Development of Interactive Multimedia-Based Science Teaching Materials on Vibration and Wave Materials

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ABSTRACT
This study aims to describe the validity, practicality and effectiveness of interactive multimedia-based science teaching materials. This study can be classified in the type of research and development using the APPED development model with the following stages: analysis and initial research, design, production, evaluation and dissemination. The subjects in this study are the VIII grade students of SMP Negeri 4 Mandrehe. There are three instruments used to collect data, they are: questionnaires used to validate teaching materials by material and media experts team, science teacher assessments and student responses to interactive multimedia-based teaching materials, and student activity observation sheets used in each learning process. The results showed that interactive multimedia-based science teaching materials have met the valid criteria with the achievement of 86.5% in the "very valid" category. The teaching materials are practical with the achievement of 83.8% in “good” category and have been effective with activities development has reached 85.51% in the "very active" category and the student response to the teaching materials has reached 87.17% in the "very high" category”..

Keywords: *Development, Science Teaching Materials, Interactive Multimedia.*

1. INTRODUCTION

Education is a real need that must exist and be met for the life of every human being. Without education, it will be difficult to develop in achieving the ideals of progress, prosperity and happiness according to the concept of the view of life of every human being. In line with the times, education also continues to develop. In the process of development, the stages occur continuously and systematically, therefore they can take place in all circumstances and conditions, whether at home, school or community environment.

Quality education can be seen from good quality education as well. The expected education is quality education. In improving the quality of education, it must be done by improving all the school supporting elements. To improve the achievement of educational goals through learning, the elements directly involved are students, teachers, subject matter, teaching methods, teaching and learning tools, learning environment and teaching materials used.

Teaching materials are all forms of materials used in learning to support teachers/instructors in carrying out learning activities. The materials used can be written or unwritten materials. These teaching materials is used to support the learning process.

Learning is a process of interaction that occurs between humans and the environment so it causes changes in behavior, attitudes and character of students to be better. There are some learning materials that are often difficult for students to understand and even teachers often have difficulty explaining them. These difficulties may occur because the learning material looks abstract, complicated, foreign, and so on. To overcome each of these difficulties, it is necessary to develop appropriate teaching materials. If the learning material to be used is abstract, then the teaching material must be able to help students explain or display something abstract, for example by explaining it in the form of pictures, photos, charts, schemes, and in other forms. So that complex material can be explained in a simpler way, according to

the thinking ability of students, so it can be easy to understand, especially in physics subjects.

Physics is a part of science that has a very big role in life, especially in the fields of technology that are developing rapidly at this time. Physics also educates students to have an intellectual and religious attitude in life by following every technological development. Therefore, students must be able to face changes in all fields, have logical and critical thinking, creative, and innovative. One of them is by studying physics. Basically, physics is knowledge, way of thinking, and investigation (experiment), its implementation in learning must be effective and efficient and able to make students motivated and interested in learning physics.

Based on the results of observations made by researchers at schools or research sites at SMP Negeri 4 Mandrehe, it was found that students had difficulty in understanding the material, which mostly contained abstract teaching materials and contained many formulas or equations that are difficult for students to understand. Student learning outcomes are also low, it is proven by the students' scores at the end of the semester which is still below the Minimum Completeness Criteria (in Indonesia it is caled KKM). The lack of students' involvement and liveliness in learning is one of the factors that causes the low learning outcomes of students also with lack of media, practical tools and teaching materials used during learning. Teachers also rarely carry out activities outside the classroom such as going to the laboratory due to the limitations of available practicum tools. The use of the internet also cannot be used by teachers in learning because of limited signal at school locations.

To obtain maximum results in the education world, it is necessary to develop teaching materials used in learning so that it can increase student motivation, and learning attitudes among students, make students able to think critically, socialize, and of course increase learning outcomes. One of the media teaching materials that can be used to increase the activity, response and learning outcomes of students is interactive multimedia-based teaching materials.

Hakim, et al, (2017) "Interactive Multimedia Thermodynamics To Improve Creative Thinking Skill Of Physics Prospective Teachers" Indicates that the creative thinking skills of prospective physics teacher students increase significantly after they experience thermodynamics learning with interactive multimedia. So it proves that the use of interactive multimedia can improve the creative thinking skills of prospective physics teacher students. This research aims to 1). describe the validity of interactive multimedia-based science teaching materials. 2.) describe the practicality of interactive multimedia-based science teaching materials. 3). describe the effectiveness of interactive multimedia-based science teaching materials.

2. LITERATURE REVIEW

2.1. Learning Resources

Humans who have mind and wisdom have been carrying out learning activities since ancient times until today's modern times. The way of learning and the learning resources used develop in line with the progress of thinking and human civilization. The learning process will take place well if there is interaction between students and learning resources. Learning resources are defined as everything in which there is information that can make it easier for humans to learn. In the current era of information technology development, people need a lifelong learning process by utilizing various learning resources provided and shown for learning, or provided for other purposes but can be used for learning process. In order to be able to utilize various kinds of learning resources, learning skills are needed, they are knowing the core or topic to learn, how the learning process is, where and when to learn it. Sitepu (2014).

Learning resources can be grouped as follows:

1. A place or natural environment, which is a place or location where anyone can carry out the learning process and have an impact on the person's life or behavior. These places can be categorized as learning resources, for example, museums, libraries, rivers, forests, and so on.
2. Objects, it is all things that can change a person after seeing or studying them. The changes can be changes in behavior or gain new understanding for someone. For example, temples, historical sites, artifacts and various mean objects or relics.
3. Person, is human who has certain abilities or expertise where we can learn something, or can be categorized as a learning resource. For example, teachers, physicists, lawyers and other experts who do have special skills.
4. Materials are in the form of writing, printouts, recordings, internet pages and others that can be used in learning.
5. Books, including everything that can be read and understood by people who read them independently and have meaning, or it is called learning resources. For example, textbooks, dictionaries, encyclopedias, folklore and others.
6. Events and facts, including everything that is happening or has happened and can be explained at the time of the incident, place and chronology, for example riots, natural disasters, and events that according to humans who see them are important, and anything that can be seen by teacher that can be can be used as learning resources.

Learning resources become meaningful for students and teachers if the learning resources have been planned through a meaning design where it can be used as a learning resource. If this is not done then the place or the natural surroundings, objects, people and books will only become something that cannot be interpreted and there is no any lesson can be learned from these things.

2.2. Teaching Materials

Teaching materials are everything in the form of materials which can be used as a medium in helping teachers/instructors in the learning process. The material can be written material and unwritten material. Teaching materials consist of or teaching materials are made up of two words, teaching and materials.

2.3. Uses of Developing Teaching Materials

There are several reasons why educators need to develop teaching materials, including: the presence or absence of materials that are in accordance with the applicable curriculum, the characteristics of students, and the process that students must go through in finding solutions to the problems they face. The development of teaching materials needs to pay attention to the demands of the applicable curriculum, where the teaching materials developed adapt to the curriculum.

2.4. Types of Teaching Materials

1. Visual Teaching Materials

Visual teaching materials are teaching materials that can be seen by the eyes or the sense of sight. Visual teaching materials can be printed or non-printed. Print results, for example, handouts, worksheets, book modules and others.

2. Audio Teaching Materials

Audio teaching materials are teaching materials that used in the form of mean sounds. As example: audio streaming, radio, cassettes, recordings containing teaching materials and so on.

3. Audio Visual Teaching Materials

Audio-visual teaching materials are teaching materials that combine audio and visual as a unit that can be seen and heard by students at the same time. For example, videos and movies.

4. Interactive Multimedia Teaching Materials

Interactive multimedia teaching materials are teaching materials that allow users to interact with the media used. Example of interactive multimedia are: Ms. Power point (made with tools that allow interaction), learning applications and learning website pages.

2.5. Preparation of Teaching Materials

Teaching materials can be anything that can be used as material in learning. The preparation of teaching materials must pay attention to the topics, learning outcomes, and competencies contained in the curriculum. According to Steffen-Peter Ballstaedt, printed teaching materials should pay attention to the following:

1. The layout of the display, the display of teaching materials should be easy and not difficult to understand, attractive, concise, and clear titles and the availability of a table of contents and evaluation for the readers.
2. Easy language, which involves: the choice of words used, clear sentences, relationships between sentences, sentences that are not too long or verbose so that they are easy to understand.
3. Testing understanding, which involves: assessing the reader can be in the form of assignments or marking parts that have been understood.
4. Stimulants, which involve the content of teaching materials which must be able to stimulate the reader's thinking.
5. Readability, which concerns: the layout of the writing where the letters used can be read clearly.
6. Instructional materials, which involve: the entire content of teaching materials, starting from the sources used to worksheets.

2.6. Multimedia

Multimedia if interpreted from the term, multimedia is a combination of several media such as video, audio, graphics, writing, animation and so on which are processed through computer devices using certain applications to achieve certain goals which must pay attention to the integration and unity of the media. This shows that the parts of multimedia must be interrelated with each other and support each other in achieving the expected goals. Processing of some media generally uses a computer or other processing tools such as tablets or even smartphones.

Multimedia in its presentation to users is divided into two, they are linear and nonlinear. Linear multimedia means that the material runs sequentially from the beginning to the end. Users can only play and pause, for now there is also navigation to speed up and return to the view that the user wants. Non-linear multimedia means that it allows interaction between media and users or feedback to users when using it.

2.7. Interactive Multimedia

Interactive multimedia is a medium that is devoted to conveying information about various things and being able to interact with its users. Multimedia is designed with an attractive appearance and easy to understand by its users. Interactive multimedia can be used by anyone from various circles starting from students, the military, service and product providers. Multimedia that can interact with users where the user can control the media he uses and get feedback from the activities he does then

the media can be called a interactive multimedia. Interactive multimedia is a combination of various informative elements into a controlled and integrated experience (Elsom-Cook, 2001). Interactive multimedia can be defined as an amalgamation of various types or parts of other media such as audio, video, graphics, text, animation and others into a single unit where the user benefits from the combination. (Reddi & Mishra, 2003). Interactivity is not a medium. Interactivity is the result of the thinking behind the use of multimedia or multimedia programs. Interactivity allows users to get access to all media that have been synergized in multimedia so that the program is more meaningful and can be utilized and provides a good user experience for users.

1. Advantages of Interactive Multimedia

The advantages of using interactive multimedia in learning are:

a. The learning process is more interactive and innovative.
b. Educators will be trained in making learning more creative.
c. Able to make a combination of several media such as text, images, audio, video into a single unit that synergizes in achieving learning objectives.
d. Increase the interest and motivation of students in the learning process which can help achieve learning objectives.
e. Able to present difficult material in visual form so that it is more real and can be understood by students.
f. Train students in independent study and construct their own knowledge that they want to know.

2. Interactive Multimedia in Learning

Learning multimedia is multimedia that can be used in the learning process, where this media can convey messages and can stimulate the attention, interest, willingness and feelings of students, so that learning can be carried out according to learning objectives. The use of multimedia that is appropriate and in accordance with the objectives of the curriculum will provide significant benefits for the development of students' knowledge. In general, the benefits that can be obtained is learning could be more interesting and interactive and also effective use of time. This can also affect various things such as the development of knowledge, skills, and even attitudes and learning can be more flexible which can be done anywhere and anytime. Interactive multimedia can be interpreted as a learning model that aims to convey messages, stimulate thoughts, concerns and feelings and interests of students which can encourage the implementation of a fun and meaningful learning process. The use of multimedia learning certainly does not only display images or visuals but must be able to provide a meaningful learning experience for students. Interactive multimedia allows users to decide what to do next and where they can ask questions and get answers.

3. Characteristics and Capabilities of Interactive Multimedia in Learning.

a. Has several media that can be combined and become one unit, for example merging moving images and audio.
b. Interactive, the ability to provide feedback from what is done by the user.
c. Independent, which gives freedom to users to access so that they can use them without the help of other.

2.8. Learning Theory

Constructivism is an understanding or foundation of (philosophical) thinking that puts forward a contextual approach where knowledge is built slowly so the results can be expanded through a limited context and not suddenly. Knowledge is not a series of facts, rules or concepts that are ready to be taken and memorized, but humans must be able to build their own knowledge and live it through real experience. Students should be accustomed to solve the problems they face. Thus, students can be trained to find solutions for problems they face and find something that they feel is useful for their lives.

Constructivism according to Piaget, known as the first constructivist, asserts that knowledge is built from within the child's mind through assimilation and accommodation. Assimilation is the absorption of new messages/information into the mind. A person uses his initial abilities to respond to the problems he faces in his environment. While accommodation is a rearrangement of the structure of the mind due to the new information that comes in. In accommodation, a person requires a change in understanding in responding to challenges in their environment.

From some of the views above, it can be concluded that constructivism is a concept of thinking in which knowledge must be built by students themselves and not the result of transferring knowledge from educators to students. This means that students must actively discover and build their own knowledge based on their ability to think. In other words, students are not a blank white paper that is ready to be filled in by the teacher.

2.9. Learning Activities

Activity is something that must exist in building interactions in the learning process. Learning activity is an activity that is carried out consciously with the aim of a change in the whole individual. Schools will become more dynamic if learning activities can be created and often held in a learning process. For this reason, the creativity of a teacher is absolutely necessary in order to be able to plan various student activities.

3. RESEARCH METHODS

This research can be classified in the type of research and development (R&D) using the APPED development model. This model can be used as a reference in R&D. The essence of research in this type of R&D is the element of research and development. The steps taken in this APPED model follow the logic of the type of R&D research.

This research is divided into two stages. The first stage is the development of teaching materials. The development of teaching materials includes i) validation of interactive multimedia-based teaching materials, ii) validation of test instruments for student cognitive learning outcomes and student activity observation questionnaires. The second stage is the implementation of teaching materials and research instruments that are considered feasible based on the results of the trial.

In this study, data collection was carried out by: 1) compiling teaching materials to be used from various sources, 2) developing interactive multimedia-based teaching materials, 3) determining learning methods and media that were adapted to the developed teaching materials, 4) validating teaching materials developed to get feedback, suggestions and comments from lecturers so that it becomes the basis for improvement, 5) testing interactive multimedia-based teaching materials that have been developed, 6) evaluating the results of testing interactive multimedia-based teaching materials, 7) making good teaching materials/ standard.

Data analysis in this study consits of qualitative data in the from assessment and revision to produce a product in the form of interactive multimedia-based physics teaching materials and quantitative data in the form of student learning outcomes. The qualitative data was obtained from the answers to the questionnaire filled out by physics lecturers, physics teachers and students on the components of the feasibility of content, language and presentation of interactive multimedia-based teaching materials that were developed and analyzed descriptively. Quantitative data were obtained from student learning outcomes, observations of student activities, in the form of psychomotor and affective assessments, as well as the results of student response questionnaires and analyzed inferentially.

4. RESEARCH RESULTS AND DISCUSSION

Research and development is made to produce interactive multimedia-based teaching materials. Stages of development through 5 stages, there are analysis and initial research, design, production, evaluation and dissemination. From the data acquisition that has been analyzed in the first and second trials, it shows that the interactive multimedia-based science teaching materials developed are valid, practical and effective.

1. Validity of Interactive Multimedia-Based Science Teaching Materials

Validation of teaching materials is carried out so that the teaching materials developed are valid and suitable for use. The validation used in development research is validation by material experts and validation by media experts on interactive multimedia-based teaching materials. The aspect of assessment by material experts includes 10 indicators that should be assessed by the validator, they are: (1) The level of relevance of teaching materials to the curriculum used. (2) the suitability of the teaching materials, (3) the ease of understanding the concept map, (4) the attractiveness/compatibility of the images with the material, (5) the language used in the teaching materials, (6) the ease of understanding the material by students by using teaching materials, (7) systematic suitability of the material presented in teaching materials, (8) Ease of activities carried out by students, (9) Motivating students when using teaching materials, and (10) Forms of evaluation that are in accordance with teaching materials.

In the aspect of "media" assessment used in teaching materials, there are 10 indicators that are assessed by the validators, they are: (1) Attractiveness in designing covers for multimedia-based teaching materials, (2) Clarity of images (illustrations) used in multimedia-based teaching materials, (3) Appropriateness of the use of fonts in multimedia-based teaching materials, (4) Interesting animation effects displayed , (5) The layout accuracy of the navigation buttons (continue, return) in multimedia-based teaching materials, (6) Easy operation of the multimedia-based teaching material system, (7) Systematic suitability of teaching materials presented in teaching materials, (8) Layout that used in multimedia-based teaching materials is interesting (9) Understanding teaching materials in multimedia-based teaching materials is easy and (10) Effectiveness of multimedia-based teaching materials developed in learning activities. Based on the results of the validation of teaching materials developed by two validators, it was declared that it met the valid criteria because it has good validity criteria.

The assessment of the validity of interactive multimedia-based teaching materials result by material and media experts showed that each indicator in several aspects is in the good category and an achievement rate of 86.5% is obtained in a very valid category.

2. Practicality of Interactive Multimedia-Based Science Teaching Materials

Interactive multimedia-based teaching materials are practical, in terms of the implementation of classroom learning where the materials applied are easy and can be applied to learning and the implementation of learning is in the good category. Implementation of learning using

teaching materials can be seen from several aspects, tehy are: (1) management of the room and learning facilities; (2) efficiency during learning; (3) can manage interactions during learning; (4) develop a positive attitude during learning; (5) demonstrating/displaying special abilities in learning; and (6) the implementation of evaluation of the learning process and learning outcomes. Aspects of the implementation of interactive multimedia-based teaching materials were assessed at each meeting.

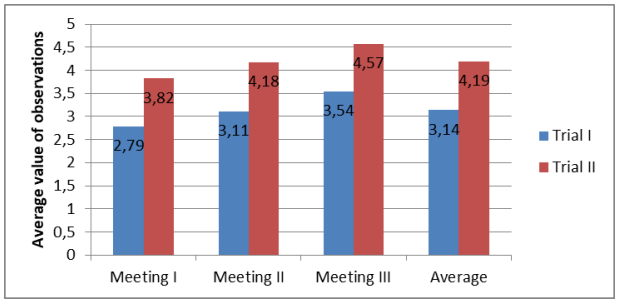

Figure 1. Implementation of Test I and Trial II Teaching Materials

In Figure 1. it is found that the overall implementation of learning in the first trial is 3.14, so the implementation of learning in the first trial is in the fairly good category. In the overall implementation of learning in the second trial is 4.19, the implementation of learning in the second trial is in the good category and has increased from the previous trial. Thus, it is found that the interactive multimedia-based science teaching materials developed are good, so it shows that the developed teaching materials have been practically seen from the implementation of learning by applying interactive multimedia-based teaching materials.

3. The Effectiveness of Interactive Multimedia-Based Science Teaching Materials

The interactive multimedia-based teaching materials that have been developed are feasible to apply if they have a positive impact on learning. So that the interactive multimedia-based science teaching materials developed must meet the effectiveness criteria. Teaching materials are said to be effective in terms of 1). Mastery of classical student learning outcomes, it means that at least 85% of students have completed fulfilling the KKM. 2). There is an increase in student activity at each meeting during learning. 3). Students respond positively or belong to the very high category in responding to interactive multimedia-based science teaching materials.

a. Completeness Test of Learning Outcomes Trial II

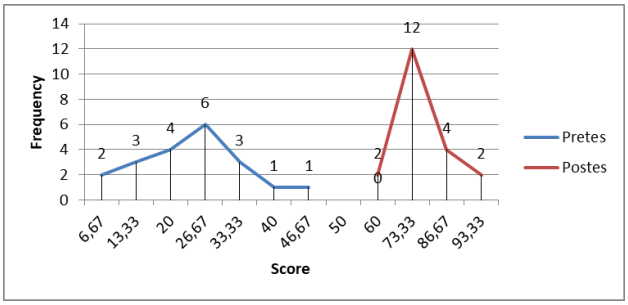

Figure 2. Graph of Pretest and Posttest Values for Trial II

The results of the pretest and posttest class II showed an increase in the students' scores during the posttest from their pretest score before the treatment was carried out. In the pretest results the average score is 26.38 which means very low, after treatment using interactive multimedia-based teaching materials given, the average score of the class increases to 80.29.

b. Student Activity Trial II

Observations were made to observe student activities during the learning process using interactive multimedia-based teaching materials. Observations were carried out by observers and carried out during learning activities which consisted of three meetings. The results of the development of activities during learning are shown in the following table.

Table 1. Development of Student Learning Activities Trial II

Aspects of Value	Meeting	Activities Score	Criteria
A. Visual B. Listening C. Motorik D. Mental E. Emotional	I	75,07 %	Active
	II	80,29 %	Active
	III	85,51 %	Very Active

From Table 1. it can be seen that the development of student activities during learning in the trial class II has increased by using interactive multimedia-based physics teaching materials that are applied to the level of achievement of student learning activities from the first meeting, which is 75.07%, the second meeting with a level of achievement of 80.29% and the third meeting with an achievement rate of 85.51% with the criteria of "very active".

c. Test Student Response II

The response of students is the extent to which feelings of pleasure, freshness, interest, clarity and interest of students in the components of interactive

multimedia-based physics teaching materials are applied. This response questionnaire was given to class VIII – C with 23 students as respondents after applying interactive multimedia-based physics teaching materials in the learning process. Student response questionnaires to interactive multimedia-based science teaching materials used included responses to several aspects of the statements given with criteria number 1 for strongly disagree, number 2 for disagreeing, number 3 for agree and number 4 for strongly agree. The results of student responses to interactive multimedia teaching materials can be shown in the following table.

Table 2. Student Response Data in Trial II

No	Aspect	Frequency				Score	Percentage (%)
		SD	DG	A	SA		
1	The physical appearance of these teaching materials is attractive to students.			5	18	87	94,57
2	This teaching material uses examples of questions related to everyday life problems.			16	7	76	82,61
3	In this teaching material there are several sections for me to find my own concept.			17	6	75	81,52
4	This teaching material explains a concept using illustrations of problems related to everyday life.			14	9	78	84,78
5	This teaching material contains questions that encourage me to think.			15	8	77	83,7
6	The presentation of the material in this teaching material encouraged me to discuss with other friends.			17	6	75	81,52
7	These teaching materials stimulated my curiosity.			14	9	78	84,78
8	The order of presentation of the material in this teaching material is clear to me.			10	13	82	89,13
9	This teaching material contains formative tests that can test how far my understanding is.			14	9	78	84,78
10	The sentences and paragraphs used in this teaching material are clear and easy to understand.			9	14	83	90,22
11	The language used is simple and easy to understand			9	14	83	90,22
12	The letters used are simple and easy to read			14	9	78	84,78
13	By using these teaching materials, it adds to my insight in studying science			8	15	84	91,3
14	This teaching material makes me happy to learn science			11	12	81	88,04
15	By using these teaching materials, it can increase the desire to learn			11	12	81	88,04
16	Using these teaching materials makes my learning more focused.			14	9	78	84,78
17	By using these teaching materials, I can better understand and understand multimedia-based physics material			10	13	82	89,13
18	This teaching material is in accordance with the learning objectives			10	13	82	89,13
19	Multimedia teaching materials can motivate me to study it			8	15	84	91,3
20	With these teaching materials, learning science is not boring			10	13	82	89,13
$p = \frac{\Sigma \text{item score}}{\text{maximum score}} x100\ \%$							87,17%

Student responses based on the analysis in table 2. it was found that the aspects given were given as a whole, the student response rate to teaching materials was 87.17% with very high criteria. This shows that students respond positively to the teaching materials used during the learning process with a percentage of 87.17%.

5. CONCLUSION

Based on the results of the analysis and discussion in this study, the following conclusions can be drawn:

1. The validity of interactive multimedia-based science teaching materials is valid for use based on the validation results from media experts and materials experts with an achievement rate of 86.5% in the "very valid" category and the subject teacher's assessment of the teaching materials obtained an achievement rate of 84% with "valid" category.

2. The practicality of interactive multimedia-based science teaching materials is already practical to use in learning, this is based on expert judgment which states that the device is able and easy to use, as well as the results of the implementation of learning with an average of 4.19 or 83.8% with the category " good".

3. The effectiveness of interactive multimedia-based science teaching materials is effective to be used in learning, this is based on: Mastery of classical student learning outcomes that has reached the minimum limit (KKM) with of 95.65% students pass KKM and activity development reaches 85.51% with the category "very active" and student responses to teaching materials have reached 87.17% with the category of "very high".

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