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Improving Students' Mathematical Communication Skills through Interactive Online Learning Media Design

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Abstract: Mathematical communication skills are very important, and interactive learning media is a good means to improve students. Therefore, this study aims to describe the design of interactive online learning media, which helps to improve mathematical communication skills. This is a qualitative descriptive study. The data collection instrument used observation and interview guidelines and was analyzed using a qualitative technique. This study produced interactive instructional media designs to help improve mathematical abilities. The results showed that interactive learning media design is by students' characteristics, the curriculum, and the project-based learning model. The design was further declared valid and had the potential to improve mathematical communication skills. Therefore, the study's contribution was integrating mathematical communication skills in interactive online learning media on geometry transformation material.

Keywords: Interactive online learning media; mathematical communication

1. Introduction

The Indonesian government needs help with improving the quality of education. This is associated with the achievement of student learning outcomes, which is often identified by test scores and is not separated from the quality teaching process (Fauzi & Masrukan, 2018). Mathematics is a science that students need to study, with many observing it as an elusive subject (Chong & Sungap, 2021). Most of the students had previous negative views about not being able to understand math, when it comes to complicated formulas. However, these difficulties have the possibility of being minimized by improving low math skills (Ernaningsih & Wicasari, 2017).

Mathematical communication skills are fundamental abilities that students must master to create good understanding (Patel, 2013). The National Council of Teachers of Mathematics (NCTM) stated that mathematical communication skills can organize arithmetical thoughts, communicate logical and clear ideas to others, and analyze & evaluate previously used strategies while also using the ideal language to express very precise ideologies (Ernaningsih & Wicasari, 2017). Furthermore, communication is observed through the following indicators: written text, drawing, and mathematical expression. The written text provides answers through developed languages, modelling situations, explaining and making questions, listening, discussing, writing, compiling arguments, and generalizations. Drawing involves reflecting real objects, figures, and diagrams into mathematical ideas. Therefore, expressions are descriptive concepts involving the declaration of daily events in languages or arithmetical symbols (Paridjo & Waluya, 2017).

As explained by Clark, the importance of having communicational skills is that mathematical communication is a way of sharing ideas and clarifying understandings. Through communication, ideas are reflected, refined, discussed, and developed. Also, this process helps to build meaning, makes ideas permanent, and explains ideologies (Sulasteri et al., 2018). Furthermore, Mathematical Communication Skills (MCS) are very important for students' ability to make arguments. The ability to argue allows students to understand various mathematical concepts, and a good understanding

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of principles impacts learning outcomes (Nartani et al., 2015).

A model that motivates, encourages, and supports the achievement of students' mathematical communication skills in comprehension is Project-Based Learning. Putri stated that there was increased communication skills through Project-Based Learning (Kusniawati, 2017). Also, the learning media is known to be a support that helps to improve students' MCS. Presently, stereotypical traditional teaching methods and environments are not popular, while multimedia technology featuring audio and visual animation effects gives more access to information. This is because, in addition to characteristics such as the amount of information, with time & space intersection, multimedia technology offers a very good sense of reality and function, which greatly fosters students' interest and motivation in learning while also getting them involved in classroom activities (Rassel et al., 2020). Therefore, this study aims to develop interactive learning media suitable for improving MCS.

2. Literature Review

Based on the Trends in International Mathematics and Science Study (TIMSS) report, Indonesia's ranking still needs to be improved. The value of arithmetical ability is thought to be influenced by mathematical communication skills, which was reinforced by Sulasteri et al. (2018) opinion that the MCS of Indonesian students is still low. Several previous studies have shown that the skills still need to be improved, which also happened in State Senior High School 4, Ternate City. Based on interviews with Mathematics teachers, it was shown that students' abilities in mathematical communication still need to be improved, with some needing help explaining and presenting their ideas. Meanwhile, Wahyudin (2018) stated that the teacher communicates with the students in the classroom learning process. However, communication skills in line with the math objectives still need clarification. Apart from the less varied learning media utilization, mathematics is often conveyed in symbols, with verbal/written communication about the ideas only sometimes recognized as an essential part of arithmetic education (Paridjo & Waluya, 2017). Therefore, a teacher should be able to use appropriate media and models in the learning process.

The ability to communicate is one of the conditions that play an important role because it helps prepare the mind and connect ideas. In comparison, Lindquist stated that communication in mathematics is necessary when it is meant to fully achieve social goals, such as mathematical literacy, lifelong learning, and arithmetic for everyone (Tiffany et al., 2017). In this modern era, where science and technology (IPTEK) development is increasingly sophisticated, a teacher must master mathematical communication skills to display more creative, innovative, and educational learning activities (Vasudevan, 2017). Furthermore, learning media is a component of the teaching system, which is an important factor in supporting the success of the teaching and learning process. Also, learning media are used to make it easier for teachers to deliver subject matter, allowing students to easily understand what is being taught (Kusniawati, 2017).

According to Darmawan and Nawawi (2020), using interactive media in learning activities increases student motivation because of their interest in multimedia, a system providing texts, images, videos, audio, and animations. This statement showed that students are interested in learning through interactive multimedia because of its attractive appearance and support for learning activities. Also, the combination of texts, images, videos, audio, and animations is a source of learning for students. Furthermore, Kassim showed that multimedia plays a role for students to generate flexible and original ideas (Putri et al., 2019). Therefore, it is known that interactive multimedia makes the learning atmosphere lively without pressure.

3. Methodology

This study used qualitative analysis to describe the design of interactive learning media and articulate storyline three (3) to improve students' MCS. The procedure consisted of learning needs and instructional media design descriptions. The needs descriptions were carried out through observations of the mathematical learning process and student outcomes while conducting interviews with teachers. The results were used to deduce learning media needs. Learning media was needed to determine the subject matter to be included in the research process.

Meanwhile, determining the basic competency target and software selection used in creating the learning media was also conducted. Furthermore, the design described was carried out through the preparation activities framework within the media and instructional design. Experts validated the learning media design to obtain their assessment and input as revision materials. Therefore, the learning media development design was considered good quality.

The subjects were class XI Science 1 students, Public Senior High School No. 4, Ternate City, Indonesia. The data collection instruments included observation and interview guidelines. They were analyzed using the Miles and Huberman technique (Miles & Huberman, 1994), consisting of three steps: data reduction, presentation, and conclusion drawing.

4. Results and Discussion

This section describes the learning media needs, design, and validity, which can improve students' mathematical communication skills.

4.1 Description of Learning Media Needs

The results of the literature study related to the description of the learning media are as follows. Using instructional media in teaching and learning arouses students' interest or desire to learn (Moreira et al., 2018). Furthermore, Matiisen et al. (2019) stated that learning is not a goal but a process to achieve objectives. A part of the learning goals in the 2013 Curriculum was to achieve mathematical communication skills. Therefore, without MCS, it becomes difficult for students to convey mathematical ideas to others (Paridjo & Waluya, 2017).

Meanwhile, the results of observations and interviews related to the teacher's description of learning media needs are as follows. At the beginning of the learning process, greetings were exchanged between the teacher and students, as the class attendance was thoroughly checked. After questions and answers about the previous lessons, the teacher discussed geometry as the students were familiar with the materials to be presented due to the possession of the handbook. The main activity was the creation of groups by the teacher, with worksheets distributed. The students completed each group's exercise and presented it to the class.

During this learning process, it was observed that some students from several groups were indifferent, while others paid attention to the material. Several others were indifferent to the explanation when a particular group presented in front of the class. The design used was student worksheets without the support of learning media by the material being studied. In learning geometry, students need clear, manipulative abstractions that make it easy to understand. Furthermore, Kosko and Wilkins (2010) stated that using manipulatives in mathematics is to help students understand abstract concepts. With supporting media, students' assumptions are by the learning presented. Therefore, interviews were conducted to obtain the students' responses, and the results are presented in Table 1.

Table 1: Student interview results

Question	Student opinions
What do you think about the learning given by your mother without learning media?	Student 1: Because of the material about geometry, it was very difficult for us to accurately determine the parts of geometry. Therefore, there is a need for supporting media to allow a better understanding
	Student 2: Without using a lined book in geometry material, it is very difficult for us to construct and determine the parts of geometry. Therefore, there is a need for appropriate supporting media, for us to understand
	Student 3: We did not understand this material at all because the images constructed were not correct

Learning media is very important in a good educational process. This is because the media makes the process very effective and positively affects student outcomes. Furthermore, it helps improve students' understanding of communication towards various materials, due to being supported by the media according to the needs of learning designs. However, this is inversely proportional to the problem because of the student's inability to present and explain mathematics. The impact of the learning process does not run effectively, and the achievement results could have improved mathematical communication skills. Also, the media application, not learning needs, impacts students 'understanding in constructing and re-explaining arithmetical ideas. Therefore, using learning media has been confirmed to affect the educational process.

4.2 Description of Learning Media Design

This interactive learning media design used articulate storyline three (3), based on Project Based Learning to help improve MCS. The media design included an opening, a main menu, and an end section. The opening section was the introduction of the media to start learning, which consisted of titles, materials, and classes. The opening section is presented in Fig. 1.

Fig. 1: Media introduction

The main menu in this media contained basic competencies, achievement indicators, learning materials, exercises, interactive quizzes, and bibliography. The main menu is presented in Fig. 2.

Fig. 2: Main menu

Fig. 3 presents learning materials regarding the concept of geometric transformation, its types, and their relation to the matrix.

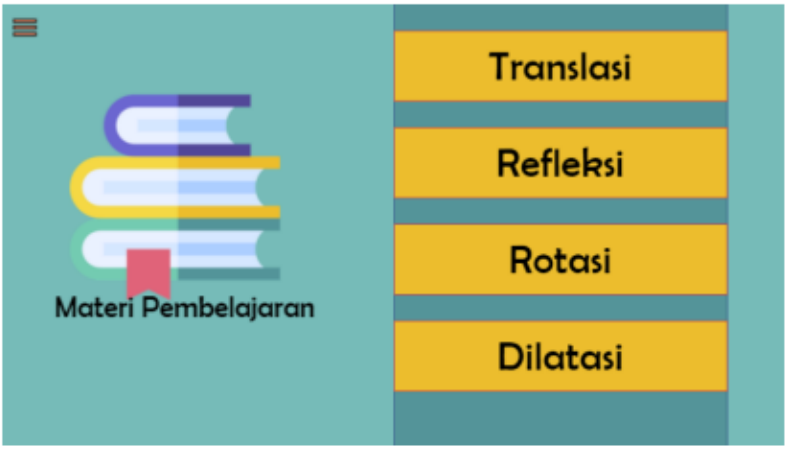

Fig. 3 Materials

The problem interactive exercises and quizzes were designed based on the arithmetical indicators (I1, I2, I3) to measure mathematical communication skills. The interactive exercises and quizzes are presented in Fig. 4.

Fig. 4: Problem exercises on media

The end section is where students get information on the use of media (button instructions), maker profiles, and bibliography. The bibliography is used by teachers as reference material. The end section is presented in Fig. 5.

Fig. 5: Media information

This media design contained learning based on the Project-Based model. This requires a long period and focuses on the activities of students' ability to understand a principle and obtain relevant solutions, which are effectively implemented in project works. Therefore, students experience meaningful learning processes by building their knowledge (Cobb & Gravemeijer, 2014). Furthermore, the syntax present within the model were (S1) planning, (S2) designing, (S3) implementation, and (S4) reporting. At the planning stage, the teacher sets a project theme, establishes learning concepts, and plans activities which need to be carried out. At the designing stage, the teacher processes the activities carried out by students. Furthermore, at the implementation stage, the teacher supervises students in implementing activities to complete the project. At the reporting stage, the teacher assesses students' written and oral reports (Antika et al., 2017).

4.3 Validity of Learning Media Design

The validators tested the validity of this learning media design. The assessment was carried out by filling out the design validation sheet based on the content of learning media, the model steps, and the stages involved in solving the problem. Also, based on the assessment of the design validation sheet, the score obtained was on the feasibility of the learning media material. Based on Table 2, it was observed that the feasibility of the instructional media design got a good category. Therefore, the media design was concluded as valid. When these results were compared with Kurniawati and Suparman (2020), Hernawati and Suparman (2020), and Wardani and Suparman (2019) several similarities and differences were detected. Furthermore, the similarity was based on the fact that all studies have similar targets regarding improving mathematical communication skills. However, the differences were because the authors designed a valid instructional media, while those involved in Kurniawati and Suparman (2020), Hernawati and Suparman (2020), and Wardani and Suparman (2019), only created student worksheets.

Table 2: Media design assessment result

No	Validator	Score	Category
1	Validator 1	34	Good
2	Validator 2	35	Good

5. Conclusion

This study described how interactive learning media was used to improve students' mathematical communication skills in class XI Science 1, State Senior High School 4, Ternate City. Due to the Project-Based Learning model, the design of interactive learning media was declared valid by the validators. Furthermore, the design consisted of three components: the opening, main menu, and end section. The interactive learning media was designed to follow the student's characteristics and the 2013 curriculum. Also, in this study, it was observed that the learning media design could improve the communication skills of the students in State Senior High School 4, Ternate City, regarding the subject of geometric transformation. Therefore, the results are used by teachers to develop interactive learning media to understand geometry materials while also instilling communication skills into students.

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