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Incorporation of ICT-Based Multimedia In Mathematics Learning During Covid-19 Pandemic: Its Effects On Students' Learning Activity, Interest, Motivation and Metacognitive Knowledge

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Abstract. The purpose of this study was to analyze and design general physics lectures material and produce products in the form of STEM-based general physics lectures. The lecture materials are designed and made to meet scientific, technological, engineering, and mathematical aspects so that they are relevant to learning in the fields of mathematics and natural sciences. This study uses the modification of the Thiagarajan and Sammel research and development method consisting of 4 stages, namely Define, Design, Developed, and Disseminate where this research is only carried out until the development stage. The results of the research data were analyzed using quantitative and descriptive analysis techniques from expert validation data and limited trials in the form of questionnaires on respondents. The results of the validation carried out on material experts showed that the general physics equipment designed had met the criteria with a good range. Furthermore, the results of the media expert validation show that the media which is part of the lecture device that is designed is suitable for use in general physics learning with very good criteria. Similar results were seen in the results of the user response test which showed that the general physics learning material that had been designed was feasible to be used in lecture activities because general physics learning became relevant and applicable to other majors in mathematics and natural sciences.

INTRODUCTION

The rapid global change and advancement of science and technology give rise to the high demand for improvement in various aspects of life, including education. Indonesia's education system is required to adapt to the current development, especially amid the Covid-19 pandemic. This situation is impactful on education, in which the face-to-face learning process in schools is restricted to prevent the spread of such an infectious disease. Consequently, if education during the pandemic is urged to adapt, math learning as the basis of scientific development is in the same condition.

As the basis of science development, mathematics plays a crucial role in advancing science and technology and other aspects of life so that math mastery is of paramount significance. Nevertheless, mastery certainly comes with the teacher's responsibility as the main element in managing math learning. The management of math learning amid a global pandemic needs teachers to formulate creative, active, and innovative learning and media for students. Hence, online math learning will not be monotonous. Using learning media is necessary as a communication tool with the students in explaining abstract concepts.

Teaching math is not always carried out in an intense method. A teacher should be able to create a harmonious and pleasant learning climate by students' cognitive development. On this ground, math learning, particularly in

primary education, should be linked to real experience, i.e., media or props that can help students think abstractly. The learning process will be more effective with the assistance of learning media.

Learning media relate to software and hardware that can be applied to deliver learning materials to the students from learning sources [1]. The media can stimulate the students' minds, feeling, attention, and interest to make the learning process (inside or outside the classroom) effective.

Learning media feature some advantages, including standardizing the delivery of materials, creating a clear, attractive, interactive, and flexible learning process, streamlining time and effort, increasing learning outcomes, growing a positive learning attitude towards learning process and materials, as well as taking teachers to more positive and productive roles [2]. Abstract math objects are challenging for students to learn; math concepts can be understood with ease if they are concrete [3]. Therefore, it is essential to select appropriate media, one of which is interactive multimedia of math learning.

The use of media in math learning should take into account the learning modality or basic potential of students. Varied modalities of the students, along with the current pandemic situation, demand teachers to be able to incorporate different media in conveying messages; this is called a concept of multimedia. As a result, the learning process during the pandemic will be more optimal. Multimedia, as defined in Oxford-Advanced Learner's Dictionary, means "involving several different methods of communication".

Multimedia is the combination of different digital media, such as text, image, audio, and video, becoming an interactive and integrated multisensory app or presentation that delivers messages or information to the audience [4]. Audiovisual multimedia is considered more effective for students amid the Covid-19 pandemic, compared to only visual or audio multimedia. This is because interactive multimedia can potentially stimulate the students to respond to the online learning process positively. In addition, learning with two senses (sight and hearing) will be more beneficial for students; the more senses used to receive and process information, the more likely the students to understand the information and keep it in memory.

One of the topics of math learning that requires multimedia is geometry. Geometry lesson provides many approaches for problem-solving through image, diagram, coordinate system, vector, and transformation discussing the shape and size. Besides, geometry learning connects math with the physical form of reality and enables math concepts to be visualized. In the same tune, the examples of geometry strongly depend on visualization [5]. For such reasons, multimedia is of prime importance during the geometry lesson during the pandemic. It is to help to visualize difficult abstract concepts.

Interactive multimedia can generate a more interesting and interactive learning process, minimizing teaching time, bettering the learning quality of the students, improving their learning attitude, and the learning process can be performed anywhere and anytime [6]. Utilizing learning multimedia and sources during the lesson will create a greater opportunity for successful learning since the students have diverse behaviors; however, the designed multimedia and sources are relevant to learning objectives.

An effective math learning in schools will get the students more enthusiastic in participating in the process. Students' metacognitive knowledge is among the strategies for assessing the effectiveness of a learning process. The application of multimedia is expected to have a positive effect on students' metacognitive knowledge. There are three advantages of learning media, as follows: (1) attracting students; (2) improving cooperation and group work; (3) being practical, i.e., easy to package and bring outside the classroom [7].

Numerous previous studies have shown that interactive multimedia can increase student learning outcomes at all levels of education. For instance, a study by Karimah et al. concludes that interactive learning multimedia is very effective for all aspects [8]. Another study by Paseleng et al. sums up that relying on interactive multimedia can positively contribute to getting learning interest, specifically math lessons [9].

MATERIAL AND METHODS

This descriptive research was conducted in SMPN 2 Gorontalo, in the academic year of 2020/2021 (second semester). The study was started with a development process in four schools as the trial location, which were SMPN 1 Gorontalo. The development model referred to Four-D Model proposed by [10] that comprised Define, Design, Develop, and Disseminate stages. Moreover, the developed product was multimedia of the sphere.

Data analysis in the 4D model was elaborated on below.

Analysis of Validity

Expert validation was analyzed by referring to the validity criteria presented in Table 1.

TABLE 1. Validity Criteria

Mean	Validity Criteria
4.00 - 3.75	Highly Valid
3.75 - 3.00	Valid
3.00 - 2.25	Quite Valid
2.25 - 1.50	Less Valid

The above table illustrates that interactive multimedia in the learning process could be applied if it met the 'valid' or 'highly valid' criteria based on expert assessment.

Analysis of Students' Responses and the Implementation of the Learning Process

Students' responses were obtained from the result of the questionnaire, in which the data were then analyzed, and the result of every indicator was concluded. Assessing the learning implementation was performed by matching the average total score given with the following criteria:

TABLE 2. Learning Implementation Criteria

Range	Interpretation
86% - 100%	Excellent
76% - 85%	Good
66% - 75%	Fair
56% - 65%	Poor
0% - 55%	Bad

Analysis of Effectiveness

Students' interest and motivation, activities, and metacognitive knowledge were analyzed by referring to 80%. The data analysis technique in this research was effectiveness analysis. Slavin states that learning effectiveness consists of four indicators, namely (a) learning quality, (b) suitability of learning levels, (c) incentive, and (d) time [11].

1. Learning quality is the amount of information being delivered in such a way the students can learn about it effortlessly. Such a quality mostly serves as a product of the curriculum and learning quality itself.
2. Suitability of learning levels refers to the extent to which the teacher ensures the students' readiness level to learn about new information; they should have skills and knowledge regarding the information. Simply put, learning materials are not too hard or too easy.
3. Incentive is how much effort the teacher makes to motivate the students to work on assignments and learn about the provided materials. The higher the motivation, the higher their creativity.
4. Time refers to the length of time given to the students to study the presented materials. A learning process will be effective if students manage to finish the lesson under the set time.

Additionally, an effective learning process can reach the target, e.g., learning objectives and students' achievement. Therefore, indicators of learning effectiveness are: (1) the achievement of students' activity effectiveness (minimally 80%); (2) students' learning interest and motivation achieve a good category (80%); (3) the achievement of learning mastery from the outcomes of metacognitive knowledge, i.e., a student is considered "pass" if s/he gets at least 65% of absorption. Meanwhile, classical mastery is achieved if 80% of the students have "passed" the lesson. If all aspects mentioned earlier are fulfilled, the learning process of sphere multimedia will be effective. Each student has arrived at the predetermined competence.

RESULTS AND DISCUSSION

This present work produces a product, i.e., interactive multimedia of the sphere for the ninth-grade students. The development followed the Four-D model, as follows:

Define

The observation and interview results with teachers and students indicated that the utilization of instructional multimedia was limited. Hence, the development of such multimedia, particularly in the topic of the sphere, is highly required. The multimedia was designed to give an interactive effect on students to absorb the concept of the sphere. On top of that, interactive multimedia can instill positive characters in the students, namely self-reliant, responsible, honest, confident, determined, and cooperative.

Design

This stage comprised the preparation of character-based multimedia. There were also multimedia validity sheets, questionnaires to obtain response data of students' interest and motivation, observation sheets of learning implementation, observation sheets of students' activities, and learning outcome tests being developed.

Develop

The validity of learning multimedia comprised several assessment parameters, including material (content, language, and legibility) and design. Validity results revolved around qualitative suggestions and assessment sheets. Qualitative suggestions were treated as a reference to revise the multimedia.

Based on the result of expert validation involving teachers and lecturers, the achievement percentage measured at 91% with an excellent qualification (revision was unnecessary). Accordingly, the content, language, and legibility of multimedia can be applied in the learning process.

From the assessment of the design expert, the developed multimedia fell under an excellent qualification, as proven by the percentage of the achievement of multimedia by 90.15%. On that ground, the multimedia features the first-class design in terms of display and interactivity and is applicable in the classroom.

Instructional multimedia draw students' attention to study better rather than the traditional method of teaching [12]. Kuehnert's theory brings out the fact that the more senses involved in the learning process, the more successful the process itself. Once students stand in an effective situation to study and involve more senses to absorb information, it will be much easier for them to grasp the lesson.

Product Trial: The response and implementation of the learning process utilizing multimedia

It was shown in the observation result regarding learning implementation by using multimedia that the interactive multimedia was practical to use.

TABLE 3. Analysis of Learning Implementation

Lesson	Percentage of Learning Implementation (%)	Criteria
1	89.73%	Excellent
2	91.40%	Excellent
3	90.22%	Excellent
4	90.18%	Excellent
5	91.72%	Excellent

Drawing upon the analysis result of learning implementation in the site area, the multimedia can help teachers perform the lesson and achieve learning objectives. It has something to do with the fact that the learning process is

much more enticing, interactive, and time-saving. Teachers play a role as a facilitator in the learning process, guiding group activities, and offering feedback towards learning evaluation that is designed in multimedia.

Provided in Table 4 are students' responses to interactive multimedia encompassing the aspects of motivation, interest, attention, practicality, and clarity.

TABLE 4. Average Percentage of Students' Responses

Lesson	Students' Responses (%)	Criteria
1	85.29%	Excellent
2	85.00%	Excellent
3	87.52%	Excellent
4	85.15%	Excellent
5	85.22%	Excellent

Table 4 reveals that students' responses to the interactive multimedia fall under excellent criteria. In other words, they respond positively to the application of multimedia in the classroom. The students were very keen to study, as shown by their interest and attention during the lesson because the multimedia was attractive, user-friendly, and clear for them. This is in line with a study conducted by Odera on the linkage between media and computer technology towards students' learning motivation. It is found that learning motivation is of major importance in the learning process [13]. Computer-based technology and media can drive the students to study effectively and even independently.

Similarly, Newby et al. mention the benefits of learning multimedia, namely (1) realistic, in which students can listen to real events as what has been received; (2) motivating students to better their positive attitude; (3) effective for all types of learning; (4) interactive, multimedia can present information, feedback of materials, and evaluation; (5) consistent, the procedures and stages can be carried out by all students; (6) controlled, every student can use the multimedia; (7) personal, each student can control the learning process as by their level of understanding; (8) making the lesson more fascinating [14].

An effectiveness test was performed to find out the effectiveness of learning multimedia. The multimedia was tested on ninth-grade students of SMPN 2 Gorontalo who learned about this topic. The result of the effectiveness test provided the data of students' and teachers' activity in the learning process, students' responses to multimedia, and student learning outcome tests. These are depicted in the following Table 5.

TABLE 5. Analysis of Effectiveness

Analysis	Mean	Criteria
Students' interest and motivation	85.20%	Effective
Students' activities	82.35%	Effective
Students' metacognitive knowledge	80.22%	Effective

Referring to the above table, we can see that the learning multimedia is very effective, making it applicable and useful for the learning process.

CONCLUSION

Study results regarding the effectiveness show that learning multimedia of the sphere is categorized as very effective based on learning interest and motivation, activities, and learning outcomes of students' metacognitive knowledge.

All in all, the ICT-based multimedia of the sphere is effective to be applied in math lessons in junior high school.

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