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The Development of Character Building-Based Two-Dimensional Shapes Multimedia on Junior High School Students in Gorontalo Province, Indonesia

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Abstract

Mathematics is a branch of natural sciences that is capable of developing character and ability to think systematically, logically, and critically in expressing ideas or solving problems. To develop students' character and thinking capability, teachers need to consider carefully on which models, methods, and media-utilization strategies to implement during mathematics learning in a formal education setting. Learning media comprises tools used to deliver the learning material to the students in ways to stimulate their thinking, feeling, attention, and interests to study in order to optimize the learning process. An accurate and innovative learning media plan is critical to provide effective learning process for the students; hence, positively influencing their learning outcome. This study intends to identify the effectiveness of the development of interactive multimedia in two-dimensional figures topic. 4-D development model by Thiagarajan, Semmel, and Semmel (1974) was employed to develop the learning multimedia; which consists of Define, Design, Develop, and Disseminate phases. Further, an effectiveness test of the learning multimedia was conducted in Junior High Schools in Gorontalo Province. The result shows that: (1) the learning process in which the multimedia is utilized results in profound criteria; (2) learning multimedia developed is proven to increase students' activity, in which the percentage shows very good criteria; (3) the students learning outcome indicates percentage of classical completeness data that are categorized in very good criteria. Henceforth, this study concludes that the interactive multimedia of two-dimensional figures topic is proven effective to be applied in mathematics learning in junior high school level.

Keywords: Learning effectiveness; interactive multimedia; two-dimensional figures

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1.   Introduction

The rapid development of science and technology is essential to boost initiatives in utilizing technology within education to result in a creative and innovative learning process that can achieve the goals set. As a result, updates in educational technology bring positive impacts to teachers, students, and other educational elements. Integrated into the school curriculum as an important learning component, the utilization of multimedia technology is perceived as a way to nurture positive attitudes towards breakthroughs in technology.

The authors in [1] state multimedia refers to any computer-mediated software or interactive application that integrates text, color, graphical images, animation, audio, and full-motion video in a single application. Moreover, multimedia learning system consists of animation and narration, which offer a potential venue for teachers to improve student understanding.

Author in [2] identifies the main benefits of utilization of learning multimedia, i.e., 1) synchronous learning material delivery, 2) clearer and more exciting learning process, 3) interactive learning setting, 4) time and energy efficiency, 5) improved quality of learning outcome, 6) flexible learning time and place, 7) students' positive attitudes towards learning process and learning material, 8) increased teachers' productivity and performance. Author [3] asserts that students might face difficulties in learning and grasping abstract concepts in mathematics learning. Therefore, teachers need to find ways to translate the abstract concepts into more concrete ways, one of which is by applying interactive learning multimedia that fits best to the student's needs during mathematics learning.

By utilizing learning multimedia in mathematics learning, teachers are able to transfer the knowledge more effectively, hence, increasing students' passion for learning mathematics subject. The effectiveness of the learning process is observable by reflecting on students' learning outcome. One of the ways to achieve optimal learning outcome is by considering relevance with characteristics of learning material, students, and learning objectives during the development phase of learning multimedia.

In mathematics subject learning, particularly in two-dimensional shape topic, the implementation of learning multimedia can result in better learning outcome. Authors [4] study (2016) argues that learning multimedia is proven beneficial in following ways: (1) it helps to attract students' attention to the learning material (2) it enhances students' cooperation and teamwork (3) it is highly practical and flexible to use in any learning setting

Studies show that interactive multimedia is proven to increase students' learning outcome in various education levels. Authors [5] find out in their study that the implementation of multimedia is effective to enhance students' learning process. In line with that, a study conducted by Authors [6] conclude that learning multimedia elevates

learning process in ways that it helps to transform students' learning method to be more interactive, therefore, increasing students' learning interests as well as their learning quality in mathematics subject.

2. Research Methodology

This study was carried out in selected junior high schools in Gorontalo Province, i.e., Junior High School SMP Negeri 2 Suwawa, Bone Bolango Regency; Junior High School SMP Negeri 5 Paguyaman, Boalemo Regency; Junior High School SMP Negeri 1 Kwandang, Gorontalo Utara Regency; Junior High School SMP Negeri 11 Gorontalo; and Islamic Junior High School MTs Negeri 1 Limboto, Gorontalo Regency. The descriptive study employed 4-D (Define, Design, Develop, Disseminate) model by authors [7] to develop and produce learning multimedia in two-dimensional shape topic.

Moreover, the research involved several instruments in obtaining data, i.e., 1) questionnaire to obtain students' response on their study interest and motivation during the implementation of multimedia in the learning process; 2) learning process observation sheet; 3) students' activity observation sheet, and 4) learning outcome test.

Further, the data analysis technique applied Slavin's effectiveness analysis (1994), which consists of four measured indicators: quality, instruction appropriateness, incentives, and time.

- Quality refers to the information's level of understandability when being delivered to the students. Overall quality is mainly influenced by the quality of the curriculum, as well as the quality of the learning process itself.
- Appropriateness refers to the teachers' capability to determine the extent to which students are ready enough to grasp new information. In other words, teachers must ensure that students already possess prerequisite skills and knowledge related to the information being delivered; and that the material delivered is not too easy or too hard.
- Incentive refers to the teachers' effort to motivate students to complete learning tasks given and learn the learning material. Therefore, greater motivation from the teachers provides more significant incentive to the students to be more active during the learning process.
- Time refers to the duration set for the students to understand the learning material being taught. An effective learning process is achieved when students are able to complete every step of the learning process within the set duration.

Further, authors [9] also comply with the notion that affirms the correlation between students' activeness during the learning process and learning effectiveness, asserting that learning effectiveness is observed from students' activeness during steps of information discovery and organization.

Meanwhile, author [10] states that learning effectiveness is observable from reflecting on the students' passion and learning outcomes during a learning activity. This is in line with author [11], who finds out that students' interest contributes to their learning process and learning outcomes. The previous studies affirm the notion that students' interest/passion correlates significantly to their learning results; implying that if students

are not passionate enough to learn a subject, the learning process and outcomes are less likely to progress effectively and vice versa.

Reflecting on the notions regarding learning effectiveness quoted from the previously-stated studies, the study observed that author [8] emphasizes on the teachers' ability, while author [10] underlines the students' learning outcome as the contributing factor. Moreover, authors in [10,11] agree to the notion that focuses on the students' interests/responses, while authors in [9] assert more on the students' progress within learning activity.

Integrating the previous concepts, the research set four indicators to determine learning effectiveness, i.e.: (1) teachers' capability and effectiveness in learning management; (2) the effectiveness of students' activity, observed from the learning activity that is able to accomplish every steps as instructed in the lesson plan within the set period of time, with tolerance of 5 percent; (3) positive response to the learning activity, as observed if the average percentage of students' response scores 80 percent, or falls into highly interested category; (4) the achievement of minimum learning mastery (a student is considered able to complete/master the lesson if one possess understanding capability at least 65 percent out of 100), assuming that classical completeness is achieved if at least 80 percent of the class have accomplished the learning process. Therefore, the implementation of multimedia within the learning process is consideredeffective when at least three of four indicators, as well as classical competence, are achieved.

To simplify, the teaching process is consideredeffective when it accomplishes the desired goals, both in terms of learning objectives and maximum student achievement; in this context, the effectiveness of teaching process is assessed by the previous four indicators.

3.   Results and Discussion

The initial stage of the research is to develop adequate and quality learning multimedia of two-dimensional shape by employing a 4-D model. The multimedia consists of four main components, i.e., triangle, rectangle, circle, and practice test; thus provides an ease to the teachers in delivering learning material on two-dimensional shapes and to the students in learning independently. The multimedia user interface system is made with a user-friendly approach for the students to interact with since it is featured with an attractive display of information packaged in concrete and concise concepts in the form of audio and images. The features aid the students in creating a fun and enjoyable setting during processing information, therefore, stimulating their interest in interactive objects displayed in the multimedia.

As the user, students are handed full control to choose whichever topics to be learned, to solve the practice tests available, and to find out their test result.

Figure 1. Main menu interface

Figure 1 displays the main menu interface of the multimedia. The main menu consists of four sub-menus, i.e., triangle, rectangle, circle, and practice test. The main menu interface is developed to enable the students to operate, select, and understand the contents in each sub-menu with ease. Each sub-menu consists of selectable contents based on two-dimensional shapes, i.e., triangle, rectangle, and circle, as seen in figure 2.
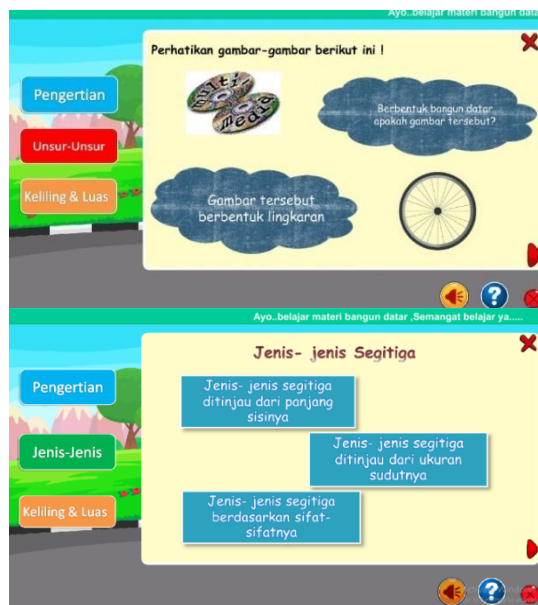

Figure 2. The interface of circle sub-menu

The interactive menu displays animation, texts, images, and audio contents in delivering the learning material. Information on mathematical concept and operations regarding the shape is displayed in the form of colorful graphical contents followed with informative audio to help elaborate each concept. The use of audiovisual cues is intended to transform abstract mathematical concepts into understandable and concrete ideas.

The informative display also applies to the practice test submenu. For instance, when selecting a practice test sub-menu of rectangular shape, students are able to choose between shapes, e.g., trapezoid, rhombus, kite, parallelogram, rectangle, and square. The practice test sub-menu is designed to evaluate the students' mastery of concepts of two-dimensional shapes.

Figure 3: Interface of practice test sub-menu

The practice test sub-menu contains questions to be solved in order to measure the students' comprehension of the learning material. The practice tests in the multimedia are formulated by referring to the indicators of learning objectives achievement. Further, the interface of practice test questions is displayed as follows.
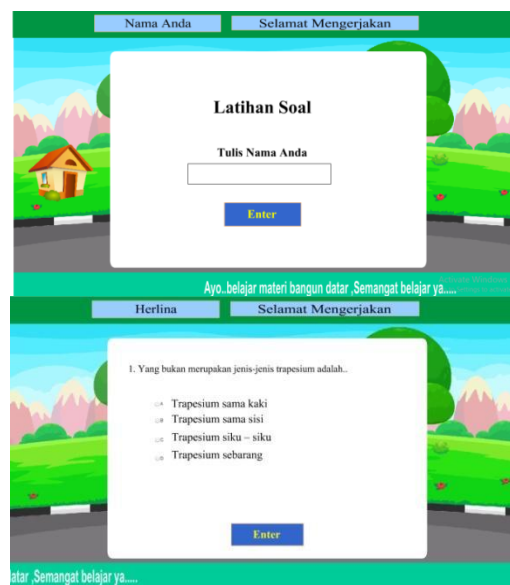

Figure 4: Display of practice test questions

In order to identify the effectiveness of multimedia developed, the researchers conduct on-site testing during two-dimensional shape learning process in five classes of junior high schools in Gorontalo Province Based on the effectiveness test, the study extracts data of students' and teachers' activity during learning process, students' response towards the multimedia, and students' learning result. The effectiveness test result is elaborated as follows:

The analysis result of the first indicator i.e. learning processis displayed in following.

Table 1: Analysis of Learning Process during Implementation of Two-Dimensional Shape Multimedia

Institution	Percentage of Learning Process (%)	Criteria
Junior High School SMPN 2 Suwawa	95.33	Very Good
Junior High School SMPN 5 Paguyaman	94.67%	Very Good
Junior High School SMPN 1 Kwandang	97.30%	Very Good
Junior High School SMPN 11 Gorontalo	94.82%	Very Good
Islamic Junior High School MTsN 1 Limboto	97.48%	Very Good

In observing the students' activity, the study refers to the determined indicators, i.e., students' interest and motivation, students' activity in operating the multimedia, and students' participation during the learning process. The following Table 2 illustrates the percentage of students' activity.

Table 2: Average Percentage of Students' Activity

Institution	Students' Activity (%)	Criteria
Junior High School SMPN 2 Suwawa	93.73%	Very Good
Junior High School SMPN 5 Paguyaman	87.67	Very Good
Junior High School SMPN 1 Kwandang	90.60	Very Good
Junior High School SMPN 11 Gorontalo		
Islamic Junior High School MTsN 1	88.93	Very Good
Limboto	93.88%	Very Good

As observed from the indicators of the students' response to interactive multimedia, i.e., interest, attention, attractiveness, convenience, and clarity, the following Table 3 displays the analysis result as follows:

Table 3. Average Percentage of Students' Response towards the Multimedia

Class	Classical learning outcome competence (%)	Criteria
Junior High School SMPN 2 Suwawa	90.98	Very Good
Junior High School SMPN 5 Paguyaman	85.80%	Very Good
Junior High School SMPN 1 Kwandang	90.30%	Very Good
Junior High School SMPN 11 Gorontalo	87.72%	Very Good
Islamic Junior High School MTsN 1 Limboto	92.33%	Very Good

Table 3 displays that the students' response towards the multimedia is categorized very well; therefore, the multimedia provides positive response towards students during the learning process. Moreover, as observed from the learning process, the students show their motivation and their attention to the lesson being taught. The attractive display in multimedia developed enables the student to perform independent learning with ease, as the concepts are deliveredclearly and concisely. This echoes authors in [12] who contend that multimedia-based learning stimulates students' learning motivation positively.

Further, the cognitive learning outcome test results as follows:

Table 4. Average Percentage of Students' Learning Outcome

Class	Classical learning outcome competence (%)	Criteria

Junior High School SMPN 2 Suwawa	93.83%	Very Good
Junior High School SMPN 5 Paguyaman	90.77%	Very Good
Junior High School SMPN 1 Kwandang	94.30%	Very Good
Junior High School SMPN 11 Gorontalo	89.62%	Very Good
Islamic Junior High School MTsN 1 Limboto	94.70%	Very Good

Table 4 indicates that the students' learning outcome is categorized into very good criteria, implying that the multimedia developed contributes positively to improving their performance during the learningprocess. By the application of multimedia, students are easier to understand mathematical concepts; echoing authors' [13] statement that interactive multimedia-based learning can help students improve their understanding of concepts.

Based on the data analysis, this study finds out that the effectiveness level of learning multimedia developed falls into the veryeffective category, thus, assuming that the learning multimedia developed is beneficial in helping to enhance the quality of learning process. The assumption is supported by data on student learning activities that show very good results. Moreover, it is also reflected through student learning outcomes which above the minimum completeness criteria (KKM) or ≥ 75, as well as meeting the whole completeness criteria. As observed from the percentage of students passing minimum learning mastery, therefore it is concluded that the whole design process of learning multimedia is effective to use.

Based on the previous elaboration, this research contends that multimedia is effectively used in the mathematics learning process, as it enables students to easily understand the learning material delivered as interactive multimedia. Moreover, author in [14] mentions that interactive multimedia is capable of transferring messages from the sender to the recipient; hence, triggering students' motivation and attention within the learning process. Author [14]'s statement correlates with the research finding that students are able to develop and increase their interest, motivation, and attention in learning the subject through the multimedia. This correlates with authors [15] who argue that "In such math skills using programs or multimedia-enhanced methods of teaching can be effective in getting students' attention."

Further, this study finds out that learning multimedia developed is qualified to be implemented in the learning process. Integrating visual and audio elements, the interactive multimedia is easy to operate and is featured with tutorials on subject that enable independent learning (author in [16]). The multimedia learning provides positive changes to the students comparing to the conventional learning. This is in line with authors' [17]'s study (2016) that finds out that "multimedia technique increased the academic success of students in social studies lesson compared to the traditional classroom."

Author in [19] points out that abstract concept in mathematics learning are required to be deliveredin a concrete manner in order for the students to easily grasp the content. Elements in multimedia help to elaborate concepts that are difficult to deliver in a conventional manner or concepts that require accurate delivery. Further, the multimedia harnesses differences in students' characteristics and learning capability, as it is adjusted with the learning material. Also, the communication between the students and the program facilitated by the teacher is actualized in the form of stimulation-response (authors in [18])

Author in [20] states that the implementation of interactive multimedia in the geometry learning process is able to motivate students to solve abstract concepts and challenging questions. Learning can be more attractive and interactive and can integrate visual and auditory learning to make comprehensive understanding of an object that they learn (author in [21]). The length of time required in learning can be shortened, and learning can be given anytime and anywhere in accordance with the wishes and needs.

4.   Conclusion

Based on the research findings and discussion, this research concludes that the multimedia of two-dimensional shapes topic developed is considered effective to be implemented during the learning process, as measured from teachers and students' activity as well as students' response and learning outcome. The multimedia developed is expected to be applied by mathematics subject teachers, particularly during the learning process of two-dimensional shapes topic displayed in the form of text, images, animation, audio formats.

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The Development of Character Building-Based Two-Dimensional Shapes Multimedia on Junior High School Students in Gorontalo Province, Indonesia

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Abstract

Mathematics is a branch of natural sciences that is capable of developing character and ability to think systematically, logically, and critically in expressing ideas or solving problems. To develop students' character and thinking capability, teachers need to consider carefully on which models, methods, and media-utilization strategies to implement during mathematics learning in a formal education setting. Learning media comprises tools used to deliver the learning material to the students in ways to stimulate their thinking, feeling, attention, and interests to study in order to optimize the learning process. An accurate and innovative learning media plan is critical to provide effective learning process for the students; hence, positively influencing their learning outcome. This study intends to identify the effectiveness of the development of interactive multimedia in two-dimensional figures topic. 4-D development model by Thiagarajan, Semmel,and Semmel (1974) was employed to develop the learning multimedia; which consists of Define, Design, Develop, and Disseminate phases. Further, an effectiveness test of the learning multimedia was conducted in Junior High Schools in Gorontalo Province. The result shows that: (1) the learning process in which the multimedia is utilized results in profound criteria; (2) learning multimedia developed is proven to increase students' activity, in which the percentage shows very good criteria; (3) the students learning outcome indicates percentage of classical completeness data that are categorized in very good criteria. Henceforth, this study concludes that the interactive multimedia of two-dimensional figures topic is proven effective to be applied in mathematics learning in junior high school level.

Keywords: Learning effectiveness; interactive multimedia; two-dimensional figures

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1.   Introduction

The rapid development of science and technology is essential to boost initiatives in utilizing technology within education to result in a creative and innovative learning process that can achieve the goals set. As a result, updates in educational technology bring positive impacts to teachers, students, and other educational elements. Integrated into the school curriculum as an important learning component, the utilization of multimedia technology is perceived as a way to nurture positive attitudes towards breakthroughs in technology.

The authors in [1] state multimedia refers to any computer-mediated software or interactive application that integrates text, color, graphical images, animation, audio, and full-motion video in a single application. Moreover, multimedia learning system consists of animation and narration, which offer a potential venue for teachers to improve student understanding.

Author in [2] identifies the main benefits of utilization of learning multimedia, i.e., 1) synchronous learning material delivery, 2) clearer and more exciting learning process, 3) interactive learning setting, 4) time and energy efficiency, 5) improved quality of learning outcome, 6) flexible learning time and place, 7) students' positive attitudes towards learning process and learning material, 8) increased teachers' productivity and performance. Author [3] asserts that students might face difficulties in learning and grasping abstract concepts in mathematics learning. Therefore, teachers need to find ways to translate the abstract concepts into more concrete ways, one of which is by applying interactive learning multimedia that fits best to the student's needs during mathematics learning.

By utilizing learning multimedia in mathematics learning, teachers are able to transfer the knowledge more effectively, hence, increasing students' passion for learning mathematics subject. The effectiveness of the learning process is observable by reflecting on students' learning outcome. One of the ways to achieve optimal learning outcome is by considering relevance with characteristics of learning material, students, and learning objectives during the development phase of learning multimedia.

In mathematics subject learning, particularly in two-dimensional shape topic, the implementation of learning multimedia can result in better learning outcome. Authors [4] study (2016) argues that learning multimedia is proven beneficial in following ways: (1) it helps to attract students' attention to the learning material (2) it enhances students' cooperation and teamwork (3) it is highly practical and flexible to use in any learning setting

Studies show that interactive multimedia is proven to increase students' learning outcome in various education levels. Authors [5] find out in their study that the implementation of multimedia is effective to enhance students' learning process. In line with that, a study conducted by Authors [6] conclude that learning multimedia elevates

learning process in ways that it helps to transform students' learning method to be more interactive, therefore, increasing students' learning interests as well as their learning quality in mathematics subject.

2.   Research Methodology

This study was carried out in selected junior high schools in Gorontalo Province, i.e., Junior High School SMP Negeri 2 Suwawa, Bone Bolango Regency; Junior High School SMP Negeri 5 Paguyaman, Boalemo Regency; Junior High School SMP Negeri 1 Kwandang, Gorontalo Utara Regency; Junior High School SMP Negeri 11 Gorontalo; and Islamic Junior High School MTs Negeri 1 Limboto, Gorontalo Regency. The descriptive study employed 4-D (Define, Design, Develop, Disseminate) model by authors [7] to develop and produce learning multimedia in two-dimensional shape topic.

Moreover, the research involved several instruments in obtaining data, i.e., 1) questionnaire to obtain students' response on their study interest and motivation during the implementation of multimedia in the learning process; 2) learning process observation sheet; 3) students' activity observation sheet, and 4) learning outcome test.

Further, the data analysis technique applied Slavin's effectiveness analysis (1994), which consists of four measured indicators: quality, instruction appropriateness, incentives, and time.

- Quality refers to the information's level of understandability when being delivered to the students. Overall quality is mainly influenced by the quality of the curriculum, as well as the quality of the learning process itself.
- Appropriateness refers to the teachers' capability to determine the extent to which students are ready enough to grasp new information. In other words, teachers must ensure that students already possess prerequisite skills and knowledge related to the information being delivered; and that the material delivered is not too easy or too hard.
- Incentive refers to the teachers' effort to motivate students to complete learning tasks given and learn the learning material. Therefore, greater motivation from the teachers provides more significant incentive to the students to be more active during the learning process.
- Time refers to the duration set for the students to understand the learning material being taught. An effective learning process is achieved when students are able to complete every step of the learning process within the set duration.

Further, authors [9] also comply with the notion that affirms the correlation between students' activeness during the learning process and learning effectiveness, asserting that learning effectiveness is observed from students' activeness during steps of information discovery and organization.

Meanwhile, author [10] states that learning effectiveness is observable from reflecting on the students' passion and learning outcomes during a learning activity. This is in line with author [11], who finds out that students' interest contributes to their learning process and learning outcomes. The previous studies affirm the notion that students' interest/passion correlates significantly to their learning results; implying that if students

are not passionate enough to learn a subject, the learning process and outcomes are less likely to progress effectively and vice versa.

Reflecting on the notions regarding learning effectiveness quoted from the previously-stated studies, the study observed that author [8] emphasizes on the teachers' ability, while author [10] underlines the students' learning outcome as the contributing factor. Moreover, authors in [10,11] agree to the notion that focuses on the students' interests/responses, while authors in [9] assert more on the students' progress within learning activity.

Integrating the previous concepts, the research set four indicators to determine learning effectiveness, i.e.: (1) teachers' capability and effectiveness in learning management; (2) the effectiveness of students' activity, observed from the learning activity that is able to accomplish every steps as instructed in the lesson plan within the set period of time, with tolerance of 5 percent; (3) positive response to the learning activity, as observed if the average percentage of students' response scores 80 percent, or falls into highly interested category; (4) the achievement of minimum learning mastery (a student is considered able to complete/master the lesson if one possess understanding capability at least 65 percent out of 100), assuming that classical completeness is achieved if at least 80 percent of the class have accomplished the learning process. Therefore, the implementation of multimedia within the learning process is consideredeffective when at least three of four indicators, as well as classical competence, are achieved.

To simplify, the teaching process is consideredeffective when it accomplishes the desired goals, both in terms of learning objectives and maximum student achievement; in this context, the effectiveness of teaching process is assessed by the previous four indicators.

3.   Results and Discussion

The initial stage of the research is to develop adequate and quality learning multimedia of two-dimensional shape by employing a 4-D model. The multimedia consists of four main components, i.e., triangle, rectangle, circle, and practice test; thus provides an ease to the teachers in delivering learning material on two-dimensional shapes and to the students in learning independently. The multimedia user interface system is made with a user-friendly approach for the students to interact with since it is featured with an attractive display of information packaged in concrete and concise concepts in the form of audio and images. The features aid the students in creating a fun and enjoyable setting during processing information, therefore, stimulating their interest in interactive objects displayed in the multimedia.

As the user, students are handed full control to choose whichever topics to be learned, to solve the practice tests available, and to find out their test result.

Figure 1. Main menu interface

Figure 1 displays the main menu interface of the multimedia. The main menu consists of four sub-menus, i.e., triangle, rectangle, circle, and practice test. The main menu interface is developed to enable the students to operate, select, and understand the contents in each sub-menu with ease. Each sub-menu consists of selectable contents based on two-dimensional shapes, i.e., triangle, rectangle, and circle, as seen in figure 2.
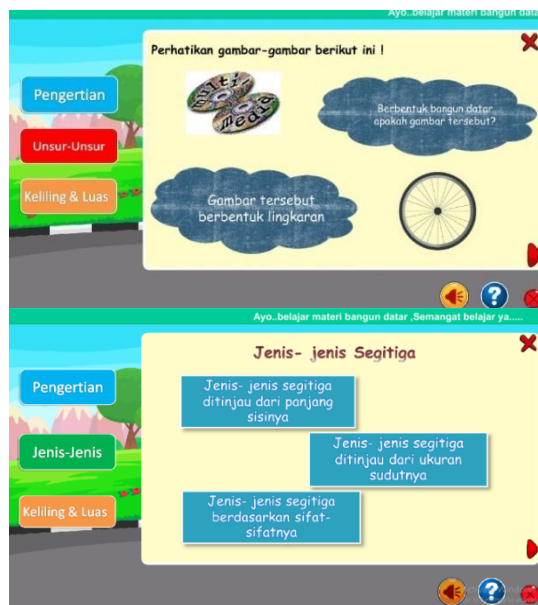

Figure 2. The interface of circle sub-menu

The interactive menu displays animation, texts, images, and audio contents in delivering the learning material. Information on mathematical concept and operations regarding the shape is displayed in the form of colorful graphical contents followed with informative audio to help elaborate each concept. The use of audiovisual cues is intended to transform abstract mathematical concepts into understandable and concrete ideas.

The informative display also applies to the practice test submenu. For instance, when selecting a practice test sub-menu of rectangular shape, students are able to choose between shapes, e.g., trapezoid, rhombus, kite, parallelogram, rectangle, and square. The practice test sub-menu is designed to evaluate the students' mastery of concepts of two-dimensional shapes.

Figure 3: Interface of practice test sub-menu

The practice test sub-menu contains questions to be solved in order to measure the students' comprehension of the learning material. The practice tests in the multimedia are formulated by referring to the indicators of learning objectives achievement. Further, the interface of practice test questions is displayed as follows.

Figure 4: Display of practice test questions

In order to identify the effectiveness of multimedia developed, the researchers conduct on-site testing during two-dimensional shape learning process in five classes of junior high schools in Gorontalo Province Based on the effectiveness test, the study extracts data of students' and teachers' activity during learning process, students' response towards the multimedia, and students' learning result. The effectiveness test result is elaborated as follows:

The analysis result of the first indicator i.e. learning processis displayed in following.

Table 1: Analysis of Learning Process during Implementation of Two-Dimensional Shape Multimedia

Institution	Percentage of Learning Process (%)	Criteria
Junior High School SMPN 2 Suwawa	95.33	Very Good
Junior High School SMPN 5 Paguyaman	94.67%	Very Good
Junior High School SMPN 1 Kwandang	97.30%	Very Good
Junior High School SMPN 11 Gorontalo	94.82%	Very Good
Islamic Junior High School MTsN 1 Limboto	97.48%	Very Good

In observing the students' activity, the study refers to the determined indicators, i.e., students' interest and motivation, students' activity in operating the multimedia, and students' participation during the learning process. The following Table 2 illustrates the percentage of students' activity.

Table 2: Average Percentage of Students' Activity

Institution	Students' Activity (%)	Criteria
Junior High School SMPN 2 Suwawa	93.73%	Very Good
Junior High School SMPN 5 Paguyaman	87.67	Very Good
Junior High School SMPN 1 Kwandang	90.60	Very Good
Junior High School SMPN 11 Gorontalo	88.93	Very Good
Islamic Junior High School MTsN 1 Limboto	93.88%	Very Good

As observed from the indicators of the students' response to interactive multimedia, i.e., interest, attention, attractiveness, convenience, and clarity, the following Table 3 displays the analysis result as follows:

Table 3. Average Percentage of Students' Response towards the Multimedia

Class	Classical learning outcome competence (%)	Criteria
Junior High School SMPN 2 Suwawa	90.98	Very Good
Junior High School SMPN 5 Paguyaman	85.80%	Very Good
Junior High School SMPN 1 Kwandang	90.30%	Very Good
Junior High School SMPN 11 Gorontalo	87.72%	Very Good
Islamic Junior High School MTsN 1 Limboto	92.33%	Very Good

Table 3 displays that the students' response towards the multimedia is categorized very well; therefore, the multimedia provides positive response towards students during the learning process. Moreover, as observed from the learning process, the students show their motivation and their attention to the lesson being taught. The attractive display in multimedia developed enables the student to perform independent learning with ease, as the concepts are deliveredclearly and concisely. This echoes authors in [12] who contend that multimedia-based learning stimulates students' learning motivation positively.

Further, the cognitive learning outcome test results as follows:

Table 4. Average Percentage of Students' Learning Outcome

Class	Classical learning outcome competence (%)	Criteria

Junior High School SMPN 2 Suwawa	93.83%	Very Good
Junior High School SMPN 5 Paguyaman	90.77%	Very Good
Junior High School SMPN 1 Kwandang	94.30%	Very Good
Junior High School SMPN 11 Gorontalo	89.62%	Very Good
Islamic Junior High School MTsN 1 Limboto	94.70%	Very Good

Table 4 indicates that the students' learning outcome is categorized into very good criteria, implying that the multimedia developed contributes positively to improving their performance during the learningprocess. By the application of multimedia, students are easier to understand mathematical concepts; echoing authors' [13] statement that interactive multimedia-based learning can help students improve their understanding of concepts.

Based on the data analysis, this study finds out that the effectiveness level of learning multimedia developed falls into the veryeffective category, thus, assuming that the learning multimedia developed is beneficial in helping to enhance the quality of learning process. The assumption is supported by data on student learning activities that show very good results. Moreover, it is also reflected through student learning outcomes which above the minimum completeness criteria (KKM) or ≥ 75, as well as meeting the whole completeness criteria. As observed from the percentage of students passing minimum learning mastery, therefore it is concluded that the whole design process of learning multimedia is effective to use.

Based on the previous elaboration, this research contends that multimedia is effectively used in the mathematics learning process, as it enables students to easily understand the learning material delivered as interactive multimedia. Moreover, author in [14] mentions that interactive multimedia is capable of transferring messages from the sender to the recipient; hence, triggering students' motivation and attention within the learning process. Author [14]'s statement correlates with the research finding that students are able to develop and increase their interest, motivation, and attention in learning the subject through the multimedia. This correlates with authors [15] who argue that "In such math skills using programs or multimedia-enhanced methods of teaching can be effective in getting students' attention."

Further, this study finds out that learning multimedia developed is qualified to be implemented in the learning process. Integrating visual and audio elements, the interactive multimedia is easy to operate and is featured with tutorials on subject that enable independent learning (author in [16]). The multimedia learning provides positive changes to the students comparing to the conventional learning. This is in line with authors' [17]'s study (2016) that finds out that "multimedia technique increased the academic success of students in social studies lesson compared to the traditional classroom."

Author in [19] points out that abstract concept in mathematics learning are required to be deliveredin a concrete manner in order for the students to easily grasp the content. Elements in multimedia help to elaborate concepts that are difficult to deliver in a conventional manner or concepts that require accurate delivery. Further, the multimedia harnesses differences in students' characteristics and learning capability, as it is adjusted with the learning material. Also, the communication between the students and the program facilitated by the teacher is actualized in the form of stimulation-response (authors in [18])

Author in [20] states that the implementation of interactive multimedia in the geometry learning process is able to motivate students to solve abstract concepts and challenging questions. Learning can be more attractive and interactive and can integrate visual and auditory learning to make comprehensive understanding of an object that they learn (author in [21]). The length of time required in learning can be shortened, and learning can be given anytime and anywhere in accordance with the wishes and needs.

4.   Conclusion

Based on the research findings and discussion, this research concludes that the multimedia of two-dimensional shapes topic developed is considered effective to be implemented during the learning process, as measured from teachers and students' activity as well as students' response and learning outcome. The multimedia developed is expected to be applied by mathematics subject teachers, particularly during the learning process of two-dimensional shapes topic displayed in the form of text, images, animation, audio formats.

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The Development of Character Building-Based Two-Dimensional Shapes Multimedia on Junior High School Students in Gorontalo Province, Indonesia

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Abstract

Mathematics is a branch of natural sciences that is capable of developing character and ability to think systematically, logically, and critically in expressing ideas or solving problems. To develop students' character and thinking capability, teachers need to consider carefully on which models, methods, and media-utilization strategies to implement during mathematics learning in a formal education setting. Learning media comprises tools used to deliver the learning material to the students in ways to stimulate their thinking, feeling, attention, and interests to study in order to optimize the learning process. An accurate and innovative learning media plan is critical to provide effective learning process for the students; hence, positively influencing their learning outcome. This study intends to identify the effectiveness of the development of interactive multimedia in two-dimensional figures topic. 4-D development model by Thiagarajan, Semmel,and Semmel (1974) was employed to develop the learning multimedia; which consists of Define, Design, Develop, and Disseminate phases. Further, an effectiveness test of the learning multimedia was conducted in Junior High Schools in Gorontalo Province. The result shows that: (1) the learning process in which the multimedia is utilized results in profound criteria; (2) learning multimedia developed is proven to increase students' activity, in which the percentage shows very good criteria; (3) the students learning outcome indicates percentage of classical completeness data that are categorized in very good criteria. Henceforth, this study concludes that the interactive multimedia of two-dimensional figures topic is proven effective to be applied in mathematics learning in junior high school level.

Keywords: Learning effectiveness; interactive multimedia; two-dimensional figures.

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* Corresponding author.

1. Introduction

The rapid development of science and technology is essential to boost initiatives in utilizing technology within education to result in a creative and innovative learning process that can achieve the goals set. As a result, updates in educational technology bring positive impacts to teachers, students, and other educational elements. Integrated into the school curriculum as an important learning component, the utilization of multimedia technology is perceived as a way to nurture positive attitudes towards breakthroughs in technology. The authors in [1] state multimedia refers to any computer-mediated software or interactive application that integrates text, color, graphical images, animation, audio, and full-motion video in a single application. Moreover, multimedia learning system consists of animation and narration, which offer a potential venue for teachers to improve student understanding. Author in [2] identifies the main benefits of utilization of learning multimedia, i.e., 1) synchronous learning material delivery, 2) clearer and more exciting learning process, 3) interactive learning setting, 4) time and energy efficiency, 5) improved quality of learning outcome, 6) flexible learning time and place, 7) students' positive attitudes towards learning process and learning material, 8) increased teachers' productivity and performance. Author [3] asserts that students might face difficulties in learning and grasping abstract concepts in mathematics learning. Therefore, teachers need to find ways to translate the abstract concepts into more concrete ways, one of which is by applying interactive learning multimedia that fits best to the student's needs during mathematics learning. By utilizing learning multimedia in mathematics learning, teachers are able to transfer the knowledge more effectively, hence, increasing students' passion for learning mathematics subject. The effectiveness of the learning process is observable by reflecting on students' learning outcome. One of the ways to achieve optimal learning outcome is by considering relevance with characteristics of learning material, students, and learning objectives during the development phase of learning multimedia. In mathematics subject learning, particularly in two-dimensional shape topic, the implementation of learning multimedia can result in better learning outcome. Authors [4] study (2016) argues that learning multimedia is proven beneficial in following ways: (1) it helps to attract students' attention to the learning material (2) it enhances students' cooperation and teamwork (3) it is highly practical and flexible to use in any learning setting Studies show that interactive multimedia is proven to increase students' learning outcome in various education levels. Authors [5] find out in their study that the implementation of multimedia is effective to enhance students' learning process. In line with that, a study conducted by Authors [6] conclude that learning multimedia elevates learning process in ways that it helps to transform students' learning method to be more interactive, therefore, increasing students' learning interests as well as their learning quality in mathematics subject.

2. Research Methodology

This study was carried out in selected junior high schools in Gorontalo Province, i.e., Junior High School SMP Negeri 2 Suwawa, Bone Bolango Regency; Junior High School SMP Negeri 5 Paguyaman, Boalemo Regency; Junior High School SMP Negeri 1 Kwandang, Gorontalo Utara Regency; Junior High School SMP Negeri 11 Gorontalo; and Islamic Junior High School MTs Negeri 1 Limboto, Gorontalo Regency. The descriptive study employed 4-D (Define, Design, Develop, Disseminate) model by authors [7] to develop and produce learning multimedia in two-dimensional shape topic. Moreover, the research involved several instruments in obtaining data, i.e., 1) questionnaire to obtain students' response on their study interest and motivation during the

implementation of multimedia in the learning process; 2) learning process observation sheet; 3) students' activity observation sheet, and 4) learning outcome test. Further, the data analysis technique applied Slavin's effectiveness analysis (1994), which consists of four measured indicators: quality, instruction appropriateness, incentives, and time.

- Quality refers to the information's level of understandability when being delivered to the students. Overall quality is mainly influenced by the quality of the curriculum, as well as the quality of the learning process itself.

- Appropriateness refers to the teachers' capability to determine the extent to which students are ready enough to grasp new information. In other words, teachers must ensure that students already possess prerequisite skills and knowledge related to the information being delivered; and that the material delivered is not too easy or too hard.

- Incentive refers to the teachers' effort to motivate students to complete learning tasks given and learn the learning material. Therefore, greater motivation from the teachers provides more significant incentive to the students to be more active during the learning process.

- Time refers to the duration set for the students to understand the learning material being taught. An effective learning process is achieved when students are able to complete every step of the learning process within the set duration.

Further, authors [9] also comply with the notion that affirms the correlation between students' activeness during the learning process and learning effectiveness, asserting that learning effectiveness is observed from students' activeness during steps of information discovery and organization. Meanwhile, author [10] states that learning effectiveness is observable from reflecting on the students' passion and learning outcomes during a learning activity. This is in line with author [11], who finds out that students' interest contributes to their learning process and learning outcomes. The previous studies affirm the notion that students' interest/passion correlates significantly to their learning results; implying that if students are not passionate enough to learn a subject, the learning process and outcomes are less likely to progress effectively and vice versa. Reflecting on the notions regarding learning effectiveness quoted from the previously-stated studies, the study observed that author [8] emphasizes on the teachers' ability, while author [10] underlines the students' learning outcome as the contributing factor. Moreover, authors in [10,11] agree to the notion that focuses on the students' interests/responses, while authors in [9] assert more on the students' progress within learning activity. Integrating the previous concepts, the research set four indicators to determine learning effectiveness, i.e.: (1) teachers' capability and effectiveness in learning management; (2) the effectiveness of students' activity, observed from the learning activity that is able to accomplish every steps as instructed in the lesson plan within the set period of time, with tolerance of 5 percent; (3) positive response to the learning activity, as observed if the average percentage of students' response scores 80 percent, or falls into highly interested category; (4) the achievement of minimum learning mastery (a student is considered able to complete/master the lesson if one possess understanding capability at least 65 percent out of 100), assuming that classical completeness is achieved if at least 80 percent of the class have accomplished the learning process. Therefore, the implementation of multimedia within the learning process is consideredeffective when at least three of four indicators, as well as classical competence, are achieved.To simplify, the teaching process is consideredeffective

when it accomplishes the desired goals, both in terms of learning objectives and maximum student achievement; in this context, the effectiveness of teaching process is assessed by the previous four indicators.

3. Results and Discussion

The initial stage of the research is to develop adequate and quality learning multimedia of two-dimensional shape by employing a 4-D model. The multimedia consists of four main components, i.e., triangle, rectangle, circle, and practice test; thus provides an ease to the teachers in delivering learning material on two-dimensional shapes and to the students in learning independently. The multimedia user interface system is made with a user-friendly approach for the students to interact with since it is featured with an attractive display of information packaged in concrete and concise concepts in the form of audio and images. The features aid the students in creating a fun and enjoyable setting during processing information, therefore, stimulating their interest in interactive objects displayed in the multimedia. As the user, students are handed full control to choose whichever topics to be learned, to solve the practice tests available, and to find out their test result.

Figure 1: Main menu interface

Figure 1 displays the main menu interface of the multimedia. The main menu consists of four sub-menus, i.e., triangle, rectangle, circle, and practice test. The main menu interface is developed to enable the students to operate, select, and understand the contents in each sub-menu with ease. Each sub-menu consists of selectable contents based on two-dimensional shapes, i.e., triangle, rectangle, and circle, as seen in figure 2.

The interactive menu displays animation, texts, images, and audio contents in delivering the learning material. Information on mathematical concept and operations regarding the shape is displayed in the form of colorful graphical contents followed with informative audio to help elaborate each concept.

The use of audiovisual cues is intended to transform abstract mathematical concepts into understandable and concrete ideas. The informative display also applies to the practice test submenu. For instance, when selecting a practice test sub-menu of rectangular shape, students are able to choose between shapes, e.g., trapezoid, rhombus, kite, parallelogram, rectangle, and square. The practice test sub-menu is designed to evaluate the students' mastery of concepts of two-dimensional shapes.
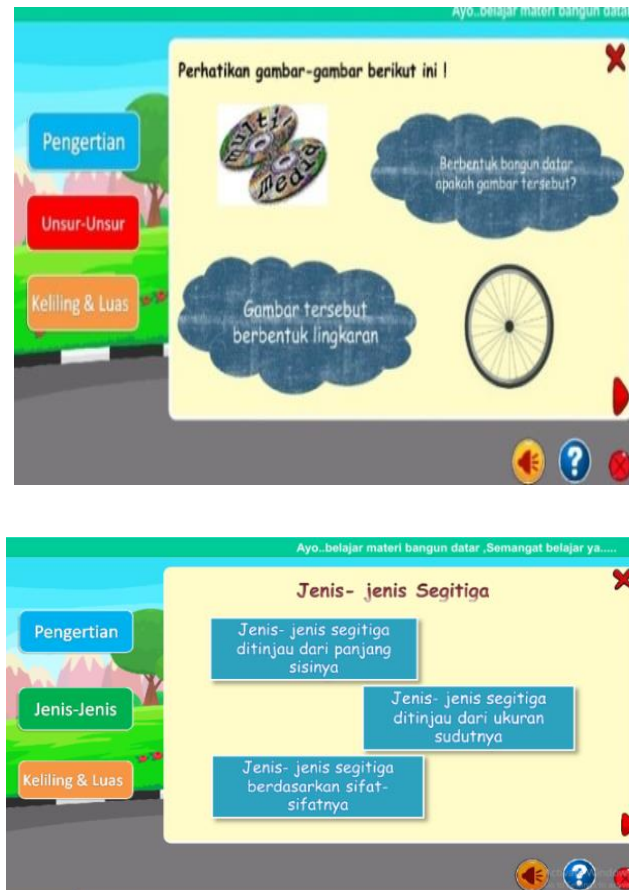
Figure 2: The interface of circle sub-menu

Figure 3: Interface of practice test sub-menu

The practice test sub-menu contains questions to be solved in order to measure the students' comprehension of the learning material. The practice tests in the multimedia are formulated by referring to the indicators of learning objectives achievement. Further, the interface of practice test questions is displayed as follows.
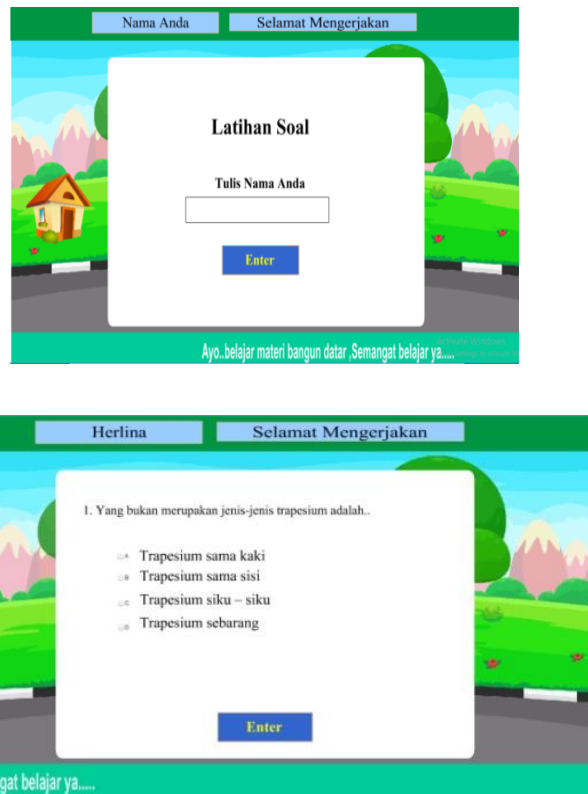
Figure 4: Display of practice test questions

In order to identify the effectiveness of multimedia developed, the researchers conduct on-site testing during two-dimensional shape learning process in five classes of junior high schools in Gorontalo Province Based on the effectiveness test, the study extracts data of students' and teachers' activity during learning process, students' response towards the multimedia, and students' learning result. The effectiveness test result is elaborated as follows:

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In observing the students' activity, the study refers to the determined indicators, i.e., students' interest and motivation, students' activity in operating the multimedia, and students' participation during the learning process. The following Table 2 illustrates the percentage of students' activity.

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Islamic Junior High School MTsN 1 Limboto	93.88%	Very Good

As observed from the indicators of the students' response to interactive multimedia, i.e., interest, attention, attractiveness, convenience, and clarity, the following Table 3 displays the analysis result as follows:

Table 3: Average Percentage of Students' Response towards the Multimedia

Class	Classical learning outcome competence (%)	Criteria
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Junior High School SMPN 5 Paguyaman	85.80%	Very Good
Junior High School SMPN 1 Kwandang	90.30%	Very Good
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Table 3 displays that the students' response towards the multimedia is categorized very well; therefore, the multimedia provides positive response towards students during the learning process. Moreover, as observed from the learning process, the students show their motivation and their attention to the lesson being taught. The attractive display in multimedia developed enables the student to perform independent learning with ease, as the concepts are deliveredclearly and concisely. This echoes authors in [12] who contend that multimedia-based learning stimulates students' learning motivation positively.

Further, the cognitive learning outcome test results as follows:

Table 4: Average Percentage of Students' Learning Outcome

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Junior High School SMPN 11 Gorontalo	89.62%	Very Good
Islamic Junior High School MTsN 1 Limboto	94.70%	Very Good

Table 4 indicates that the students' learning outcome is categorized into very good criteria, implying that the multimedia developed contributes positively to improving their performance during the learningprocess. By the application of multimedia, students are easier to understand mathematical concepts; echoing authors' [13] statement that interactive multimedia-based learning can help students improve their understanding of concepts. Based on the data analysis, this study finds out that the effectiveness level of learning multimedia developed falls into the veryeffective category, thus, assuming that the learning multimedia developed is beneficial in helping to enhance the quality of learning process. The assumption is supported by data on student learning activities that show very good results. Moreover, it is also reflected through student learning outcomes which above the minimum completeness criteria (KKM) or ≥ 75, as well as meeting the whole completeness criteria. As observed from the percentage of students passing minimum learning mastery, therefore it is concluded that the whole design process of learning multimedia is effective to use. Based on the previous elaboration, this research contends that multimedia is effectively used in the mathematics learning process, as it enables students to easily understand the learning material delivered as interactive multimedia. Moreover, author in [14] mentions that interactive multimedia is capable of transferring messages from the sender to the recipient; hence, triggering students' motivation and attention within the learning process. Author [14]'s statement correlates with the research finding that students are able to develop and increase their interest, motivation, and attention in learning the subject through the multimedia. This correlates with authors [15] who argue that "In such math skills using programs or multimedia-enhanced methods of teaching can be effective in getting students' attention." Further, this study finds out that learning multimedia developed is qualified to be implemented in the

learning process. Integrating visual and audio elements, the interactive multimedia is easy to operate and is featured with tutorials on subject that enable independent learning (author in [16]). The multimedia learning provides positive changes to the students comparing to the conventional learning. This is in line with authors' [17]'s study (2016) that finds out that "multimedia technique increased the academic success of students in social studies lesson compared to the traditional classroom." Author in [19] points out that abstract concept in mathematics learning are required to be deliveredin a concrete manner in order for the students to easily grasp the content. Elements in multimedia help to elaborate concepts that are difficult to deliver in a conventional manner or concepts that require accurate delivery. Further, the multimedia harnesses differences in students' characteristics and learning capability, as it is adjusted with the learning material. Also, the communication between the students and the program facilitated by the teacher is actualized in the form of stimulation-response (authors in [18])   Author in [20] states that the implementation of interactive multimedia in the geometry learning process is able to motivate students to solve abstract concepts and challenging questions. Learning can be more attractive and interactive and can integrate visual and auditory learning to make comprehensive understanding of an object that they learn (author in [21]). The length of time required in learning can be shortened, and learning can be given anytime and anywhere in accordance with the wishes and needs.

4. Conclusion

Based on the research findings and discussion, this research concludes that the multimedia of two-dimensional shapes topic developed is considered effective to be implemented during the learning process, as measured from teachers and students' activity as well as students' response and learning outcome. The multimedia developed is expected to be applied by mathematics subject teachers, particularly during the learning process of two-dimensional shapes topic displayed in the form of text, images, animation, audio formats.

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