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Teacher-student interaction in mathematics learning

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ABSTRACT

Teacher-students interaction is one of the most important interactions in learning. Teacher-students interaction affects student understanding. However, in practice, there are still many lessons that have not applied teacher-students interaction properly. This study aimed to reveal teacher-student interaction in the mathematics learning process that affects students' mathematical understanding. This study used a qualitative method with a phenomenological approach. The research subjects were eighth-grade junior high school students. Research data were obtained through observation, interviews, and documentation. Observations were conducted in the eighth grade and interviews were conducted with six students from the class. The students were interviewed to express their opinions concerning learning process interactions. The results of this study showed that teacher-student interaction has affected students' mathematical understanding consists of: 1) The teacher transfers the material-the students attend to the material; 2) Question-answer amid teacher-students; 3) The teacher makes interesting learning strategies-students are actively involved in learning; 4) Teachers give awards-students receive awards.

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1. INTRODUCTION

Education is an effort conducted by humans to improve themselves. Improvements are conducted in the emotional intelligence field, intellectual intelligence, self-control, and religious spirituality. Quality education plays an important role in the nation's progress. An indicator of a developed country is shown by the progress of the education sector. Education changes into important along with the development of knowledge and technology, therefore education plays a big role in country progress. Consequently, the progress of education quality is a top priority for every country [1].

Mathematics is one of the important subjects in human life [2]-[4]. Mathematics is considered as one of the basic subjects given to students for all levels of education. Starting from elementary school and even kindergarten to college. The mathematics learning process starts from recognizing numbers to complex mathematics. Mathematics is a compulsory subject for students at every primary and secondary education level. Mathematics is also needed in a world that is changing with globalization. Mathematics plays an important role in technological advances at this time. The examples of mathematics used in technological advances consist of the technology development use in various fields such as artificial intelligence, computer science, medicine, control engineering, decision theory, expert systems, associations, management science, operations research, pattern recognition, and robotics [5]-[7].

The role of mathematics in life is extremely important, especially in technological advances in the globalization era. However, to adjust for this progress, the understanding, mastery, and skills of mathematics have not been followed, especially in Indonesia. There are still many obstacles in the effort to improve students' understanding, mastery, and math skills. These constraints cause mathematics quality to be relatively low. This is indicated by the results of learning mathematics and the mathematics ranking obtained through the international mathematics arena which is still quite low.

The mathematic quality of Indonesian students, when viewed from the Program results for International Students Assessment (PISA) in 2015, shows that Indonesia is in 62 positions out of 70 countries [8]. In addition, seen from the results of the Trends International Mathematics and Science Study (TIMSS) in 2015, Indonesia ranked 44 out of 49 countries [9]. This result is still very concerning, even Indonesia is lower than in other Southeast Asian countries.

The results of the PISA and TIMSS need attention. Suffering in mind that Indonesia's objective in participating in the event is to obtain information about the abilities of Indonesian students in the fields of mathematics and science [8], [10]. Considering knowing these results, it is hoped that it can motivate students and educators to improve their mathematics skills in the following years. The PISA and TIMSS results show that mathematics in Indonesia is still lagging behind other countries. Investigating deeper into the cognitive domain in TIMSS, namely knowing, applying and reasoning, the percentages are 35%, 40%, and 25% respectively [10].

To improve the ability to understand mathematics can be done through improving the learning process, one of which is the teacher innovating in learning [11], the teacher provides effective support and the learning process in the classroom that affects students' attitudes towards mathematics [12]. Learning innovation and support can be provided through positive interactions in the learning process. The results of the study said that students' social interactions influenced student achievement in mathematics [13], [14]. With interesting positive interactions, the students who were initially afraid of mathematics gradually became fond of mathematics. This needs to be done continuously in the learning process. To improve students' mathematical understanding skills in solving math problems.

Teacher-students interaction needs to be created in learning, especially in mathematics. Students need attention, stimulation, and guidance in learning mathematics. However, there are still many teachers who have not implemented positive teacher-student interactions. The results of interviews with several mathematics teachers said that the teacher had not interacted well with students. There are still teachers who only deliver material, give assignments then leave students and return to the office, then discuss questions, and give homework. According to students, mathematics teachers tend to be grumpy and angry when there are students who have not been able to work on the questions. This creates students afraid to ask questions and interact with the teacher. Apart from this, there are still many teachers who do not know how and what interactions teachers-students need to be carried out in learning to build a conducive learning atmosphere and a good understanding of mathematics. Many studies suggest that student interaction is the basis for a deep understanding of student achievement. However, many research results also show that the application of student social interaction is not good, the results of data analysis show that the interaction is still at a low level [7]. In practice, student interaction in the classroom proved difficult [15].

The teachers-students interaction is at the center of teaching in the classroom and is a major factor in teaching quality and improving student achievement [11]. The nature and quality of teacher-students interaction is the basis for understanding student engagement [16]. Good teacher-students interaction fosters a conducive learning atmosphere. A conducive classroom environment emphasizes cooperation and openness between teacher and students [17], [18]. Therefore, in learning, students must be allowed to interact with teachers, classmates, and their surroundings. Interaction with the environment during the learning process will stimulate all students' senses and encourage students to learn creatively and innovatively [16].

The learning process in class cannot be avoided by the interaction process in it. Interaction is part of the effort a person makes to understand something. Considering the importance of teacher-student interactions in mathematics learning, it is necessary to reveal the interactions that need to be built between teacher-students. The forms of teacher-students positive interaction need to be known and developed by the teacher to realize better learning. Thus, this study aims to reveal the form of teacher-student interaction that needs to be applied to build a conducive learning atmosphere and increase students' mathematical knowledge. This study observes the learning process in a school to see the interactions that occur between teacher-students. The results of the observations are constructed into forms of interaction that can serve as a guide for other teachers in implementing learning. The forms of interactions found can be included in the lesson plan made by the teacher as a guide for implementing learning in class. Consequently, the research question in this study is how the forms of teacher-students interaction in mathematics learning need to be developed to build a good learning environment that can help students build and improve mathematical understanding.

2. RESEARCH METHOD

This study aimed to reveal teacher-student interactions that construct students' mathematical understanding. This research was conducted by observing directly the process of learning mathematics in the classroom to see teacher-student interactions. Researchers appreciate and observe, select, and interpret teacher-student experiences in mathematics learning in the classroom. Observation aims to gain a deep understanding of teacher-student interactions in mathematics learning. This study used qualitative method with a phenomenological approach. Phenomenology is the science of describing what a person receives, feels, and knows in his direct awareness and experience. In addition to what arises from consciousness is called a phenomenon. Phenomenology reveals what becomes reality and an experience experienced by individuals, reveals, and understands. Researchers research by going directly to the class where mathematics learning occurs, describing and constructing existing realities. Phenomenology is used in this study so that researchers can reveal every meaning of student experience that is carried out with the teacher in mathematics learning.

2.1. Participant

The participant is selected using purposive sampling. Participant in this study is VIII B grade students with criteria as active classes and taught by teachers who had long experience in teaching. The teachers have teaching experience for more than 15 years. The interview was conducted by six students from the class. These students were chosen based on their ability to express opinions about teacher-student interactions in the mathematics learning process.

2.2. Data collection

Data is collected by conducted observations and interviews with participants and study documentation. The data obtained in this study were in the field notes form, semi-structured interviews, video recorders of teacher-student interactions in the learning process and students' mathematics learned outcomes. The main instrument in this research is the researcher herself, the researcher as the main instrument in extracting information from observations and interviews. Separately from the researchers, the instruments in this study were also in the form of interview sheets and observation sheets. Data collection used observation sheets and interview guides and the interview is used as a semi-structured interview.

2.3. Data analysis

The analysis of this study was used as a combination of phenomenologi data analysis from Moustakas [19]: 1) Consider each statement with respect to significance for description of the experience; 2) Record all relevant statements; 3) List each nonrepetitive, nonoverlapping statement; 4) Relate and cluster the invariant meaning units into themes; 5) Synthesize the invariant meaning units and themes into a description of the textures of the experience; 6) Reflect on your own textural description; 7) Construct a textural-structural description of the meanings and essences of your experience. To ensure the validity of research data in this study, several steps to test the validity of the data were carried out to obtain valid data. Accordingly, the validity of the data in this study consists of credibility or internal validity with the triangulation method. Data triangulation was done by collecting then combining, cross-checking the data that had been obtained through observation, interview, and documentation techniques. Transferability or external validity, and dependability or reliability, dependability is done by conducting an audit of the entire research process that has been carried out.

3. RESULTS AND DISCUSSION

The results and discussion in this study are presented in the form of a description. Results of teacher-students interaction in this study were obtained from observation, interviews, and documentation. Based on the data collection technique, the researcher will show the observations results, the interview results, and also documentation result of teacher-students interaction in the learning process. The data that the researcher presents is data that has been read carefully, has been reduced and the researcher has cross-checked the results of observations, interviews, and documentation. The interaction data that the researcher presents are the interactions that the teacher conducted to stimulate learning activities or student interactions in responding to the interactions provided by the teacher. These interactions take the form of actions taken by teachers or students.

3.1. Teachers transfer material-students attend to material

Teacher-student interaction consists of the teachers delivering material and students paying attention is one form of interaction that is needed in understanding mathematics. This give and take interaction is

important in learning activities. Teachers as material givers and students as material recipients collaborate to carry out good learning activities, with the result that learning objectives can be achieved maximally.

Mathematics teachers must be skilled in using appropriate learning strategies in delivering material in case the students are interested in learning. The task of the math teacher is to guide students to understand mathematics, carry out the mathematics learning process, and foster a sense of pleasure and love for mathematics. To achieve this, the teacher must have the knowledge, ability, and skills regarding mathematics, the characteristics, and the mathematics learning process [20], [21]. Good mastery of material skills, delivery skills, the ability to select learning strategies to create active learning for students. In presenting material, the teacher should also use examples in everyday life or known as realistic mathematics so that it is easily understood by students. Realistic Mathematics Education makes a significant contribution to the development of early childhood mathematics competence [22]. Because the mathematics stage for junior high school students is still at the concrete mathematics stage. With these abilities, students will be interested and want to pay attention to the material presented by the teacher. The students are interested in mathematics learning, students learn mathematics with pleasure and students understand the material presented by the teacher.

The delivery of material by the teacher is influenced by the mastery of the material and skills in selecting the right strategy. Both are related to each other, if mastery of the material is good but the strategy used is not right then the students will not be interested. If the strategy used is correct but the teacher does not master the material, students will not get the information they need. This is suitable for the statement which states that what the teacher does in learning activities affects student achievement [14], [23]. Consequently, everything that is done by the teacher will be an example for students. In case, the teacher must always consider the things that must be done so that students can understand mathematics well.

Teachers' mathematical knowledge made statistically significant changes in their lesson design, their mathematical agenda, and the classroom climate [24]. However, student involvement was significantly related to student grade acquisition. The statement said that teachers' mathematical knowledge had an important role in learning design and classroom climate. Teachers who master mathematics will create attractive learning designs and a harmonious classroom climate in learning. However, the value of students in mathematics is influenced by the involvement of students in it. This shows that the relationship between teachers and students affects student grades.

Interaction of caring for each other affects students' mathematical understanding. Pay attention to each other in this case, the teacher is concerned with the students in case they try to provide and convey the material well. Meanwhile, students' attention to teachers is in the form of students' seriousness in accepting and paying attention to the material presented by the teacher. Students will find it difficult to understand the material if they do not pay attention to the material presented by the teacher. Therefore, students will find it difficult to solve problems. Hence, the teacher-students interaction in the form of teachers delivering material and students paying attention to the teacher when delivering material or the interaction of caring for each other affects students' mathematical understanding.

3.2. Questions and answers amid teacher-students

Based on the results of the observations, it was found that one of the interactions in the research class was a question and answer session between teachers and students. In the research class, it appears that the teacher asks questions about the students' initial understanding. The question is a question about the previous material. The teacher also asked questions several times to focus on students' attention when presenting the material. In addition, the teacher also asks questions at the end of the lesson, questions in the form of questions that must be done by students. Questions in the form of questions are given to find out students' understanding of the material being discussed.

The teacher usually gives oral questions when the teacher is delivering the material. Occasionally the teacher asks oral questions, for example, *"What do you know about number theory? according to your language, what is meant by number theory? Try to mention examples of number theory in everyday life?"*. This kind of question is a form of the question that the teacher gives to get students' attention. Questions like this are used to lead students to focus more on the material being discussed. These questions are also asked to attract students to think critically and actively in learning. Questions have a beneficial effect on whether they are presented before or after the related learning material. Questions at the beginning of the lesson focus students' attention on concepts during learning, while questions after learning provide retrieval and feedback on the information that has been learned. Equally early learning questions and post-learning questions provide substantial profit from repetition [25].

In addition to oral questions, the teacher also provides questions in the form of practice questions. After the teacher explains the material, the teacher discusses sample questions before giving exercises to students. After discussing the sample questions, the teacher provides some questions for practice. This

question is given to find out the students' understanding of the sample questions that have just been discussed.

Asking has an important role in teaching mathematics [26]. Questions are a means by which teachers lead students to correct mathematical concepts and procedures through "negotiating meaning for the required learning conditions" [27]. Questions are one of the most powerful tools for constructing a learning environment and fostering successful performance [28]. The purpose of the questions the teacher gives is, the teacher tries to investigate whether the student listens to and then understands the lesson that has just been taught [29], [30] Additionally by using questions, the teacher assesses students' knowledge, determining the need for focused re-teaching, and encourage students to think at a higher cognitive level [31].

According to Vega, *et al.* [32], students' questions have two functions the first function is for students to ask themselves math questions so that they learn to think like mathematicians who often advance knowledge by asking new questions and trying to solve them. The second function is for students to ask their teacher learning questions during lessons when they do not understand certain parts of the lesson. Both teacher questions and student questions have a purpose and function in learning mathematics.

Consequently, it can be concluded that the question and answer interaction between the teacher and students affects students' mathematical understanding of number patterns in the form of solving the given questions by obtaining satisfactory results. Asking and answering questions makes students more familiar with the material being discussed. By asking and answering students get an understanding of the material being discussed. Students can also work on problems well when they get answers from their ignorance.

3.3. Teachers create learning strategies that are attractive-students are actively involved in learning

Another interaction that appears in the observation class that can improve students' understanding of the material being discussed is the learning strategies use. Learning strategies in the observation class is a learning game strategy. The teacher uses games to foster motivation and attract students' attention in case students focus and work on the questions they receive.

In the classroom observation, the teacher makes a game and students are actively involved in the game. The teacher composes a game involving all the students in the class. The teacher contributes several questions to be solved by the students. However, the teacher provides a time limit in working on the problem. Subsequently, the agreed time limit is finished, students are invited to leave their answers on the table. Students gather in front of the class and watch the teacher check their answers. The teacher closes the book if the students' answer is correct. The teacher leaves the book open, if the student's answer is still wrong. In this activity, the teacher and students are involved in an interesting interaction. Learning interactions that foster enthusiasm and motivation in students. Learning interactions that foster enthusiasm and motivation have an impact on student understanding. Students who learn with fun learning strategies, active learning situations are easier to accept the material presented.

In a study, it was found that in learning activities using certain types of games students experienced improvements in the three psychosocial features of the learning environment (teacher support, personal involvement, and relevance) as well as academic success and enjoyment in mathematics [33]. Through math games and activities with other students, students build an understanding of mathematical values and based on that they act by constructing and modifying their thinking [34]. Based on this opinion, it can be seen that the game strategy in learning has a good impact on students' understanding ability. Generally, the students considered mathematics is boring, mostly irrelevant, and useless [35]. Therefore, educators should strive to use resources and strategies that capture student interest and motivation [35]. Teachers are advised to use appropriate learning strategies to meet the needs of students in delivering material.

To strengthen the educational process, it is necessary to combine various strategies for active and cooperative learning [36]. In learning, you cannot only apply one learning strategy. There needs to be a mix of strategies to create active, attractive, and effective classes of pursuit. In the research class, the teacher applies several learning strategies including lectures, problem-solving, and games. The purpose of combining these strategies is to meet the needs of students in learning activities. To convey the material the teacher uses a lecture strategy, to increase student interest and motivation, the teacher uses game strategies to make students interested. Meanwhile, to observe students' ability to solve problems, the teacher uses problem-solving strategies. Research conducted by Claudiu and Langa [37] stated that overall, the majority of students felt that being in a collaborative environment helped improve their mathematics learning.

The strategies used in learning activities affect students' mathematical abilities. The choice of strategy is adjusted to the conditions in the learning classroom. It is important to define a strategy directed at a specific goal or target [38]. It is important to use strategies in learning mathematics. Many studies have stated that the learning strategies used in mathematics learning affect students' mathematical understanding, mathematical abilities, and mathematics achievement. Some of the benefits of using learning strategies and learning mathematics include learning using strategies that are effective in students' mathematics

achievement [39]. General, the majority of students feel that being in an environment of collaborative learning strategies helps improve their mathematics learning [40]. Learning strategies need to be used by students because they can encourage the application of their results in education [41].

3.4. Teacher gives awards-students receive awards

Interaction consists of giving and receiving rewards are part of the learning activities that appear in-classroom observation. The teacher gives rewards to students. Furthermore, the students receive the award. In the observation class, it is seen that the teacher applies an interesting learning strategy by making a game. The teacher gives the questions then the students work at a certain time. Students who answered correctly received awards in the form of congratulations and positive words such as "good, keep up the spirit and keep it up". Furthermore, the teacher also asks all students to clap their hands as a sign of appreciation for students who have answered correctly. As an appreciation also for students who are not correct because they are cooperative and want to accept the punishment given.

This activity is a teachers-students interaction in learning. The students answer correctly the teacher wants to give appreciation. This is a reciprocal interaction that occurs in learning activities that aim to create a harmonious and pleasant learning atmosphere. The students who receive the award feel happy and satisfied with their success in answering the questions given correctly. The students also asked the teacher to repeat the game. Researchers see students getting more motivated in participating in the next game. The students who previously answered wrong are full of enthusiasm and optimism will be able to do next. Meanwhile, the students who are enthusiastic and trying to keep succeeding in working on the next problem.

The teacher gives awards in the form of positive reinforcement, using words of praise to students who can work on the questions. The teacher provides words of comfort and encouragement to students who have not been able to work on the questions. The aim is to encourage them to be more motivated in learning. Students' motivation towards learning mathematics is largely influenced by reinforcement such as grading, certificates, and written comments on their work samples. There is a significant difference in student motivation towards learning mathematics at post-intervention which ultimately determines student achievement in learning [42].

In a study, it was shown that real rewards do have an impact on students' motivation in mathematics. Real rewards can be used to positively encourage students to achieve higher scores on tests and assignments. This award can also be used to get more involvement in-class activities. Real rewards can also be used as stepping stones to foster intrinsic motivation in a small percentage of students. Experiments conducted by Hurlock on the effectiveness of rewarding showed that students' mathematics improved the most when students were given praise, then when they were given reprimands, and at least increased when students were ignored. Rewards have been shown to enhance various forms of learning [42]. It is suggested that teachers prefer to use rewards as a motivational stimulator in the educational process [43]. Awarding has a significant effect on students' mathematics learning outcomes [43], [44]. Based on these theories, it is known that award-giving has a positive effect on learning mathematics, in fostering student motivation, on student learning outcomes. Therefore, giving awards can improve students' mathematical understanding

Based on the description above, it can be seen that several teacher-student interactions need to be developed in learning. These interactions are: 1) Teachers Transfer Material-Students Attend to Material. Teachers must master math material and be able to convey it well to students. Students must also receive and listen to all information from the teacher to build and improve mathematical understanding. 2) Questions and Answers amid Teacher-Students, question and answer between teachers and students are very necessary, there are so many benefits that students get through the interaction between questions and answers with the teacher. 3) Teachers Create Learning Strategies that are Attractive-Students are Actively Involved in Learning, learning strategies are important to increase student activity, therefore students need to actively participate in the strategies used in mathematics learning that have been planned by the teacher, 4). Teacher Gives Awards-Students Receive Awards, awards are a form of external motivation needed by students. Teachers are advised not to be stingy in giving awards to students who have successfully worked on math problems. This can be a motivation for students to be better in the future. These forms of interaction are no stranger to learning activities. However, generally, the application is still not maximal, only a few are applied and others are considered not very important. Not all teachers recognize that what is considered normal turns out to have an important role in learning. The same is the case with other forms of interaction. Through the explanations in this study about the benefits and importance of teacher-student interactions, it is hoped that the teacher will be more open-minded to study these interactions and apply them in mathematics learning.

The results of the study in the form of teacher-student interactions in learning have been described. These results have been supported by previous theories and research which state that these interactions are necessary and play a role in learning mathematics. With the results of this study, it is hoped that readers can use it, especially teachers of mathematics, to increase positive relationships with students that can help build

and improve students' understanding of mathematics. Teachers can also add learning media that can support learning activities such as computers, tablets, and other technologies According to research on computer use, tablets can also improve students' mathematical understanding [45], [46].

4. CONCLUSION

The results of this study are forms of teacher-student interaction in mathematics learning that can help students build and improve mathematical understanding. These results can be used by mathematics teachers in classroom learning to help to learn activities become better. The forms of interaction between teacher-students that need to be known based on the results of this study are: 1) The teacher transfers the material-students pay attention to the material; 2) Questions and answers in the middle of the teacher-students; 3) The teacher makes learning strategies that attract students to be actively involved in learning; 4) The teacher gives an award - the student receives an award.

The results of this study guide mathematics teachers in planning the implementation of learning in the classroom. In addition to implementing activities that are full of interactions between teachers and students, teachers can also add learning media that can support learning activities such as computers, tablets, and other technologies. For the next research, it is hoped that the researcher can describe more clearly each interaction and its impact on learning mathematics. Furthermore, researchers are expected to show the weaknesses and strengths of each of the existing interactions.

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