



CONSTRUCTIVISM-BASED MATHEMATICS LEARNING MULTIMEDIA TO IMPROVE STUDENTS' MATHEMATICAL COMMUNICATION SKILLS

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ABSTRACT

This study aims to describe the process of developing Constructivism-based Mathematics Multimedia, determine students' perceptions of Multimedia and find out the level of improvement in students' mathematics communication skills after using this Multimedia. This research ran for 1 month in class X MIPA 1, X MIPA 2, and X MIPA 3 SMAN 1 Jambi. The development model used in this study is the ADDIE development model. The type of data is qualitative data and quantitative data. From the results of the pre-test and post-test, it was found that 13 students had an increase in mathematical communication skills with high criteria, 7 students had an increase in mathematical communication skills with medium criteria, and 12 students had an increase in mathematical communication skills with low criteria. Based on the results of the study it can be concluded that Constructivism-based Multimedia can improve the students' mathematics communication skills.

MULTIMEDIA PEMBELAJARAN MATEMATIKA BERBASIS TEORI KONSTRUKTIVISME UNTUK MENINGKATKAN KEMAMPUAN KOMUNIKASI MATEMATIS SISWA

ABSTRAK

Kata Kunci:

Konstruktivisme
Komunikasi matematis
Multimedia pembelajaran

Penelitian ini bertujuan untuk mendeskripsikan proses Pengembangan Multimedia Matematika Berbasis Konstruktivisme, mengetahui persepsi siswa terhadap Media serta mengetahui peningkatan kemampuan komunikasi matematik siswa setelah menggunakan Multimedia yang telah dikembangkan. Penelitian ini dilakukan selama 1 bulan di kelas X MIPA 1, X MIPA 2, dan X MIPA 3 SMAN 1 Kota Jambi. Model pengembangan yang digunakan dalam penelitian ini adalah model pengembangan ADDIE. Jenis data yang diambil dalam penelitian ini berupa data kualitatif dan data kuantitatif. Dari hasil dari Pretes dan Postes diperoleh bahwa 13 siswa memiliki peningkatan kemampuan komunikasi matematik pada kriteria tinggi, 7 siswa memiliki peningaktan kemampuan komunikasi matematik sedang, dan 12 siswa memiliki peningkatan kemampuan komunikasi matematik rendah. Berdasarkan hasil penelitian dapat disimpulkan bahwa Multimedia Berbasis Konstruktivisme dapat menignkatkan kemampuan komunikasi matematik siswa.

1. INTRODUCTION

In this era of digitalization, technology has changed the way to assimilate knowledge and the development of student skills [1]. For this reason, to gain knowledge, the role holders in education must be technology literate. Developing Science and Technology requires higher-order thinking skills such as logical, critical, and creative thinking, communication, and also the ability to collaborate proactively. These skills can be developed through learning mathematics [2]–[7]. Mathematics learning is most often related to the problem-solving process which does not always rely on a standard formula. Complex mathematical problems require the ability to think creatively to solve them [8]–[11]. One very important factor that students must have to learn mathematics is mathematical communication skills [12].

Mathematical communication skills are the ability to convey mathematical ideas as well as the ability to understand and accept mathematical ideas of others carefully, analytically, critically and evaluatively to sharpen understanding [13], [14]. There are at least two reasons why communication in mathematics needs to be developed among students. First, the term ‘mathematics as language’ means that mathematics is not just a tool to aid thinking, a tool for finding patterns, solving problems or drawing conclusion, but mathematics is also a valuable tool for communicating ideas clearly, precisely and accurately. Second, mathematics learning as social activity, mathematics also acts as a means of interaction between students, or teachers and students [15].

To improve students’ mathematical understanding and communication skills can be done by applying active learning models or learning strategies such as think talk write learning, and by giving open ended questions/tasks. The advantages of using think talk write strategy in learning are: (1) accelerating students’ skills in using strategies, (2) helping students to accelerate understanding, and (3) giving students the opportunity to discuss a problem-solving strategy to accelerate the process of problem-solving and reasoning. In addition, several learning theories that underlie think talk write strategy are the theory of discovery learning and constructivism [16].

Learning is an initiative process based on students’ prior knowledge and experience. Before starting learning, teacher must prepare two things. First, compare and analyze material on curriculum standards and textbooks, and confirm learning targets. Second, analyzing and understanding students’ needs, finding out students’ prior knowledge and experience [17]. The stages of Constructivism learning approaches are (a) Apperception, (b) Exploration, (c) Consolidation, (d) Formation of attitudes and behaviors, and (e) Formative Assessment [18].

Besides think talk write learning strategy, learning media can also support to improve students’ mathematical communication skills, including interactive multimedia. One of the advantages of Interactive Learning Media is to grow students’ curiosity and foster students’ motivation to learn further [19].

The development of interactive multimedia mathematics based on indicators of problem solving can help students consistently practice problem solving, both collaboratively or individually, both in and outside the classroom. As the results, students become more focused, effective, efficient, conscientious, critical, and creative in solving problems with a variety of strategies. The process of improving problem solving skills by utilizing multimedia has a significant impact on improving students’ mathematical reasoning abilities in terms of analyzing data, verifying, drawing conclusions, and checking the validity of arguments. Increased student motivation to learn mathematics is also a positive reaction from the use of multimedia, because multimedia has an interactive video display, contains complete material, and students’ feelings when learning is not

burdened with space and time [20]. This statement is proven by a research result which has proven that learning using Adobe Flash media improves students' mathematical communication skills in the good category, this improvement is seen in each cycle [21].

Mathematical communication skills provide opportunities for students to develop their ability to communicate ideas through language and symbols to solve a mathematical problem. Based on this it was revealed that mathematical communication skills can improve student mathematics learning achievement [22]. Therefore, we are interested in developing a Mathematical Learning Multimedia based on Constructivism theory to improve students' mathematical communication skills. We design a multimedia that is suitable for group learning to see the ability of students to communicate through discussion and presentation. In addition, this multimedia is also developed based on constructivism theory, so that students can construct their previous understanding into a correct new understanding. So, after using this multimedia, students' communication skills can be better.

2. METHOD

The development model used in this research is ADDIE development model. ADDIE is an acronym from Analyze, Design, Develop, Implement and Evaluate. ADDIE is a product development concept [23]. ADDIE development model procedure that we use in this study is explained in the Table 1.

Table 1. Development Procedure

ADDIE Development Stages	Development Procedure
Analyze	
Gap Analysis	To find out the problems that occur in school, we conducted observations with questionnaire instruments aimed at teachers, the questions are about students and the school environment.
Determining Instructional Objective	We set research objective by identifying gaps between actual performance and expected performance, looking for the main causes of the problems and then choosing priority action.
Identifying Student Characteristics	To analyze the characteristics of students, interviews were conducted with several students and teachers.
Identifying the resources needed	There are four types of resources needed: content resources, technology resources, teaching facilities and human resources.
Arranging program/project management plan	The work plan in this research is to create a multimedia design, compile the objectives of implementation or development, produce a testing strategy, and validate multimedia.
Design	
Managing the task lists	This activity contains identification of the program. Through this identification, we determine: multimedia title, targets, and subjects to be written in the multimedia.
Making work goals	At this stage, researchers create a multimedia flowchart and storyboard.
Arranging test strategy	At this stage, we compiled a Media Validation instrument and Material Validation instrument which will be tested by the Material Expert and Media Expert, and compiled an Instrument to find out Teacher and Students responses to this Multimedia.
Development	
Multimedia realization	At this stage, we create interactive learning multimedia. This activity ended with producing Learning Multimedia.
Design validation and material validation	After the product is ready, we conduct media validation and material validation tests. Validation is done by giving open questionnaires to media experts and material experts. Material experts and media

	experts give some suggestions for our product, then the multimedia is revised according to comments and suggestions from the experts.
Individual Trial	Individual trial is conducted to get suggestion about the instructional media. The subject of individual trial is a teacher who is well-experienced and competent in his/her field. In an individual trial, an open questionnaire is used to obtain suggestions for the media, so, the data obtained is qualitative data.
Small Group Trial	At this stage, the trial subjects consisted of 8 students. The results of this small group trial are suggestions that are used to make product revisions. The questionnaire used was a closed questionnaire. The data obtained is quantitative data.
Large Group Trial	Results from small group trial are used to improve the quality of the media before being tested on a large group. Large group trial involved 22 students or one class. The questionnaire used was an open questionnaire. The data obtained is qualitative data.
Implementation	
Pre-test	Before multimedia is implemented in the learning in classroom, we provide pre-test in the form of 5 essay questions. This pre-test aims to determine students' initial knowledge before using Multimedia. The results of this pre-test will be used to measure students' mathematical communication skills improvement.
Applying multimedia in learning Observation	Using Multimedia for learning in class. Observations were made during learning process, and aiming to observe students' mathematical communication skills during the discussion. At the observation stage, researchers provide a closed questionnaire to see students' perceptions about Multimedia that has been used during learning.
Post-test	After Learning process and Observation are finished, the next stage is providing a post-test that aims to determine the improvement of students' skills after using Multimedia Learning.
Evaluation	
Evaluation	Evaluations are done at the end of each research and development stage to see improvements in the product. Post-test is also a part of the evaluation stage.

This research took place at SMAN 1 Jambi starting from July 2017 to May 2018. The research subjects were students of class X MIPA 1, X MIPA 2, and X MIPA 3. The data analysis process in this study included analysis of the results of the validator questionnaire, the results of individual trial questionnaires, the results of small group trial, and analysis of the results of large group trial. The instruments used during the pre-test and post-test include seven mathematical communication indicators. Indicators of mathematical communication skills are: (a) represents real objects, images, and diagrams in the form of mathematic ideas and/or mathematic symbols, (b) expressing ideas or opinions, situations and mathematic relations both orally and in writing, and describing them visually in the form of real objects, images, graphs, and algebraic expressions, (c) declare or create mathematical models of daily events or other mathematic problems in the language of mathematical symbols, terms, and structures, (d) Listening, discussing, and writing about mathematics, (e) Reading with an understanding of a written mathematics presentation, (f) Compile mathematical questions that are relevant to the problem, (g) construct conjectures, arguments, formulate definitions and generalizations [24].

The gain data is used to find out the increase in students' abilities after treatment. This data is obtained from the difference between the post-test score and the pre-test score [25]. The gain index determines the high/low improvement of students' abilities, the gain index criteria are explained in Table 2 below.

Table 2. Gain Criteria (g)

Gain score (g)	Criteria
$g \geq \bar{X}_g + s_g$	High
$\bar{X}_g - s_g < g < \bar{X}_g + s_g$	Medium
$g \leq \bar{X}_g - s_g$	Low

With:

- g : Gain score
- \bar{X}_g : Average gain
- S_g : Gain standard deviation

N-Gain (normalized gain) data is data obtained by comparing the difference between post-test and pre-test scores with the difference between the Ideal Maximum Score (IMS) and Pre-test [26]. N-Gain data is determined by this formula:

$$N\ Gain = \frac{Post\ test\ score - Pre\ test\ score}{IMS - Pre\ test\ score} \tag{1}$$

With the N-Gain criteria shown in Table 3 below.

Table 3. N-Gain Criteria

N-Gain score	Criteria
$N\ Gain \geq 0,70$	High
$0,30 < N\ Gain < 0,7$	Medium
$N\ Gain \leq 0,30$	Low

3. RESULTS AND DISCUSSION

The results of this research and development are: (1) A constructivism-based mathematics multimedia to improve students’ mathematical communication skills, (2) Results of content validation and multimedia design by material experts and media experts, (3) Teacher and student responses, (4)) Students’ perceptions or responses to multimedia, and (5) Student pretest results before using learning multimedia and student post-test results after using learning multimedia.

3.1 Analyze

At this stage, we made an observation at SMAN 1 Jambi in July 2017. From the observation, it was obtained that the mathematics teacher at the school could not use or design Multimedia Learning with computers. So that the learning process is still using ordinary textbooks. After knowing this problem, we set the instructional objective, which is developing mathematics learning multimedia that is feasible and can support student-centered learning, so that students can construct their own knowledge.

The next stage is to identify the characteristics of students, so that this multimedia will adjust the characteristics of students. The result of this stage is the fact that students prefer to use a cellphone camera to take pictures of notes on the board. Besides, students prefer to find the final answers to each question from the teacher through Google. Through the use of this learning multimedia, students no longer need to take pictures of notes on the board, because this multimedia can be owned by students and used by students to learn by themselves.

Formative Evaluation at the Analyze stage was obtained from the responses of the mathematics teacher at SMAN 1 Jambi which stated that the school really needed Learning Multimedia in Mathematics to Improve Students’ Mathematical Communication Skills.

3.2 Design

At this stage, we make a Media Program Outline. After the Media Program Outline was created, we then created a flowchart and storyboard.

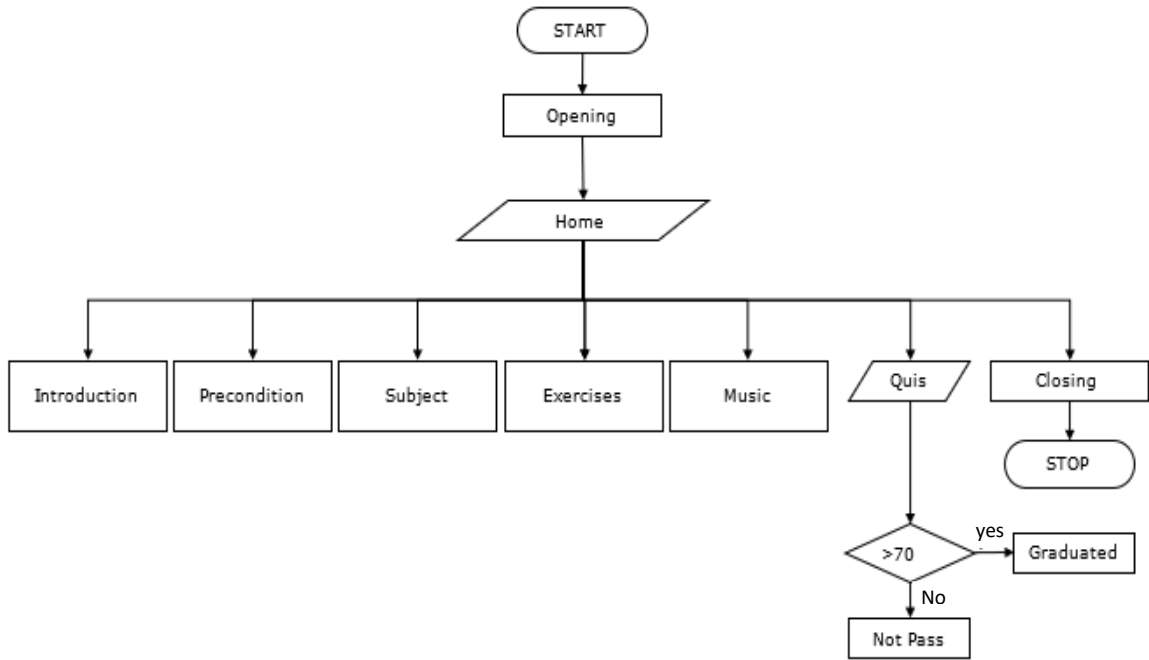
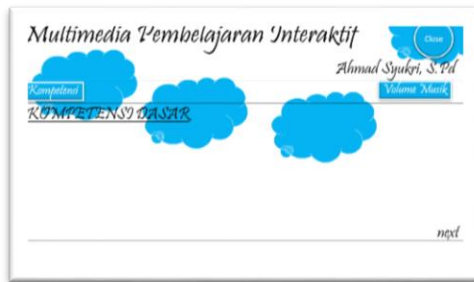


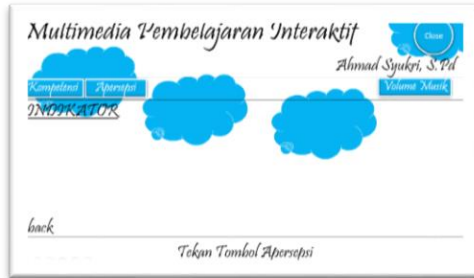
Figure 1. Mathematics Learning Multimedia Content Flowchart

Table 4. Multimedia Storyboard

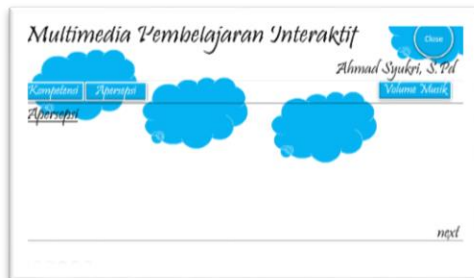
No	Visual	Explanation
1		<p>Opening Display include:</p> <ol style="list-style-type: none"> 1. Introduction, there are opening sentences such as “Interactive Learning Media”, “Ahmad Syukri”, “Welcome to Interactive Mathematics Learning Multimedia in Trigonometry Comparison material in class X”, and guiding sentence “press the Competency button” 2. “Competency” button to enter the Basic Competence page, “Music volume” button to adjust music volume on the media and “X” button to exit. 3. The music “Lagu Daerah Jambi/Jambi Folk Song” is expected to attract the attention of students. 4. And moving background and some shapes
2	Competency Page	<p>Include:</p> <ol style="list-style-type: none"> 1. Basic Competencies and learning Indicators. 2. “Next” button to go to the next page, “Back” button to go to the previous page, “Apperception” button to go to the Apperception page, Music Volume Button and Exit Button. 3. The music “Lagu Daerah Jambi/Jambi Folk Song” is expected to attract the attention of students.



4. Moving clouds background and several shapes.

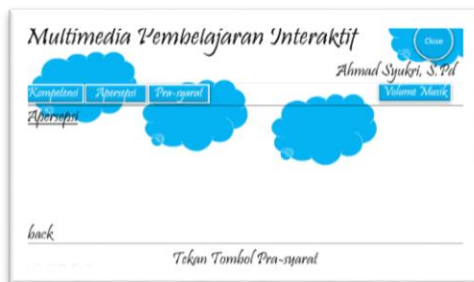


3 Apperception page

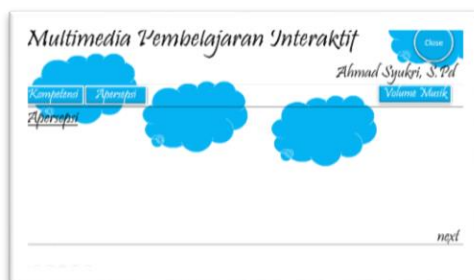


Include:

1. Text in the form of the contents of the Trigonometry Comparison
2. The picture of the Bridge and Arasy Tower.
3. "Next" button, to go to the next page, "Back" button to go to the previous page, "Prerequisite" button to go to the Prerequisite page, music volume button and Exit button.
4. The music "Lagu Daerah Jambi/Jambi Folk Song" is expected to attract the attention of students.
5. Moving clouds background and several shapes.

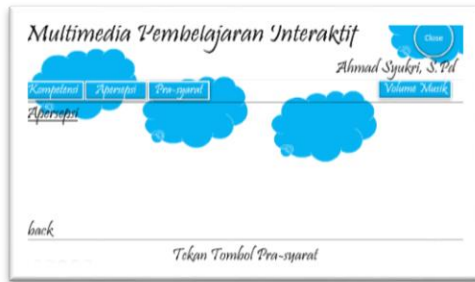


4 Prerequisite page



Include:

1. Prerequisite Material Questions.
2. "Input" is a dialog box for users to fill in answers to prerequisite material questions.
3. Some images that are made from several shapes provided by the swish max software.
4. "Next" button, to go to the next page, "Back" button to go to the previous page, "Material" button to go to Learning Materials page, Music Volume Button and Exit Button.



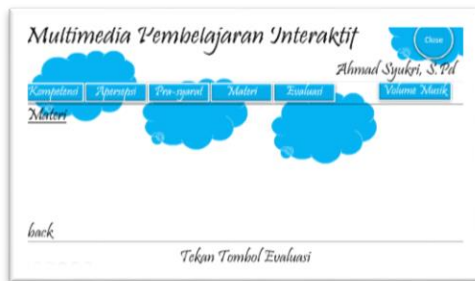
5. The music “Lagu Daerah Jambi/Jambi Folk Song” is expected to attract the attention of students.
6. Moving clouds background and some shapes.

5 Material, Sample Questions, and Tasks Pages

Include:



1. The contents of the learning material.
2. “Input” is a dialog box for users to fill in answers.
3. Some images are made from several shapes provided by the swish max software.
4. Video that contain questions and discussion, and video about how to measure tower height using the concept of Trigonometry comparison.
5. “Next” button to go to the next page, “Back” button to go to the previous page, “Evaluation” button to go to the Learning Evaluation page, Music Volume Button and Exit Button.



6. The music “Lagu Daerah Jambi/Jambi Folk Song” is expected to attract the attention of students.
7. Moving clouds background and some shapes.

6 Evaluation page

Include:



1. Assignments to evaluate student learning outcomes.
2. “Input” is a dialog box for users to fill in answers.
3. “Next” Navigation Button, to go to the next page, Music Volume Button and Exit Button.
4. The music “Lagu Daerah Jambi/Jambi Folk Song” is expected to attract the attention of students.
5. Moving clouds background and some shapes.



In the next stage, we compile an Instrument that will be used to assess and validate Multimedia. The instrument used is a qualitative data instrument. Formative evaluation at the design stage is carried out by a supervisor who stated that the flowchart and multimedia storyboard are very good to proceed to the Multimedia development stage.

3.3 Development

At this stage, researchers began to compile a Constructivism-Based Mathematics Learning Multimedia. Multimedia development is carried out based on the storyboard. Multimedia created using “Swish Max 4” software. After the multimedia is complete, the next stage is evaluation, validation by material expert and media expert. Based on the material expert, the validator stated that this multimedia was good enough and could be continued to the field trial stage. Based on media expert, the validator also stated that this multimedia was good enough and could be continued to the field trial stage. One suggestion given by media expert is to add a control button to the Learning Video. This change can be seen in Figure 2 & 3 below



Figure 2. Before Revision



Figure 3. After Revision

Individual trial was conducted by a mathematics teacher in class X SMAN 1 Jambi. The results of this stage are: (1) the feasibility of multimedia content is excellent, (2) the language used in multimedia is excellent (3) the presentation of material contained in multimedia is excellent, and (4) the graphic images in multimedia are good.

Small group trial was taken through a closed questionnaire, tested on 8 students of class X MIPA 3 Jambi. The results of the questionnaire data analysis can be seen in Figure 4

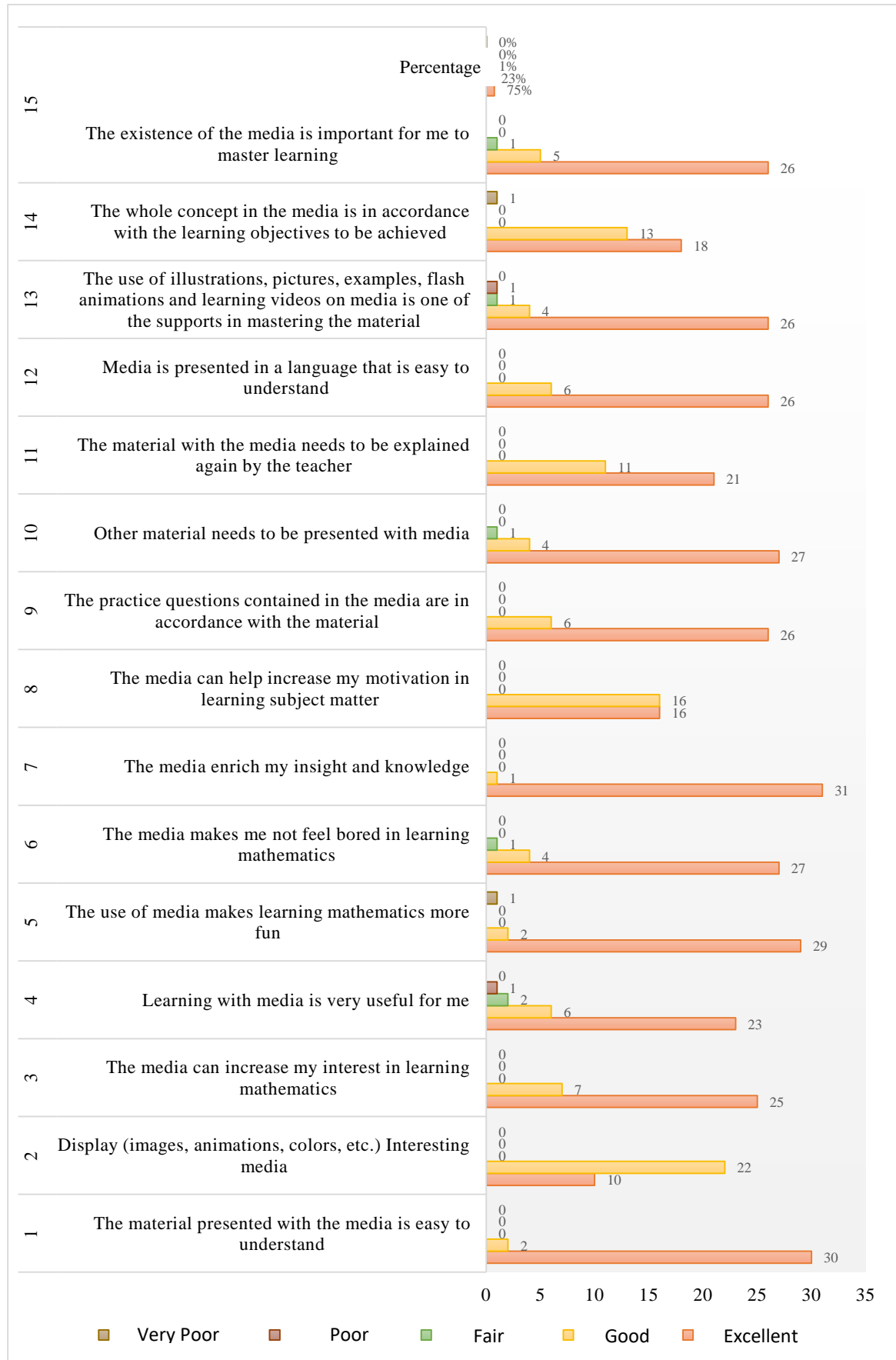


Figure 4. Results of Small Group Trial Questionnaire Analysis Results

The next step is conducting a large group trial on 20 students of class X MIPA 2, this sample is taken randomly. The questionnaire used in large group trial is an open questionnaire, in order to find out student responses about this multimedia. The results of data analysis can be seen in the following Table 5.

Table 5. Data Analysis of Large Group Trial

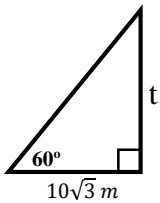
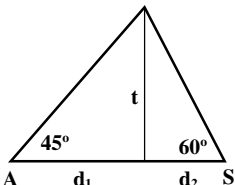
No	Question	Frequency of Positive Answer	%
1	Is the application of multimedia easy and can be used immediately?	18	90%
2	Does the display of learning multimedia make you interested in learning?	19	95%
3	Is the color display in multimedia attractive?	19	95%
4	Does this multimedia use appropriate font?	20	100%
5	Are the tools in the program simple enough and easy to operate?	19	95%
6	Are the navigation buttons on learning multimedia easy to use?	20	100%
7	Does it feel like math time is running so fast when using this multimedia?	18	90%
8	Is the language used in the description of the material presented through multimedia easy to understand?	19	95%
9	Can you hear the audio (the music) in multimedia clearly?	12	60%

3.4 Implementation

At the implementation stage, this multimedia was implemented in class X MIPA 1 of SMAN 1 Jambi. We also did pre-test and post-test to see the improvement of students' mathematical communication skills.

Before starting real class learning, we gave pre-test questions in the form of 5 essay questions about trigonometric comparisons to determine students' initial abilities before using Multimedia. Here are examples of questions and student answers used during the pretest.

Table 6. Pre-Test Question and Student Answers

Question	Student Answers
<p>1. A tower whose top is seen from a distance of $10\sqrt{3} m$ from the foot of the tower with an elevation angle of 60°, the tower's height is ...</p> 	$\tan 60^\circ = \frac{t}{10\sqrt{3} m}$ $\sqrt{3} = \frac{t}{10\sqrt{3} m}$ $t = 10\sqrt{3} m \times \sqrt{3}$ $t = 30m$
<p>2. Ahmad observes the top of the Arasy Tower from an angle of 45°, Syukri observes the top of the Arasy Tower from an angle of 60°, who is closer to the Arasy Tower?</p> 	$t_1 = t_2$ $d_1 \tan 45^\circ = d_2 \tan 60^\circ$ $d_1 \cdot 1 = d_2 \cdot \sqrt{3}$ $d_1 > d_2$ <p>So, Syukri is closer to the Arasy Tower than Ahmad</p>

Based on the pre-test results, it was found that: (1) 100% students can represent real objects, images, and diagrams in to mathematical ideas, (2) 100% students can explain ideas or opinions, situations and mathematic relations both verbally and in writing, and describing them visually in the form of real objects, images, graphs, and algebraic expressions, (3) 100% students can state daily events in mathematical language, (4) 91% students can listen, discuss, and write about mathematics, (5) 70% students can read with

an understanding of a written mathematics presentation, (6) 27% students can compile mathematical questions that are relevant to the problem, (7) 0% students can make conjectures, construct arguments, formulate definitions and generalizations.

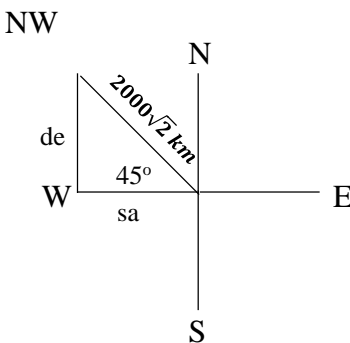
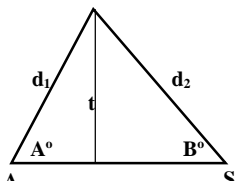
After getting the pre-test results, we began the treatment by dividing students into groups, each group consisting of 4 students, then we gave them the student activity sheets. Next, we display multimedia learning in front of the class, learning begins by asking students to read the competencies that must be achieved in this lesson, then giving Apperception about Trigonometry comparison by giving an overview of how we measure the height of a tower without climbing the tower but only using a small calculation of the Trigonometry comparison.

After giving the Apperception, we give several Prerequisite questions contained in multimedia to be answered together. Then, each student in each group is asked to draw a right triangle with the same angle but with a different side size. Students are asked to calculate the ratio of each side of the right triangle they have drawn, so, in the calculation, students will find the same comparison results even though the length of the sides they draw are different. Then, several students from each group were asked to give an explanation about this.

After students construct their understanding of the definitions of Trigonometry comparison, students are asked to find the values of the Trigonometry comparisons for angles 0° and 90° . To deepen students' understanding about Trigonometry comparison, students are asked to watch a video on discussing the problem of trigonometry comparison. In the video, there are several control buttons for "stop" and "play" so that students have the opportunity to answer questions first before the video reveals further explanations.

Then we provide post-test questions to determine the ability of students after learning by using learning multimedia. These are examples of the questions and students' answers in the post-test.

Table 7. Post-test Questions and Students' Answers

Question	Student Answer
<p>1. Plane A leaves the airport and flies $2000\sqrt{2}$ km to northwest, from the same airport, Plane B flies to the west then continues to the north so that Plane B and A meet. Determine the distance traveled by Plane B!</p>	 $\sin 45^\circ = \frac{de}{mi}$ $\rightarrow \frac{\sqrt{2}}{2} = \frac{de}{2000\sqrt{2} \text{ km}}$ $\rightarrow de = 2000 \text{ km}$ $\cos 45^\circ = \frac{sa}{mi}$ $\rightarrow \frac{\sqrt{2}}{2} = \frac{sa}{2000\sqrt{2} \text{ km}}$ $\rightarrow sa = 2000 \text{ km}$ <p>Aeroplane B Mileage = $de + sa$ $= 2000 \text{ km} + 2000 \text{ km}$ $= 4000 \text{ km}$</p>
<p>2. Ahmad observes the top of the Arasy Tower from an angle of A°, Syukri observes the top of the Arasy Tower from an angle of B°. If $\sin A^\circ > \sin B^\circ$ who is closer to the Arasy Tower?</p>	 $\sin A^\circ = \frac{t}{d_1}$ $\rightarrow t = d_1 \cdot \sin A^\circ$ $\sin B^\circ = \frac{t}{d_2}$ $\rightarrow t = d_2 \cdot \sin B^\circ$ $t = t$ $d_1 \sin A^\circ = d_2 \sin B^\circ$

Because $\sin A^\circ > \sin B^\circ$

So $d_1 < d_2$

Ahmad's distance to Arasy Tower is closer than Syukri's distance

Based on the post-test results, we found that: (1) 100% students can represent real objects, images, and diagrams in to mathematical ideas, (2) 100% students can explain ideas or opinions, situations and mathematic relations both verbally and in writing, and describing them visually in the form of real objects, images, graphs, and algebraic expressions, (3) 100% students can state daily events in mathematical language, (4) 100% students can listen, discuss, and write about mathematics, (5) 97% students can read with an understanding of a written mathematics presentation, (6) 70% students can compile mathematical questions that are relevant to the problem, (7) 21% students can make conjectures, construct arguments, formulate definitions and generalizations.

3.5 Evaluation

Evaluation phase for Multimedia development is obtained from student responses, student pre-test and post-test scores, and improvement of students' mathematical communication skills in each indicator.

For the results of students' perceptions are shown in Table 8 below.

Table 8. Students' Perceptions

Criteria	Excellent	Good	Fair	Poor	Very Poor
Percentage	75%	23%	1%	0%	0%

For normalized gain (N-Gain) results from students' mathematical communication skills shown in the Table 9.

Table 9. N-Gain score

	Pre-test	Post-test
Total Score	2.552	2.848
N-Gain	0,46	
Criteria	Medium	

Constructivism-based interactive mathematics learning multimedia is considered suitable for delivering trigonometric comparison material because it can involve animation, video, and audio in learning, so students feel more interested in learning than just using textbook media. This result is in line with the result of previous study which stated that the advantages of interactive multimedia are students feeling involved verbally, visually, and kinetically so that the information is easily understood [27].

During field trials, students look serious and are interested in learning, this is clearly seen from discussion activities. The students were very enthusiastic in expressing their opinions when they found the trigonometric comparison values on triangles that they had considered difficult and unattractive before, because previously, the teacher only asked them to memorize. After learning by using this Multimedia, students are able to use the concept of trigonometric comparison. This makes students better understand trigonometric comparison material, according to Confucius' statement: (1) I hear and I forget, (2) I see and I remember, and (3) I do and I understand [28].

Based on the pre-test and post-test results, it is known that 13 students have an increase in mathematical communication skills in the high category, 7 students have an increase in mathematical communication skills in the medium category, and 12 students have an increase in mathematical communication skills in the low category. So, the total N-Gain score is 0.46 in the “medium” criteria. This result is in line with the result of previous research which revealed that interactive multimedia has a positive impact on students’ mathematical communication skills [29]. Other research also revealed that interactive multimedia not only could improve students’ mathematical communication skills, but also effectively improve students’ creative thinking skills [30].

4. CONCLUSION

Based on the results of the research data analysis, constructivism-based interactive mathematics learning multimedia is declared suitable for use because it has passed the validation test by material expert and media expert, and has been declared feasible and interesting to use based on field trials (individual trial, small group trial, and large group trial). In addition, the results of N-Gain test from the pre-test and post-test data also showed that the use of interactive multimedia was effective in improving students’ mathematical communication skills.

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