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The analysis of student's mathematical communication ability viewed from learning styles through project based learning models on cylinder and cone materials

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Abstract

Indonesian students' mathematical ability was ranked in the 10th lowest level in which one of the mathematical abilities is mathematical communication ability. The aims of this study were to find out whether students' mathematical communication ability had reached minimum criteria of mastery learning, teacher's and students' activity, and to describe students' mathematical communication ability viewed from learning styles. The learning method used in this study was a mix method. The population was IX grade students of MTsS Hidayatul Athfal Pekalongan. Particularly, the sample was class IX D as the research class. The data collection method of this research was documentation, questionnaire, observation, test, and interview. The result in this study showed that (1) students' mathematical communication with Project Based Learning model reached minimum criteria of mastery learning, (2) teacher's activity was in very good category, (3) students' activity was in very good category, (4) subjects with visual, auditory, and kinesthetic learning styles on the top category were able to fulfill entire mathematical communication indicators. The subject with visual learning style on the middle category was able to fulfill two indicators. Then, the subjects with auditory and kinesthetic learning styles in the middle category were able to fulfill three indicators. While subjects with visual, auditory, and kinesthetic learning styles on the bottom category were able to fulfill only one indicator.

1. Introduction

In the Regulation of the Minister of Education and Culture No. 21 of 2016 on the standard of the content of primary and secondary education is that one of the competencies that must be achieved in learning mathematics is that students have the ability to communicate the idea of mathematics clearly and effectively. According to the National Council of Teachers of Mathematics (NCTM) (2000), there are five basic skills that students must have: problem solving, reasoning, communication, and the ability of representation. It shows that the ability of mathematical communication is a capability that students must own. The students' ability to communicate their mathematical ideas when solving problems, or when conveying process and problem-solving results is also an ability which can develop high-level mathematical thinking abilities such as logical, analytical, systematic, critical, creative, and productive (Asnawati, 2017).

Ramelan et al (2012) state that mathematical communication is the ability to express mathematical ideas coherently to friends, teachers, and others through the oral language of writing. This means that in the presence of mathematical communication, the teacher can more understand students' ability in interpreting and expressing their understanding of the concepts they are learning about.

According to Sumarmo (2006) and NCTM (2000), someone can be said to have mathematical communication ability when he is able to connect real objects in mathematical ideas and able to declare daily events with mathematical symbols in presenting mathematical ideas in writing. Also, he is able to explain ideas, daily situations, and

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mathematical relationships, in writing, with images, able to understand and evaluate mathematical ideas in solving daily problems in writing, and able to communicate the conclusions of answers to daily problems question.

The results of the Trend in International and Science Study (TIMSS) study in 2015 show that Indonesian students' math skills are ranked 45th out of 50 participating countries with an average score of 397, while the international average score is 500. It is supported by the Programme for International Student Assessment (PISA) study in 2015 which reports that Indonesian student's math skills are ranked 63 out of 70 participating countries with an average score of 386, while the international average score is 490. Based on the results of the TIMMS study and PISA, Indonesian students' math skills are still low. As has been previously described that communication ability is one of the abilities of mathematics, the low mathematical ability of Indonesian students is also influenced by the low ability of students' mathematical communication.

The result of the observation that has been done in MTsS Hidayatul Athfal Pekalongan in July 2017 shows that students' mathematical communication ability is still low. The teacher of mathematics subject mentions that the students' answers to the story-shaped story, in general, are still not in accordance with the given problem. Usually, students immediately write down the end result only. It means that students still have difficulty to express ideas or mathematical ideas.

MTsS Hidayatul Athfal Pekalongan is one of the private schools located in Pekalongan City and is one of the schools that still use School-based Curriculum or known as KTSP. The learning process in this school is still using the expository method, so the two-way communication is still not optimal. The low interaction between teachers and students makes the atmosphere in the classroom unfavorable and tends to be boring.

Wahyuningrum (2013) argues that considering the importance of mathematical communication ability then in designing and implementing learning, the teacher should include the development of mathematical communication ability in the design of learning. According to Suhana (2014), the learning model is an approach to anticipate changes in student behavior adaptively and generatively. Teachers as classroom managers must be creative in developing and using learning models that can motivate students to be active in communicating their mathematical thinking.

As had been previously explained that the ability of mathematical communication is one of the important ability for students, it is necessary to use a learning model that can encourage students to better cultivate the ability of mathematical communication. In addition, the selection of learning models should also consider the learning style of students. The learning model used should be able to accommodate different learning styles of students that is Visual learning style, Auditorial, and Kinesthetic. Learning styles are one of the factors that affect students' abilities, including the ability of mathematical communication. According to DePorter and Hernacki (2008) learning style is the tendency of a person to receive, absorb, and process information. Understanding learning styles can be utilized by the teachers or educators in maximizing student learning outcomes and supporting effective learning by using teaching methods with different learning styles (Mousa, 2014).

A learning model that can accommodate all learning styles is the learning of active learning strategies (Lujan & DiCarlo, 2006). One of the lessons that implement active learning strategies is project-based learning. ChanLin (2008) argues that in project-based learning, students are given complex, quite difficult, complete, but realistic tasks or projects and then they are given sufficient assistance in order to complete the project. It is also reinforced by Prabowo (2012) that the implementation of project work in groups allows discussion among members on matters related to the indicators so that the results of the project are more optimal. Therefore, in project-based learning, students are required to be active in the learning process.

According to Winartiningsih (2018), project-based learning is a fun lesson. It accommodates all student learning styles, enhances teacher creativity, and explores student potential. In addition, it is well suited to educating 21st-century students who are required to have problem-solving ability, critical thinking, collaboration, and communication ability. Siwa et al. (2013) suggest that the project-based learning model is a learning model involving the centralization of meaningful questions and problems, problem solving, decision-making, the search process of multiple sources, the provision of opportunities for members to work collaboratively, and closing with real-world product presentations. Thomas (2000) also argues

that project-based learning can improve the quality of learning in a variety of subjects or subjects. In addition, it can help improve student attendance, attitudes, confidence in students. Project-based learning is also an effective strategy for teaching complex ability such as planning, communication, problem solving, and decision-making.

According to Bell (2010), project-based learning is an innovative teaching strategy to cope with the development of the 21st century. The 21st century students are expected to be not only good at cognitive aspects, but also in terms of creativity and professionalism. As Guo & Yang (2012) points out that project-based learning contributes greatly to improving the capacity of teachers and students. Increased capacity is one of them is in terms of communication ability.

The advantages of project-based learning include increasing students' activeness by working in groups, encouraging students to develop communicative ability due to presentation presentations, and most importantly can make the learning environment enjoyable (Widyantini, 2014). Learning through the application of project-based learning can also develop students' ability to plan, communicate, solve problems, and make decisions (Sani, 2014). Ravitz et al. (2012) found that the use of project-based learning can improve the ability of the 21st century in which one of them is communication.

Project-based learning can be applied to mathematics learning. One of the mathematical material that makes it possible to see students' mathematical communication abilities is geometry as for there are many objects, definitions, symbols and images that can be ideas that can be expressed by students.

Regarding to the explanation above, the aims of this study were to find out whether student's mathematical communication ability reach minimum criteria of mastery learning, to find out teacher's and student's activity, and to describe student's mathematical communication ability viewed from learning styles.

2. Methods

The method used in this research was a mixed method. The research design was sequential explanatory, which is a combination research method that combines quantitative and qualitative research methods in sequence in which in the first phase of the study by using quantitative methods and in the second stage by using qualitative methods with the aim to strengthen the results of quantitative research (Sugiyono, 2013).

This study began with initial data collection for normality test, giving a learning style questionnaire to know the learning style of students, the implementation of learning in the classroom, observation of teacher activities and students in the classroom during the learning process, and giving the test of mathematical communication ability to measure mastery learning students and know description of student's mathematical communication abilities. Based on the mathematical communication test and classification of learning styles, nine subjects which were chosen consisted of students with high, medium, and low group in each learning style. Sampling intends to capture as much information from various sources and buildings (Moleong, 2010) then proceed with an interview.

Further, the data collection methods used in this study are documentation, questionnaire learning style, observation, tests, and interviews. The population in this study were students of IX grade MTsS Hidayatul Athfal Pekalongan on an academic year 2017/2018 which consists of 242 students. The sample in this research was the students of IX D which consists of 32 students. The quantitative data collection and analysis were used to determine the students' learning completeness. While the collection and analysis of qualitative data used to describe student's mathematical communication ability based on learning styles in groups high, medium, and low.

The data analysis on quantitative research used data value of students' mathematical communication ability to test the truth of the research hypothesis. A hypothesis test is a classical exhaustiveness test by using one-party proportion test (left). The data analysis in qualitative research included data reduction, data presentation, and verification or draw conclusions. To test the data validity, this study used triangulation techniques.

3. Results & Discussions

3.1. Quantitative

Based on the result of the early stage analysis, the result of calculation of normality test of the initial stage in research class $\chi^2{}_{count} = 5{,}34$ with $\chi^2{}_{table} = 7{,}81$. So that $\chi^2{}_{count} < \chi^2{}_{table}$ which means that research class was normally distributed.

The results of the given learning style questionnaire indicate that the research class

students have different types of learning styles. However, the dominant learning style is auditorial learning style. This is in line with the results of the Abidin (2011) study that students prefer to an auditorial learning style.

Then, the result of final data analysis in the form of student's mathematical communication skill shows that by normality test result in research class $\chi^2{}_{count} = 4{,}77$ with $\chi^2{}_{table} = 7{,}81$. So that $\chi^2{}_{count} < \chi^2{}_{table}$ which means that research class was normally distributed. After that, the hypothesis was tested by testing the proportion to knowing that students' mathematical communication ability of the research class had reached the classical completeness. Based on the test results of the proportion of one party (left), it is obtained that value $z_{count} = 0{,}47$ with $-z_{tabel} = -1{,}64$. Since $z_{count} > -z_{table}$, it can be concluded that the proportion of students who complete study in the study class more than 85%.

Regarding to preliminary explanation, it can be concluded that students' mathematical communication ability subject to the project-based learning model has reached the classical completeness. This is consistent with Bas (2011) research that project-based learning can have a more positive impact on student achievement. The results show that from 32 students who took the test, there were 28 complete students. It means that there were 87.5% of all students. In brief, the research results above indicate that project-based learning can be used in developing mathematical communication ability.

In addition, there are several factors that affect student's mastery in which one of them is the phase in the project-based learning model. It makes the students able to get a deep understanding of the material taught since it is through guided discovery. This phase is the determination of fundamental questions, designing project planning, scheduling, monitoring students and progressing projects, testing results, and evaluating experiences. Thomas (2000) states that project-based learning can improve the quality of learning in a variety of subjects or subjects. In addition, it can help to improve students' attendance, attitudes, and confidence. Project-based learning is also an effective strategy for teaching complex ability such as planning, communication, problem solving, and decision-making.

Project learning allows the students to interact with others and teachers to handle the assigned tasks so they will be able to what they have learned. As known that in project-based learning, students are required to be active in discussion activities, students can further develop their mathematical communication ability. This is in line with Ravitz et al. (2012) who suggest that the use of project-based learning can improve the ability of the 21st century students in which one of them is communication skills.

3.2. Qualitative

In the project-based learning process, the researcher also observed the activities of teachers and students. The observation here refers to the activities contained in the lesson plan or called *RPP*. Based on the result of teacher activity observation, it obtains an average of 85.34% which means that teacher activity in project-based learning in this study pertained very good criteria. Despite the excellent criteria, there are still shortcomings, especially at the first meeting. At the first meeting, researchers were still not too fluent in learning because researchers had to adapt to students who were accustomed to being taught by conventional methods.

Based on the student activity observation that has been done, it shows that the student activity result was in an average of 86.25% which means that students' activity in project-based learning in this study are very good criteria. They tend to be active and conducive, but at the first meeting, their activities were less than optimal because project-based learning was new for students so they were not accustomed to it and still looked confused. In addition, at the first meeting, they were also still shy to express their opinions. On the contrary, at the next meeting, students' activity ran more optimally. The observations of teacher and students activities can be seen in the following table.

Table 1. Observation Results of Teachers Activity and Students Activity

Meeting-	Teachers Activity	Students Activity
1	84,48%	81%
2	85,34%	88%
3	85,34%	87%
4	86,21%	89%
Rata-rata	85,34%	86,25%

The description of mathematical communication ability of research subjects through learning model.

3.2.1. Mathematical Communication Ability of High Group Visual Learning Style

Based on the results of mathematical communication ability test, the subjects with visual learning styles in the high group could complete all the items well. The problem solving steps done by the subject have been appropriate which were write the information what they knew, write the information in question, then calculate the completion. They were able to write down the information they knew, able to draw the geometry according to the problem with the size description. In the evaluation process, the subjects did the calculation correctly and were able to write a conclusion of the problem. The use of symbols done by the subject was also appropriate. Shortly, based on the analysis of mathematical communication ability, it can be concluded that the subject with Visual learning style in high group has been able to fulfill all indicators.

3.2.2. Mathematical Communication Ability of Medium Group Visual Learning Style

Subjects tend to be able to do all the items well enough. They were able to write down information known and the information being asked, and able to write the formulas used and perform calculations appropriately. The subject also took the appropriate steps of writing down the information they knew, writing down the information being asked, then calculating the completion. In other words, the subjects were only able to fulfill indicator 1 and 4. They were unable to fulfill indicator 2, 3, and 5. It is proven by the lack of subject ability in using mathematical symbols, the subjects did not write a description of the geometry that she drew and did not write a conclusion of the problem. Based on the analysis, it can be concluded that the subjects with Visual learning style in the group were able to fulfill only 2 indicators.

3.2.3. Mathematical Communication Ability of Low Group Visual Learning Style

Subjects with visual learning styles in the low group were still less able to solve the problem well. Based on the indicator 1, the subjects had not been able to write down information which was known and asked. It went without saying that they had not been able to fulfill the indicator 1. In addition, they had not been able to use mathematical symbols correctly, so it can be said they were less able to fulfill the indicator 2. Form the given questions, the subjects were able to draw the geometry with the size description which means that they were able to fulfill the indicator 3. This is in accordance with Ozbas' (2013) research that students with Visual learning style will prefer tools such as drawing in solving a problem. But on the calculation of the problem, the subject is less able to write the formulas in accordance with the information asked so that the calculation of the subject is also not right. Then the subjects also wrote the conclusion of the problem yet with the wrong result and did not write the unit. It indicates that the subject is less able to fulfill indicators 4 and 5. Based on the analysis, it can be concluded that subjects with visual learning style in low group were only able to fulfill 1 indicator namely indicator 3.

3.2.4. Mathematical Communication Ability of High Group Auditorial Learning Style

Based on the results of the test of mathematical communication ability, subjects with auditorial learning styles in the high group could fix all items well. The problem solving steps done by the subjects had been appropriate which were write the information that was known, write the information in question, then calculate the completion. They were able to write down information which was asked and they knew and able to draw the geometry according to the problem with the size description. In the evaluation process, the subjects did the calculation correctly and were able to write a conclusion of the problem. The use of symbols done by the subject was also appropriate. Hence, the subjects with auditorial learning style in high group had been able to fulfill all indicators.

3.2.5. Mathematical Communication Ability of Medium Group Auditorial Learning Style

Based on the result of mathematical communication ability analysis, the students with Auditorial learning style in the medium group could complete all the items well enough. In indicator 1, the subjects were able to write the information that was previously known and asked precisely. It indicates that they were able to fulfill indicator 1. For more, the subjects were also able to use mathematical symbols and draw the geometry according to the problem with the size description well, so that the subject is able to fulfill the indicators 2 and 3. But on the evaluation, the

subjects were still wrong in doing the calculations. It led their error in writing the conclusion. At the writing of conclusion, the subjects were less able in unit usage which means that they were less able to fulfill indicators 4 and 5. This is in accordance with Tiffani's (2015) opinion that students with auditorial learning style are less able to recalling information during the process of planning and execution of completion. In brief, the subjects with auditorial learning style in medium group were able to fulfill 3 indicators.

3.2.6. Mathematical Communication Ability of Low Group Auditorial Learning Style

Subjects with audotorial learning styles in the low group were still less able to solve the problem well. Based on the indicator 1 the subjects had not been able to write down the information that was known and asked. It means that they had not been able to fulfill indicator 1. Additionally, they were less able to complete indicator 2. It is proven that they had not been able to use mathematical symbols correctly. From the known problem, they were able to draw the geometry with the size description which means that they were able to fulfill the indicator 3. But on the calculation of the problem, they were less able to write the formulas in accordance with the information asked consequently, their calculation was also incorrect. Then the subjects also wrote the conclusion of the problem yet with the wrong result and did not write the unit. It shows that they were less able to fulfill indicators 4 and 5. Lastly, the subjects with auditorial learning style in low group were only able to fulfill 1 indicator, indicator number 3.

3.2.7. Mathematical Communication Ability of High Group Kinesthetic Learning Style

Based on the results of students' mathematical communication ability test, the subjects with kinesthetic learning style in the high group could do all the items well. The problem solving steps done by the subject have been appropriate, namely writing the information that was known, writing the information in question, then calculating the completion. They were able to write down information that was known and asked. Also, they were able to draw the geometry according to the problem with the size description. In the evaluation process, the subjects completed the calculation correctly and were able to write a conclusion of the problem. The use of symbols done by the subject is also appropriate. Based on the analysis of mathematical communication ability can be concluded that the subjects with kinesthetic learning style in high group had been able to fulfill all indicators.

3.2.8. Mathematical Communication Ability of Medium Group Kinesthetic Learning Style

Based on the test results of mathematical communication ability, subjects with learning style kinesthetic could do all the items well enough. They were able to write the information that was previously known and asked which means that they were able to fulfill the indicator 1. On the contrary, the subjects were able to fulfill indicator 2. It is proven that the subject had not been able to use mathematical symbols well. For more, on the indicator 3, subjects were able to draw the geometry according to the problem with the size description. It means that they were able to fulfill the indicator 3. In the process of evaluating mathematical ideas, they could write the formulas used in solving problems and use the appropriate steps. It means that they were able to fulfill the indicator 4. On the contrary, the subjects could not fix the indicator 5. They could not write the conclusion of the problem properly since they did not write the unit. This is in accordance with research of Anintya (2016) that students with kinesthetic learning style were less able to declaring with mathematical symbols and communicating the conclusion of the answer. Based on the analysis, it can be concluded that subjects with kinesthetic learning style in the medium group were able to fulfill 3 indicators.

3.2.9. Mathematical Communication Ability of Low Group Kinesthetic Learning Style

Subjects with kinesthetic learning styles in the low group were still less able to solve the problem well. Based on the indicator 1 the subjects had not been able to write down the known and asked information, so they could not fulfill the indicator 1. In the same way, the subjects had not been able to use mathematical symbols correctly which means that they did not really complete the indicator 2. However, they were able to draw the geometry with the size description which means they were able to fulfill the indicator 3. But on the calculation of the problem, the subjects were less able to write the formulas in accordance with the information asked, as the result, their calculation was also incorrect. Additionally, they wrote the conclusion of the problem but they wrote the wrong result and did not write the unit. It shows that the subjects were less able to fulfill indicators

4 and 5. Based on the analysis above, it can be concluded that subjects with kinesthetic learning style in low group were only able to fulfill 1 indicator that is indicator number 3.

4. Conclusion

Based on the description of the research and discussion, there are several conclusions are obtained, as follows; (1) students' mathematical communication ability with project-based learning model successfully achieves classical completeness, (2) teachers activity in project-based learning process from first to fourth meeting includes in very good category, (3) students' activity in project-based learning process from first to fourth meeting includes in very good category, (4) the description of students' mathematical communication abilities viewed from learning styles through project-based learning models on cylinder and cone materials are as follows: (a) subjects with visual learning styles in high groups are able to fulfill all indicators of mathematical communication ability, (b) subjects with visual learning styles in medium group are able to fulfill two indicators of mathematical communication ability that is indicators 1 and 4, (c) the subjects with visual learning style in low group are only able to fulfill one indicator of mathematical communication ability that is indicator 3, (d) the subjects with learning style auditorial in high group are able to fulfill all indicators of mathematical communication ability, (e) the subjects with auditorial learning style in medium group are able to fulfill three indicators of mathematical communication ability that is indicators 1, 2, and 3, (f) the subjects with auditorial learning style in low group are only able to fulfill one indicator of mathematical communication ability that is indicator 3, (g) the subjects with kinesthetic learning style in high group are able to fulfill all indicators of mathematical communication ability, (b) the subjects with kinesthetic learning style in medium group are able to fulfill three indicators of mathematical communication ability namely indicators 1, 3, and 4, (c) the subjects with kinesthetic learning style in low group are only able to fulfill one indicator of mathematical communication ability namely indicator 3.

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