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Development of Quantum Learning-Based Articulate Storyline Learning Media to Improve Students' Mathematical Communication Skills

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ABSTRACT

The main purpose of this study is to describe the validity, practicality, and effectiveness of articulate storyline learning media based on quantum learning. This medium is specifically designed to improve students' mathematical communication skills. The research conducted is included in the development research category. The development model used in this research is the ADDIE model with 25 students in class VIII-1 and 25 students in class VIII-2 at SMP Tunas Karya. The research instrument used was a test of students' mathematical communication skills. The results showed that the learning media met the required validity criteria, which was shown from the analysis conducted by validators. In addition, the learning media proved to be practical, as observed during its implementation, and was considered effective in improving students' mathematical communication skills. This effectiveness is evidenced by the achievement of students' communication skills classically, and students are interested in learning media. In addition, the average N-Gain is in the medium category which indicates that the learning media is successful in improving students' mathematical communication skills.

A. INTRODUCTION

Mathematics is a fundamental discipline that plays an important role in the advancement of modern technology and holds important positions in various fields of science. This is in accordance with the Law on the National Education System of the Republic of Indonesia (Depdiknas: 2003), which mandates that mathematics be taught at both primary and secondary education levels. Mathematics learning is intended to equip students with the ability to apply mathematical concepts and ways of thinking in everyday life. One of the objectives of mathematics learning listed in Permendiknas 22 Year 2006 is that students can communicate ideas in the form of symbols, diagrams, tables, orother media. Based on this, it is very important to consider students' mathematical communication skills, because those with strong communication skills are better equipped to solve math problems. This confirms the need for the development of students' mathematical communication skills. In accordance with Minarni et al (2020: 87) which states that students need to have adequate mathematical communication skills to understand and express potential solutions to given mathematical problems. and give arguments from the thoughts he conveys. The importance of mathematical communication is increasingly highconsidering that mathematics itself is a science that prioritizes the use of symbols to express something, such as concepts, facts, principles and operations.

Hayati et al (2019: 558) assert that to learn mathematics effectively, one must have good communication skills. Mathematics is not only a language but also a tool that uses different definitions and symbols that can be applied in everyday life. Furthermore, mathematics provides a structure that allows students to understand the subject matter better, and as a result, they are better equipped to solve math problems. Furthermore, according to Baroody (in Ansari, 2018: 5), there are special communication skills that a person must have. The first skill is the use of mathematics as a language. This means that mathematics is not only a problem-solving tool or a way to identify patterns, but also a valuable method for effectively communicating ideas with clarity, precision, and attention. The second skill is the introduction of mathematics learning as a social activity. Thus, mathematics serves as a means of interaction between students and a tool to facilitate communication between teachers and students.

Mathematical communication skills are indispensable. By having good communication skills, it can help students solve math problems. as revealed by Nahdi (2019: 138) that communication between students, especially in mathematics, allows for exploration and consolidation of ideas, knowledge and development in problem solving. Despite the importance of students' ability to communicate mathematically, the current state of affairs shows the difference between importance and reality; it is seen that students' mathematical communication skills are still lacking. The results of TIMSS 2011 (Siregar &; Ramadhani, 2021: 257) show that the mathematical communication skills of Indonesian students are only 57% compared to other countries.

Based on previous research, research conducted by Sari & Revita (2022: 656) proves that mathematical communication is often plagued by problems. Numerous studies have explored the subject of students' mathematical communication and have identified common difficulties. This includes (1) The inability to articulate mathematical concepts through visual aids such as diagrams and drawings. (2) Students fail to build mathematical models of the mathematical problems they face, such as solving story problems. (3) Students are not able to present arguments in a straightforward and easy-to-understand manner when solving mathematical problems. (4) Implement group discussions during presentations and question and answer sessions in the learning process, which are active only a few with students who (5) at the end of the learning process, students cannot conclude what has been learned. Based on this description, that students' mathematical communication is very important to pay attention to. Efforts need to be made to be able to improve existing problems, namely low communication skills and mathematical disposition of students. Learning activities carried out must involve students actively.

Following the development of science and technology into a medium that can be used to transfer knowledge. The use of technology, especially computer technology, which is computer as a learning medium to help understand mathematical concepts. By helping students use media, teachers get the role of facilitators and those who remain active in the process are the students themselves. In line with this, according to Zaharah et al (2021: 2771) that a mathematics teacher should find solutions to mathematics learning situations that are complicated, difficult to understand, difficult to communicate and must follow the development of science and technology as desired by students. Therefore, by helping students use media, teachers get the role of facilitators and those who remain active in the learning process are the students themselves.

It is necessary to develop learning media that help improve students' mathematical communication skills. Suri et al (2022: 229) stated that mathematical communication can be improved by understanding the material using media that is presented visually. Furthermore, Safitri et al (2021: 97) stated that learning activities become more effective and interesting when the learning media is arranged according to the learning topic. So media is needed that can be developed, seen and understood by users. Meanwhile, Freeman et al (2020: 286) stated that technology can help improve students' mathematical communication skills. So it is necessary to use learning media with the help of technology.

The media developed is interactive media with the help of software, namely articulate storyline. This interactive media can combine various media such as images, audio and text simultaneously in one program and provide feedback for users to be able to carry out various learning activities. For this reason, the learning media developed can be seen visually which will contain images, text, video and audio with an articulate storyline. Indriani et al (2021: 28) state that the articulate storyline application is a software that provides features -features such as videos, images, animations, audio photos and others. So this application is suitable for use to develop learning media. The articulate storyline application makes learning student-centered. Students dig up information from various sources, then collect the information obtained in the articulate storyline application and students can provide responses to each other on presentation activities that can add information. It is hoped that by using this media students' interest in learning mathematics will increase, in this case it will also support students' mathematical abilities, especially students' mathematical communication abilities. The use of articulate storylines as a learning medium involves students directly, so that students will be actively involved in learning.

The development of mathematics learning media in the learning process needs to be adapted to the learning model. As stated by Munir (2021: 68), the multimedia-based learning process depends on the learning model used. For this reason, it is necessary to choose a learning model that can make students actively construct their own knowledge. By constructing their own knowledge, it is hoped that students' mathematical abilities, especially mathematical communication abilities, will also develop. Utari et al (2020:178) state that students' mathematical communication skills in learning can be improved by learning that creates an effective learning environment by involving students directly and using the learning environment as a forum for interaction between teachers and students. One learning model that can be

applied is the Quantum Learning model. In this quantum activity, the teacher creates a conducive atmosphere. Teachers also guide students to construct their own knowledge. As stated by Sufianti et al (2019: 132-133) that the Quantum Learning model is student-centered. Students are encouraged to be actively involved in the learning process and express their creativity, resulting in a more significant and effective learning experience that can contribute to increasing student achievement. One important factor that contributes to better learning outcomes is student satisfaction with the teaching and learning process.

Furthermore, according to Qohar (2011: 6) students' mathematical communication can be improved by using contextual problems in mathematics learning. In accordance with the quantum learning model which connects learning with students' daily lives. As stated by Silfia et al (2019: 75), the basic principles of the quantum model emphasize that the main step that a teacher must take to start the learning process is to enter the student's world. This involves relating the material to events and experiences in one's daily life. Based on the explanation above, the learning media that will be used to improve students' mathematical communication skills are interactive, visual and multimedia media as well as contextual learning. In accordance with the media developed, namely articulate storyline learning media based on quantum learning, it has several characteristics that can improve students' mathematical communication skills.

B. RESEARCH METHODS

The research was conducted at SMP Tunas Karya located on Jl. Medan Batang Kuis, Batang Kuis District, Deli Serdang Regency, North Sumatra Province, using research and development (R&D) methodology. This research will take place in the even semester of the 2022/2023 academic year and involves grade VIII students of SMP Tunas Karya Medan. This research will use a procedural model to outline the different stages of the product development process. The purpose of this study is to create Quantum Learning-Based Articulate Storyline Learning media. The development model used in this study will follow the ADDIE approach consisting of Analysis, Design, Development, Implementation, and Evaluation. The specific steps of the ADDIE Development Model used in this study are as follows:

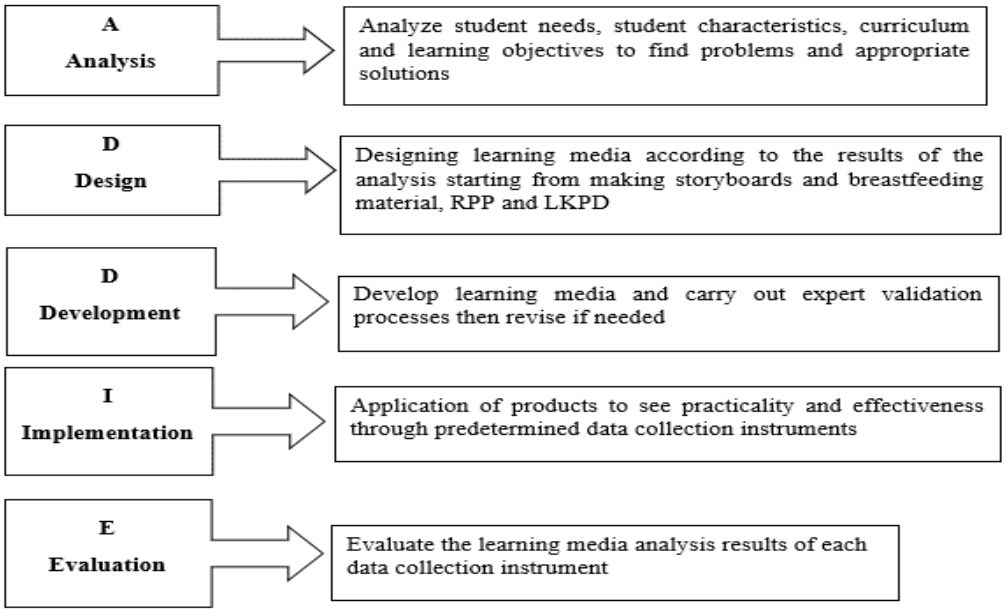

Figure 1. ADDIE Development Research Model

Data collection techniques use types of test instruments and questionnaires. The validity instrument used in this study consists of learning media validation sheets, lesson plans, LKS, and tests to evaluate students' mathematical communication skills. The practicality instrument of learning media is in the form of observation sheets to assess the implementation of the learning process. The effectiveness instrument consists of a test to measure students' mathematical communication skills and a questionnaire to collect students' responses to learning media. The data collected during the validation stage is categorized into qualitative and quantitative data. The purpose of this analysis is to provide an overview of the data characteristics for each variable. Qualitative data consists of advice and critical from experts, the aim is to improve this media product. Meanwhile, quantitative data is obtained from questionnaire assessments filled

out by expert validators and responses to the media. To see the quality of articulate storyline media, a measurement scale using the Likert technique is used. The scale in question uses a range of one to four to obtain data from respondents in a way that avoids the tendency for neutral responses on a score of three.

C. RESULT AND DISCUSSION

This research constitutes a developmental study. The goal of the project is to create a comprehensive learning tool known as articulate storyline learning media centered on quantum learning principles. The purpose of this medium is to improve students' abilities in mathematical communication. The result of this development effort is the creation of articulate storyline learning media. The RPP, LKPD, student mathematical communication ability test instruments are used as data collection tools and completeness of the research process.

1. Validity of Learning Media

In media development, the validation process has significance because it facilitates the detection and improvement of deficiencies and weaknesses in the results of previous learning media. To validate learning media and research instruments, they must be submitted to validators along with validation sheets that assess their feasibility. Validation assessment criteria include the quality and purpose of the content, the learning strategies used, and the design of the learning media. The results of expert validation of the learning media created are described in the table below.

Table 2. Results of Expert Validation of Learning Media

Aspects	Average	Category
Quality of Content and Purpose	3.67	Valid
Instructional/Instructional Strategies	3.70	Valid
Media Design	3.62	Valid
Total Average	3.67	Valid

The table above illustrates the results of the assessment of learning media. Based on the table, it can be seen that the cumulative average value of expert validation of learning media is 3.67 so that it meets the validity standard in the "valid" classification.

2. Practicality of Learning Media

To find out whether learning media is practical or not to use or see whether learning using this media runs as expected, data is collected through observation forms for learning implementation. If you look at the value of learning implementation as part of the minimum criteria that are classified as "well done", it can be concluded that this learning media is practical and user-friendly. The average score of the observations of learning implementation in the first trial was included in the category of "poorly implemented" with a score of 2.85. This score does not meet the criteria for achieving practicality. The average observation score of learning implementation using learning media developed in Trial II was in the "well done" category with a score of 3.65. It has qualified practicality. The implementation of learning in the second trial was better than in the first trial because the classroom atmosphere was more conducive. Student involvement in learning, discussing and expressing opinions is also getting better at each meeting.

3. Effectiveness of Learning Media

The effectiveness of the media is seen from: (1) the minimum test score of students' mathematical communication is 65 ("medium" category) and classically at least 85% of students meet the completeness of the learning; (2) The average student response is at least in the "interested" category. (3) There is an increase in students' mathematical communication skills in the minimum moderate category.

Students' Mathematical Communication Skills

Assessment of students' ability in mathematical communication is carried out twice during their learning journey. The first evaluation occurs before the start of the learning activity and is referred to as the pretest. The second assessment is given at the end of the lesson and is known as the posttest. The purpose of pretest and posttest administration is to determine the extent of improvement in students' communication skills after their exposure to quantum learning-based media on cube and block materials. In the first trial, the average score of students' mathematical communication skills on the pretest was 55, which was included in the "low" category and the posttest was 72.3 ("medium" category). The presentation of classical completeness in the pretest was 20% complete and 80% of students incomplete, while in the postest 68% complete and 32% of students incomplete. The average posttest score of students' mathematical communication skills is in the

"medium" category, but has not reached classical completeness. So that it has not met one of the requirements for the effectiveness of quantum learning-based learning media.

In test II, the average mathematical communication skills of students in the pretest were 60.1 ("low" category) and posttest was 81.1 (" High" category). The percentage of classical completeness in the pretest was 28% complete and 72% of students were incomplete, while in the postest it was 88% complete and 12% of students were incomplete. Students' Mathematical Communication Ability Scores After Learning Using Quantum Learning-Based Articulate Storyline Learning Media (Through Posttest Results) achieved classical completeness of 88% with an average of 81.1 or the "high" category. The research results are in line with the results of research conducted by Simanullang (2023: 215) which states that by using storyline learning media students have achieved classical mastery of mathematical communication skills and are declared very effective.

Student Response to Learning Media

Student response questionnaires were given to the respondents at the end of the trial. After analyzing the results of student responses, it was found that both in Trial I and Trial II, students expressed curiosity about learning media developed based on quantum learning principles. This can be seen from the average score of student responses that show interest in using articulate storyline learning media made in accordance with quantum learning. The students' response scores on the first and second trials were sequentially 3.65 and 3.72 with the interested category. Based on the student responses, it can be seen that students are interested in using the developed articulate storyline learning media. In line with the results of research conducted by Zahara (2021: 2779), it was found that students stated that the quantum learning-based mathematics learning multimedia used was interesting and easy to use.

Improvement of Students' Mathematical Communication Skills

After analyzing the results of mathematical communication skills tests conducted in both the first trial and the second trial, there was an improvement in students' communication skills. The results revealed that the average N-gain in the first trial was 0.40 which showed a moderate improvement in students' mathematical communication skills. Of the 25 students, 22 students showed improvement in mathematical communication skills belonging to the moderate category, while the other 3 students showed improvement in the low category. In the second trial, an average N-gain of 0.54 was obtained, which showed a moderate improvement in students' mathematical communication skills. All students showed improved mathematical communication skills belonging to the "moderate" category.

Based on the research findings, it can be concluded that the teaching materials made meet the criteria of valid, practical, and effective. In terms of validity, media and learning devices have been considered valid and able to meet the requirements of educational needs to improve students' mathematical communication skills on Cube and Block material. Supported by the opinion of Arsyad (2015: 74) who explained that the media must be in line with the needs of learning tasks, this is one of the criteria of good media. The acquisition of quantum learning-based articulate storyline learning media is caused by several things. First, the articulate storyline learning media based on quantum learning developed has achieved content validity. This implies that quantum learning-based media is relevant to existing trends. This curriculum requirement is associated with the core abilities (IC) and basic abilities (KD) that students must achieve during the learning process which depends on the material provided and the steps using quantum learning-based articulate storyline media. In line with this, according to Fitria et al (2017: 17) that the media is said to be suitable for use if it supports the content of learning materials. The validity of this content is also often referred to as curriculum validity. Second, quantum learning-based articulate storyline learning media has fulfilled construct validity. According to Fitria et al (2017: 17) explained construct validation is a validation process as a matter related to consistent associations between each component of a product. This means that in the development of quantum learning-based articulate storyline learning media, it is in accordance with the concepts and aspects of communication skills and mathematical dispositions of students. The learning media developed are arranged to complement each other, namely articulate storyline learning media, (RPP), and (LKPD) which are adapted to quantum learning. According to the findings and viewpoints of the study, as well as development research by Marselina and Muhtadi (2019: 206), any learning media can be considered of exceptional quality and is only suitable for use after being evaluated for the validity of its content and construct by a validator.

The articulate storyline learning media based on quantum learning developed has met practical criteria where judging from the assessment results of experts who state that the learning media developed can be used with a little revision and learning implementation. This is supported by the opinion of Nieveen (1999: 127) who states that practicality criteria are met when experts or validators confirm that the developed product can be implemented. Fitria et al (2017: 17) also support this view, stating that practical products are products

that can be applied in the field according to practitioners and meet at least the "good" category for implementation. Then, through the observation sheet of learning implementation using quantum learning-based articulate storyline learning media, it was obtained that the observation score of learning implementation in trial I was not in accordance with criteriona. Meanwhile, in trial II, the average observation results of the implementation of learning in the second trial were in the category of "well done". Therefore, the quantum learning-based articulate storyline learning media developed has achieved the second learning goal, which is to meet practical indicators.

From the results of the implementation of learning in trial I, there were obstacles such as lack of student involvement in solving and discussing problems. Apart from that, at the demonstration stage students are required to present the results and respond to them, but there are still students who lack confidence in expressing their opinions during discussions, especially at the first meeting. The implementation of learning in trial II was better than in trial I because the classroom atmosphere was more conducive. Student involvement in learning, discussing and expressing opinions also gets better at each meeting. At each meeting, the implementation of both Trials I and II, learning progressed increasingly better. From the explanation above, teacher involvement in implementing learning is considered very important. Teachers must be able to condition the class to be more conducive so that learning takes place well.

Based on various criteria, the learning media developed is believed to be effective. These criteria include the level of success achieved in learning, student reactions to learning media, and improvement of students' mathematical communication skills. By analyzing student responses, it can be seen that they show high interest in utilizing articulate storyline learning media that have been created. This finding is in line with the results of research conducted by Zahara. (2021: 2779) obtained that according to students, quantum learning-based multimedia used for mathematics learning is interesting and user-friendly. The articulate storyline learning media developed contains text, images, music and videos. Furthermore, Kustandi and Darmawan (2020: 202) emphasized that in educating students, the use of media in the classroom can make the material more interesting and memorable for them. Not only that, combining different forms of media can further enhance their understanding. For example, pairing images with text can be more effective than using text alone, as it helps students better understand the information presented. Based on students' responses to the quantum learning-based articulate storyline media developed, it was concluded that the media was effective.

In improving communication skills, the results of this study are in line with Simanullang's research (2023: 212) where the application of Quantum Learning-based articulate storyline learning media is able to improve students' mathematical communication skills. This research highlights the effectiveness of interactive learning media, especially Articulate Storyline 3, in encouraging the improvement of students' mathematical communication skills. Completeness was not achieved in trial I because there were still deficiencies in the learning media, namely that it was not equipped with example questions and their discussion. The achievement of classical completeness and increased communication skills in trial II was better in trial I due to improvements in learning media, namely adding examples of questions and discussions so that students will better understand solving communication problems in the media and LKPD. Learning media has an impact on achieving and improving students' mathematical communication skills because as explained earlier that the media is arranged based on predetermined goals and in accordance with aspects of communication skills that are arranged based on quantum learning models with learning stages that are grow, natural, name, demonstrate, repeat and celebrate. This is in line with research conducted by Zaharah (2021: 2780), namely the results of N-Gain show that communication skills have improved significantly after using multimedia products with quantum learning. These products belong to the category of tools that are effective in improving students' mathematical communication skills.

Using this articulate storyline learning media, students participate directly in using it. As stated by Firdaus et al (2022: 69), digital environments that use articulate storyline learning media are effective because students can interact in various directions, both with teachers and with digital learning resources. In addition, research by Zaharah et al (2021: 2780) shows that the increase in mathematical communication can be related to the way in which students undergo the learning process. They are led to perform a task or physical activity through direct involvement, such as clicking or dragging based on predetermined, quantum-learning syntax tailored directions, such as growing, experiencing, naming, demonstrating, repeating, and celebrating. This is achieved through the use of learning media, enabling students to effectively convey their thoughts through written and oral.

The research carried out has a novelty, namely learning media in the form of an Android application which contains material, example questions and practice questions regarding cubes and blocks. With this,

students can be directly involved in using learning media, besides that they can be used anytime and anywhere.

D. CONCLUSION AND SUGGESTIONS

According to the results of this study and a thorough analysis, several conclusions can be found:

1. The quantum learning-based articulate storyline learning media developed has been valid, judging from the assessment of validators
2. The articulate storyline learning media based on quantum learning developed has been practical to use, judging from the results of observations of the implementation of learning that is carried out well.
3. The quantum learning-based articulate storyline learning media developed has been effective based on the achievement of students' classically complete mathematical communication skills, students' responses to learning media are interested. The learning media is effective in improving mathematical communication skills.

The focus of this research is to develop valid, practical and effective learning media in improving students' mathematical communication skills. For further research, the researcher suggests developing research by not only looking at how students' abilities are increased, but it needs to be developed by looking at the differences in the abilities of students who are taught with learning media and those who are not taught with learning media. Researchers also suggest developing learning media on other subjects using computer technology or other applications to produce better and more interesting learning media. Teachers can also design the learning process using this learning media, in groups or individually by looking at the available facilities. If media use is carried out individually via smartphone, before the learning process begins the teacher should ensure that facilities are available where all students bring smartphones to be able to use learning media according to the purpose.

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