Common examples of concrete media include: Manipulative blocks: Physical objects such as blocks, coins, and other tangible objects used to illustrate mathematical concepts, Tangram: Geometric manipulative tools used to teach spatial and geometric concepts, Measuring instruments: Such as rulers, scales, and other measuring instruments that help students understand the concept of measurement. The study found that concrete manipulatives help students better visualize and understand abstract mathematical concepts. The use of physical objects allows students to experience more real and immersive learning (Research by Moyer, Bolyard, and Spikell 2002). The research highlights that concrete manipulatives increase students' motivation and engagement in learning math's. Students are more enthusiastic and active when interacting with real objects (Boggan, Harper, and Whitmire (2010)). The study revealed that concrete manipulatives help in the development of problem-solving and critical thinking skills. Hands-on experience with physical objects allows students to develop more effective strategies and solutions (Uttal, Scudder, and DeLoache 1997).

Digital learning media includes various technologies used to deliver learning materials through electronic devices such as computers, tablets, or smartphones. Examples of digital media include: Educational software: Computer programs designed to teach mathematical concepts through interactive exercises, Mobile apps: Apps on mobile devices used to learn math independently, E-learning platforms: Websites or learning management systems that provide online math courses. This research shows that digital media provides wider access to learning resources and flexibility in the time and place of learning. Mobile technology in particular enables more interactive and adaptive learning (Crompton et al. 2016). The study discusses the use of artificial intelligence in education and how digital technologies can be personalized to meet students' individual needs. This personalization allows for more effective and efficient learning (Holmes 2018).

## Research Method

Theoretical studies utilize *the Systematic Literature Review* (SLR) methodology. Khan, Kunz, Kleijnen, and Antes (2003) mention 5 levels for conducting literature review. (1) Develop *research questions;* (2) Search articles; (3) The value of the article; (4) Summarize the article; (5) Interpret the findings of the paper. The search for research papers and literature is carried out from the perspective of: (1) Utilization of mathematical educational media in the era of Revolution 4. 0.; (2) The advantages and disadvantages of digital mathematics education media; (3) The strengths and weaknesses of certain mathematical education media; library source search is done using Google Scholar, Researchgate, and ERIC databases. Currently, the tips used in searching for library sources are: concrete mathematics education media, digital mathematics education media, educational media during the Industrial Revolution 4. 0, physics

math operations, virtual math operations. After completing the research, *the research* evaluates the results of searching for library sources. The literature is sorted based on specific criteria to find literature source articles in *this research*. These criteria are: (1) Literature according to certain aspects, (2) Literature magazine articles and literature published from 2011 to 2023. (4) Literature in the form of journal articles is entirely available to the public or proceedings products.

## Result and Discussion

The first step of *this research* is *research* reviewing various library sources and *research findings* on the use of tangible and digital educational media in the era of Revolution 4.0. The results of observations, then compiled *research questions* as follows: (1) What are the uses of educational media aspects of mathematics in the era of Revolution 4. 0? (2) What are the strengths and weaknesses of mathematics-specific educational media? (3) The advantages of digital educational media in mathematics What are the advantages and disadvantages? After compiling *research questions*, researchers review library sources such as research articles and texts using certain aspects, databases, and tips. The next step is to evaluate the results of searching for library sources. Currently, we have 30 papers that are able to answer our *research* questions for more detailed study.

**Table 1**. A summary of the search results is shown

| ***Keywords*** | **Multiple Articles** |
|---|---|
| Educational media in the era of revolution 4.0 | 4 |
| Concrete matrematics education media, *physical math manipulatives* | 8 |
| Digital mathematics education media, *virtual math manipulatives* | 7 |
| Mathematics education media, *math manipulatives* | 11 |

Then, in phases 3 and 4, researchers summarized and interpreted the 30 articles identified in the previous phase. Based on the results of this phase, further explanations are made.

A brief explanation of the results of the explanation of known library sources below.

### The Use of Learning Media in the Era of Revolution 4. 0.

Various equations are used to describe digital educational media, including technology-based educational media and virtual educational media. In the era of the Industrial Revolution 4.0, various countries including Indonesia proposed learning support through technology. At the end of 2019, the world was presented with the Covid-19 pandemic which resulted in countries in the world choosing a certain way towards the world of education. Schools should choose remote or online learning to avoid face-to-face to keep their distance from each other. This means that digital education media will play a role in this situation. Learning by means of digital educational media can be very helpful in helping students interpret abstract mathematical concepts, although learning must be done from a distance or *online.* However, in certain regions in Indonesia, the rapid advancement of technology is not supported by adequate

infrastructure, this is a real problem in the world of education. For example, certain areas in Indonesia do not have electricity. This makes the signal uninterrupted or unreachable. Another thing, not all students have adequate financial capabilities to support the implementation of learning models like this, the question then is whether digital educational media can be used more precisely than concrete educational media in the era of the Industrial Revolution 4.0. Theoretical reviews show that this is not certain. Concrete learning media and digital educational media each have strengths and weaknesses. Regarding this is described in detail in the next review.

**Advantages and Disadvantages of Digital Mathematics Learning Media**

Result of research Golafshani (2013) investigated the reaction of educators when applying concrete and digital educational media, teachers initially argued that students are better able to understand mathematical concepts when using concrete learning media than digital learning media I think I can understand it better. However, by implementing digital educational media and seeing students learning using this digital media, teachers change their minds. The advantage of digital educational media is that it requires less preparation in its use, so it is more effective and efficient in terms of time (Akkan, 2012). These media do not require special care when compared to concrete educational media. The advantage of other aspects of digital educational media is that currently there are many websites that present digital educational media for students in understanding mathematical concepts, and are free and simple, easily accessible (Akkan, 2012; D'Angelo & Iliev, 2012). Thus, it certainly facilitates work and cuts teachers' time, where they no longer need media development because it is available quite well and interestingly from the digitized educational media.

However, educators are expected to continue to sort and choose the need for media information obtained which media is educational and useful for students. From the student side, the advantages of digital educational media can optimize the interpretation of students' mathematical concepts (Nurdin et al., 2019) and minimize errors in interpreting theories (Loong, 2014). The Case of Digital Learning Media. The case contains various examples of concepts, meaning that media can optimize student learning outcomes (Lagrange &; Kynigos, 2014; Moyer-Packenham & Westenskow, 2013; Nurdin et al., 2019; Paseleng &; Arfiyani, 2015). Another thing, the use of media also optimizes the interest and motivation of students in learning (Lagrange &; Kynigos, 2014; Paseleng &; Arfiyani, 2015). The increase is reflected in a significant increase in the comparison of aspects of attention, interest, and participation of students during learning with control classes that do not use media. The results of *research* conducted by Kim and Park (2018) found that digital educational media with Minecraft sandbox games benefit students because they involve them proactively in the learning process using discovery learning methods.

The disadvantage of digital education media, where this media requires an adequate signal for its operation, is very much felt for developing countries such as Indonesia. The difficulty of signal connectivity in various regions of Indonesia makes students in these regions unable to access educational media provided by educators (Sadikin &; Hamidah, 2020). The financial resources of students are insufficient in getting laptop and smartphone devices

because of the high price (Putri &; Muzakki, 2019). In various regions in Indonesia, many students are not tech-savvy. This makes it difficult for students to use digital educational media (Dewi, 2020; utami &; Cahyono, 2020). Another thing is that educators must have the ability to utilize educational media through digital. Educators must have adequate abilities, thus educators are expected to be able to create and present good and interesting learning. Teachers who use digital educational media in their learning also experience difficulties in classroom management (Akan, 2012). This is because students, especially at the elementary school (SD) level, use digital media more to play.

**The difference between concrete and digital mathematics in aspects of student attitudes, student understanding and outcome aspects**

Viewed from the aspect of student attitude, attitude in learning has an impact on the sincerity of students in learning. A supportive attitude towards concrete mathematics increases the seriousness of learning activities when compared to an unsupportive attitude. The attitude of learning is not only what others perceive but how oneself sees it. Learning attitude determines the learning activities of students, a positive attitude towards learning is closely related to interest and motivation. Students with a supportive learning attitude are more proactive and with more meaningful achievements than students with an unsupportive learning attitude.

From the point of view of learners' understanding. Concrete media are factual media or in actual conditions, and because students generally think from concrete to abstract, it forces the minds of students to understand the meaning of each problem to stimulate learning. Thus, utilizing the medium of concrete objects to fill the void. Teaching concrete objects that are the purpose of existence is relatively simple and free of large costs, and because we encounter these media at school and everyday at home, it is easier for us to remember what is meant by teaching them. Realistic and meaningful abilities make the learning environment comfortable, encourage individually, increase the enthusiasm of students to want to study intensively, and help them master the learning delivered.

In terms of results, the determination of good and correct learning methods, and various has a significant impact on learning outcomes. Various media uses can also minimize learning barriers faced by students. Related media used. Based on the aspect of obstacles, it can be seen that students experience obstacles in understanding mathematics lessons. Overcoming these obstacles, researchers found a solution using concrete media. Other research shows that real media can optimize math learning outcomes. Concrete learning media is very suitable for use because students do not need to imagine the learning process and can immediately see in real terms what facts are being learned. In addition, students respond more appropriately in paying attention to and understanding the learning process than the abstract learning process. The use of concrete media makes abstract learning easier for learners to understand. By utilizing real media, it allows students to get real experience making it easier for students to master the material presented. The use of concrete media has a significant impact on the learning process. Media helps motivate learners to engage with the overall learning material (Miaz et al., 2018).

## Conclusion

Education through various media is needed to make it easier for students to understand the learning delivered. Learning in the era of Industry 4.0 revolution, especially in mathematics subjects in supporting the improvement and development of 4C skills. Concrete educational media and digital educational media each have strengths and weaknesses. These two media can be used together by prioritizing and highlighting the advantages of each of these educational media, so that what are the advantages of each of these methods can be copied, strengthened, and helped students more easily understand and master the subject matter, especially mathematics delivered.

Media with digital education makes the classroom atmosphere fun with an attractive design and appearance, coupled with encouraging audio so that students are expected to be enthusiastic in listening and listening to the teacher deliver the material without boredom. Media with concrete education can also be used in conjunction with media with digital education, media with concrete education is factual media or in actual conditions, helping students see and feel concrete media that are intended so that it is real in everyday life what is learned is not something abstract but what is learned is real around the environment both the school environment and the home environment. Thus, the combination of concrete educational media and digital educational media, especially during the Industrial revolution 4.0 era, increasingly makes the world of education easier, more interesting and fun, especially studying the field of mathematics.

## Declaration of conflicting interest

The authors declare that there is no conflict of interest in this work.

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