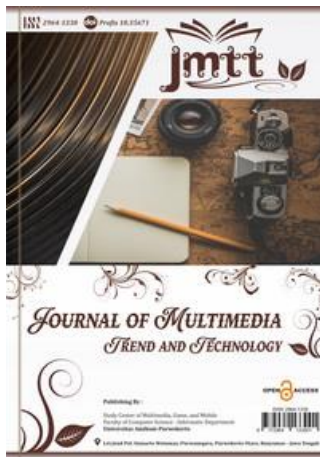


Literature Review: Study of the Use of Interactive Multimedia in Mathematics and Natural Sciences Learning in Indonesia

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ABSTRACT

The use of information and communication technology (ICT) in teaching has become an important issue in recent years in order to improve the quality of education. One use of ICT is as a learning tool, namely in the form of interactive multimedia. Learning using interactive multimedia develops on the basis of conventional learning which cannot meet students' learning needs. This interactive multimedia can be a supplement and complement to learning which represents learning resources. Interactive multimedia is multimedia that is equipped with a controller that can be operated by the user, so that the user can choose what they want for the next process. Interactive multimedia has been widely created and used in Mathematics and Natural Sciences learning in Indonesia. In this paper, a literature review study will be carried out on the use of interactive multimedia in learning in the fields of mathematics and natural sciences, to see developments, development methods, weaknesses and the results that have been achieved. On this occasion, the author provides observation results based on evidence through a literature review regarding the extent of multimedia use in learning, especially in the field of exact sciences such as mathematics and natural sciences.

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INTRODUCTION

Information and communication technology is being used in many aspects of life, including education. At the moment, information may be retrieved quickly and easily via the networks that are available, including the internet and local area networks (LANs) [1]. The field of education has been greatly impacted by developments in information technology, particularly with regard to the learning process [2]. When opposed to the traditional learning process, ICT offers a number of benefits that can be used in the educational process [3]. There are a few challenges in the process of teaching using information technology, namely, from instruction to homework, from classroom space to where and when to meet, from keyboard to "online" or workspace, from physical workspace facilities to work spaces, and from scheduled time to actual time [4].

One of the ways that information technology is being used in education is through interactive multimedia instruction [5]. Learning through interactive multimedia is gaining ground on traditional learning methods that are unable to meet the needs of students in the learning process. This interactive multimedia can serve as a support and a component in education that satisfies the learning objectives of each student [6].

The proliferation of learning storage, the rise in instructors and lecturers creating multimedia-based curricula, the rise in articles published in journals, conferences, and seminars, and the sheer number of final assignments, theses, and student dissertations that make use of interactive multimedia all point to the recent and rapid growth in the use of interactive multimedia [7]. The use of computers in education, particularly interactive multimedia in the study of mathematics and the natural sciences in Indonesia, will be examined in this article in order to identify advancements, methods of development, flaws, and accomplished outcomes.

1.1. Computer-Based Learning

The way that educational activities are organized is impacted by the use of computers in the classroom [8]. This organizing allows for the division of the use of computers in the classroom into three categories: Teaching without the use of computers. Educators have all accountability for organizing instructional activities. (2) Incorporating mixed learning. Although computer specialists handle some of the teacher's work, the teacher is still in charge of organizing the lessons. (3) Automated instruction. Teachers' roles are replaced by computers, which also autonomously organize educational activities.

Figure 1 illustrates how computer-based learning differs from traditional teaching methods and computer-assisted school administration. The most popular type of computer-based learning is blended learning. On the other hand, automated instruction is typically applied in the workplace or outside of the educational setting [9].

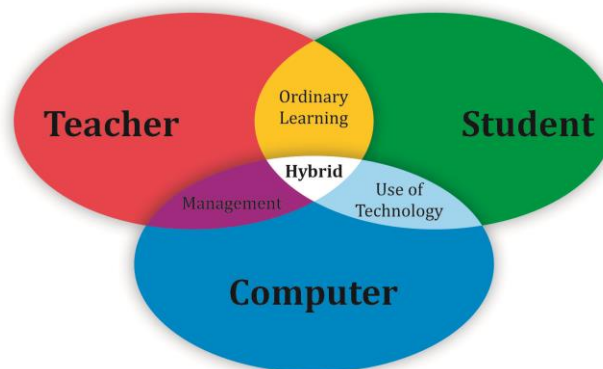


Figure 1, Computer Involvement in Teaching [9].

Using computers as a learning tool has several benefits, one of which is the ability to provide graphs and images in a way that makes them observable and analyzed. According to a number of educational academics, computers have a significant potential to raise learning standards [10].

In this context, the first advantage of media using computers is that they work according to programs, which helps them to be more responsive to the input that is given. Furthermore, computers are capable of processing both audio and visual media. Third, computers can do mathematical and logical operations, sort data, and output it as necessary. In the meanwhile, computer-based remediation can be done without the need for brushes or incredibly long-term remediasi [11].

Computer-based learning is increasingly known and has been widely implemented in schools from elementary to tertiary level. The development of computer-based learning software is considered feasible and important because it has several advantages, including: (1) it is a very effective learning medium and can facilitate learning and improve the quality of learning, (2) it can increase learning motivation, (3) it can be used as a direct and immediate effective delivery to students, (4) strongly supports individual learning, (5) trains students to skillfully select the desired parts of learning content, (6) enables students to become more familiar with and familiar with computers is becoming increasingly important in society modern, and (7) becomes more interesting because it is equipped with color, song, picture, graph and animation facilities so that it is able to present learning in an interesting way.

1.2. Multimedia Based Learning

There is a wide variety of learning media available. It is separated into two categories: interactive multimedia and linear/non-interactive multimedia based on user interaction and the media [12]. Other categories include static and dynamic media depending on the type of media, online and offline, stand-alone and non-stand-alone, multimedia-based learning media and conventional media, and many more. To distinguish it from non-interactive learning multimedia, interactive multimedia-based learning materials are frequently referred to as interactive multimedia in IT circles [13].

Multimedia derives its etymology from the Latin words multi (nouns), which imply numerous and varied, and medium (medium), which implies something that is used to carry or convey something. Interactive multimedia is one kind of multimedia that is suggested for usage in education (MMI) [14]. With MMI, users can direct the computer's next action by asking questions or receiving responses that affect the machine's decision-making. At least two key components make up MMI: video "captures" the moving image, which is subsequently stored in a series of still images and re-played into motion for the predetermined amount of time, and animation, which is a collection of images processed to create the illusion that the images displayed are moving [15].

Multimedia can also be defined as media that combines two or more media elements. integrated manner. The combination of two elements or more types of media emphasizes computer control as the driving force for the overall combination of media (that type of equipment) [16]. This combination constitutes a single unit that jointly displays information, messages, or lesson content. Meanwhile, interactive is the ability of a system/program to ask the user something (hold a question and answer) and then take action based on that response. So it can be concluded that learning using interactive multimedia is learning using media that combines two or more media elements consisting of text, graphics, images, photos, audio and animation in an integrated manner and has the ability to take action from user responses [8][17].

To develop interactive multimedia, robust research and analysis are required. As of right now, there are many different types of riset that can be used to develop multimedia-based interactive learning materials. Some examples of these are the riset groups listed in Table 1 below.

Tabel 1, Perkembangan Riset Pembelajaran Berbasis Multimedia

Topic	Area	Contibution	Contributor
Design Techniques	Information Technology	Generate ideas in designing and creating multimedia works from all fields.	[18][19][20]
Methodology	Multimedia	Discusses implementation techniques and strategies in implementing multimedia.	[21][22][4]
Media Trends	Social	The emergence of platforms that can be used as online media and social media.	[23][24][25]
Technology Development	Artificial Intelligence	Use of supporting technology such as AI, IoT and big data.	[26][27][28]
Analysis of Implementation Results	Literature Review	Observation of the results obtained with multimedia.	[29][30][31]

It can be concluded from findings made in the literature that multimedia technology is still evolving today. The fundamental problem that remains between goals and technical advancements is the effectiveness of using multimedia in general. It is specifically in the learning area in this study.

METHOD

The method used to view known issues is through a bibliography, the author uses the bibliometric technique. Bibliometric analysis is the process of evaluating and quantitatively measuring the information contained in a literature collection, be it scientific journals, articles, books, or other documents. The stages in carrying out bibliometric analysis generally include the following steps:

1. Determine the purpose of bibliometric analysis, for example to identify research trends, evaluate the impact of a research topic, or map collaboration networks between researchers.
2. Identify data sources that will be used in bibliometric analysis, such as scientific databases (Web of Science, Scopus, Google Scholar), institutional repositories, or other digital library databases.
3. Collect relevant bibliometric data according to the analysis objectives, such as article title, author's name, year of publication, reference list, number of citations, and so on. Carry out data processing to clean, organize and tidy up the bibliometric data that has been collected. This includes removing duplicate data, standardizing data formats, and eliminating irrelevant data.
4. Perform quantitative analysis of bibliometric data using statistical methods or other data analysis techniques. This may include calculating descriptive statistics, such as frequencies, distributions, and proportions, as well as network analysis or regression analysis to identify patterns and trends.
5. Interpret bibliometric analysis results to evaluate findings and achieve a deeper understanding of the research subject. Identify trends, patterns, relationships, and contributions from analysis results. Present bibliometric analysis results in a clear and easy-to-understand format, such as a table, graph, or diagram. Prepare a report or document that summarizes the findings and interpretation of the analysis results.
6. Apply findings and recommendations from bibliometric analysis in relevant contexts, such as policy development, strategic planning, decision making, or further research.

RESULT

After seeing the development of issues in research regarding the implementation of multimedia in learning, especially in the fields of mathematics and natural sciences. We will see to what extent the role of multimedia technology is implemented. From the results of the bibliometric analysis, the following matrix results were obtained:

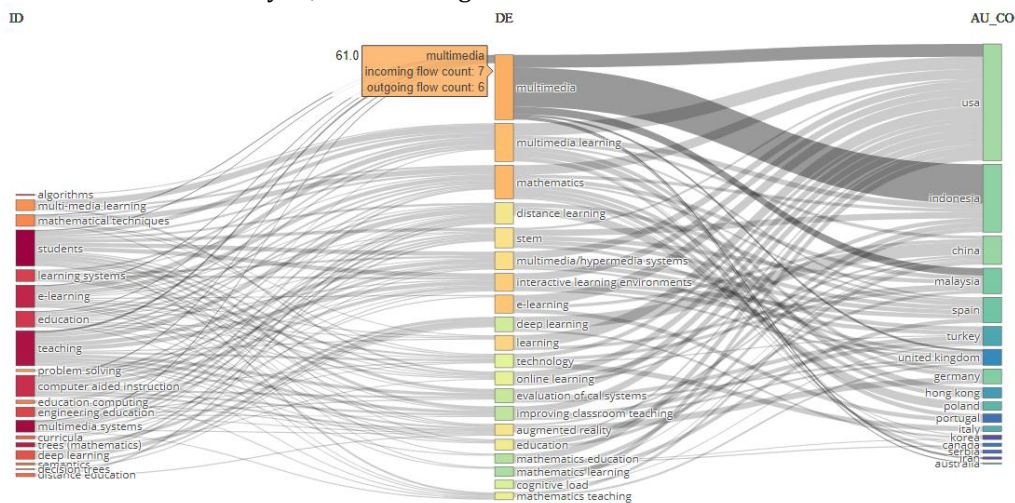


Figure 2, Matrix of the role of multimedia technology in learning science, mathematics and Mathematics and Natural Sciences.

Looking at the topic journey flow map, we see the middle multimedia area which is connected to the right side, namely country affiliation. Indonesia is in second place out of 20 countries that study the role of multimedia in mathematics learning. This means that Indonesia is also following developments that are currently trending, namely the role of information technology in the world of education.

However, if we look at the left side, namely the subtopics discussed recently, Indonesia in terms of multimedia, there are keywords that are studied including, (1) Curriculum, (2) Multimedia Learning, (3) Semantics, (4) Deep Learning, (5) Mathematical Engineering, (6) Learning Systems, and (7) Teaching. This concludes that the role of Multimedia Technology in the study of natural sciences and mathematics itself still discusses techniques/methods in learning using multimedia. What is most studied is the use of algorithms such as deep learning to formulate. However, the media section is still a platform like video.

Then, if we look at the condition of the role of multimedia in mathematics learning, it can be seen that when designing platforms it is still common that the majority use only videos. There are interactive elements but not many. On average, the design also uses the same method, namely the Multimedia Development Life Cycle Model.

Research development approaches were used in a number of studies that were based on findings from the literature and involved the creation of interactive multimedia. The systems approach is one method that is frequently employed (Ysejwin, 1992). There are three phases of implementation in developing media, according to Ysejwin (1992). These are the conception phase (concept creation) in the first stage, the realization phase in the second stage, and the utilization phase in the third stage. The full system approach is displayed as follows in Figure 2:

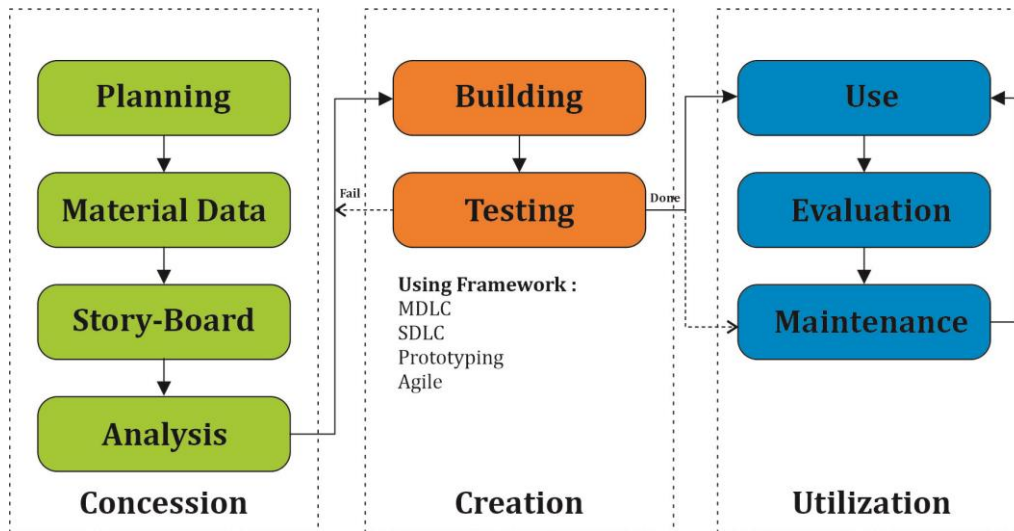


Figure 3, Systems Approach to Interactive Multimedia Development.

Then we try to look at the elements of the level of focus in multimedia studies in mathematics learning. In the bibliometric analysis of the cluster section, the following mapping results were obtained:

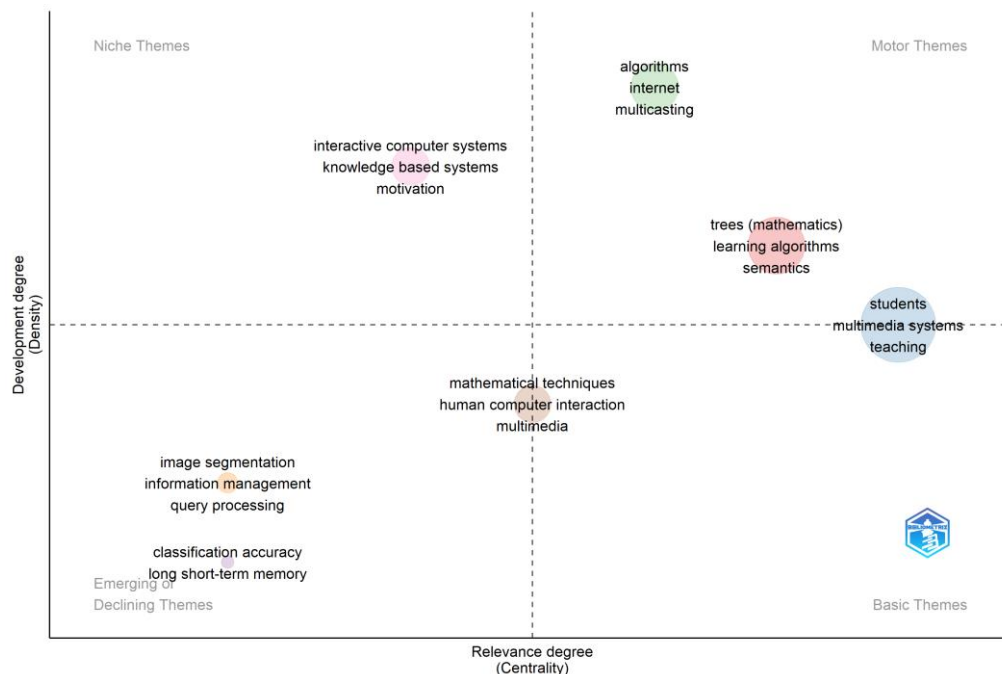


Figure 4, Focus mapping of multimedia topics in mathematics learning.

It can be seen in the picture that the focus in this study is on keywords, mathematical techniques, human computer interaction, and multimedia. This concludes that so far the role of multimedia has focused centrally on interaction models, mathematical formulation techniques, and the multimedia platforms used.

DISCUSSION

The process for developing Interactive Learning Multimedia is outlined in the book *Tips and Tricks for Creating Interactive Learning Multimedia at the Directorate of High School Education - Indonesia*. The steps include needs analysis, topic selection, content outlines, script writing, production implementation, evaluation and revision, and finalization.

Although interactive multimedia creation has advanced so quickly, the author claims that there are still numerous issues, such as: (1) Some students may feel distracted by animations that are too moving or complex visual effects, affecting their ability to focus on the material being taught. (2) Mathematics learning often requires direct interaction between teachers and students, as well as between the students themselves. The use of multimedia can reduce these interactions, especially if students are more focused on the screen than interacting with the teacher or their peers. (3) Some mathematical concepts, especially abstract ones, may be difficult to understand using multimedia alone. Students may need verbal explanations or physical manipulation to understand these concepts. (4) Not all students have the same access to technology and multimedia in their homes. This can create accessibility gaps among students, which can impact equity in learning. (5) Students with learning styles who prefer to learn through verbal, tactical, or auditory approaches may have difficulty understanding material presented via multimedia.

Although multimedia can present mathematical problems in an interesting way, they may not always be able to effectively support problem-based learning, where students are invited to actively solve mathematical problems. Despite some drawbacks, multimedia can still be a valuable tool in mathematics learning if used wisely and accompanied by strategic use of other teaching methods. The combination of multimedia with direct interaction, verbal explanations, and practical exercises can help maximize students' mathematics learning potential.

To optimize the role of multimedia in mathematics learning, several steps can be taken. First, multimedia should be used as a component in mathematics learning which also involves direct interaction, verbal explanations and practical exercises. Integrate multimedia into diverse teaching methods to create a holistic learning experience. Second, create multimedia content that is relevant to the mathematics curriculum and planned learning structure. Make sure that the multimedia content is well designed and presents information in a structured manner to facilitate understanding of mathematical concepts. Design multimedia content that captures students' attention and maintains their engagement throughout the lesson. Make sure the content illustrates mathematical concepts clearly and integratedly, thereby helping students understand the relationships between concepts. Third Consider students' learning styles and level of understanding when designing multimedia content. Adapt teaching materials and approaches to individual student needs to maximize learning effectiveness. Ensure that multimedia content can be easily accessed by all students, including those with limited access to technology. Consider alternative solutions for presenting material to students who do not have access to certain technology devices.

Provide training and support for teachers in the use of multimedia in mathematics learning. Help them develop skills and strategies to effectively integrate multimedia in their teaching methods. By following these steps, the use of multimedia in mathematics learning can be optimized to increase student understanding and engagement and support the achievement of the desired learning goals.

CONCLUTIONS

In utilizing the role of multimedia in mathematics learning, several important conclusions can be drawn, namely (1) The use of multimedia can increase student

involvement: Multimedia provides an interesting and interactive approach in presenting mathematics material, helping to increase student involvement in the learning process. (2) Integration of multimedia with diverse teaching methods: It is important to integrate multimedia with diverse teaching methods, including live interactions, verbal explanations, and practical exercises, to create a holistic learning experience. (3) Relevant and structured multimedia content: Multimedia content must be well designed, relevant to the mathematics curriculum, and presented in a structured manner to facilitate understanding of mathematical concepts. (4) Pay attention to students' learning styles: Multimedia content must take into account students' learning styles and level of understanding, so that it can be adapted to students' individual needs to increase learning effectiveness. (5) Encourage interaction and problem solving: Multimedia can be used to encourage students' active interaction with mathematics learning material as well as facilitate problem solving that allows students to apply the concepts learned in real situations. (6) Evaluation and feedback: It is important to evaluate the effectiveness of multimedia content in supporting mathematics learning and receive feedback from students and teachers to continuously improve the quality of the content. (7) finally regarding the accessibility of multimedia content: Multimedia content must be easily accessible to all students, including those who have limited access to technology, so that all students can make good use of it.

The use of multimedia in mathematics instruction can be adjusted to raise students' comprehension, engagement, and achievement in the subject by taking these factors into consideration.

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