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To cite this article: B Tanujaya and J Mumu 2019 *J. Phys.: Conf. Ser.* **1321** 022101

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Learning from student thinking in a mathematics classroom

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Abstract. The study aims to investigate thinking of students during the mathematics instruction. Data were collected by conducting observations and interviews at 7 secondary schools in Manokwari, West Papua, Indonesia. Observations were held in the classroom and studied videos of instruction to identify what they think during the classroom activities. Data obtained then triangulated through intensive interviews with students, teachers, and pre-service mathematics teachers. The results showed that there are two groups of students, those who have positive and negative thinking. Students who think positively tend to be active, confident and have high motivation. But they tend to be dominant so that it can disrupt the instruction process. On the other hand, students who think contrary tend to be inactive. Students who are inactive are caused by low ability, lack of courage and poor perception of teachers. All groups of students need help from teachers through different teaching strategies.

1. Introduction

Data-driven decision making has become an important pillar of policies expected at school improvement and significant efforts to achieve unbiased results for students. Teachers are requested to use data to improve their teaching activities [1]. Teaching, as well as teaching mathematics, should be sequenced and carried out according to students' ability. Teaching without sequence or logical connection will confuse students seriously, and they will then learn nothing. Consequently, when implementing teaching and learning activities, teachers should emphasize foundation building and progression [2].

To obtain data, first of all, mathematics teacher must ask some questions of the students. By asking questions, the teacher will know the knowledge, attitudes, and skills of students. This is because learning of mathematics must start from what is known and what is not known by students [3]. Teachers request questions to facilitate students master what has been studied, to comprehensively explore the subject matter, to set up discussion, to inspire the recall of prior knowledge, to encourage comprehension, and to establish critical-thinking skills [4]. Good questioning should start with simple problems and then progressively increase the difficulty; until finally, the hardest of questions can be solved easily. This is one aspect of emphasizing a learner's foundation and progression [2].

In addition to asking the questions, the mathematics teacher should make observations to obtain data. Observations about student learning activities in the classroom are important data sources for designing further instruction [5]. Furthermore, the student should be able to request questions, comments, and other statements to declare their understanding [6]. Students must be able to express what they want and what they think. Therefore, the teacher will have accurate data about their students.



This suggests that teachers must consider students' foundations and extent of experience. Teaching is hardly effective if it does not fit students' reality or is beyond their capability. It is not wise, to begin with excessively difficult problems. If you do so, students may not be able to go further. If you have a sound study at the beginning, you can go far [2]. Learning must follow the sequence, and mathematics knowledge of student is accumulated step by step. It is impossible to get excellent results instantly.

In addition to knowing knowledge, attitudes, and skills, the teacher also needs to know what students think. What students think is data that is important for a math teacher to design effective and efficient learning. What students think is usually manifested in attitudes and behavior in learning.

Therefore, it is crucial for the teacher to know what students are thinking. What students think is not just about learning. There are other aspects that students think about during instruction. What is thought is sometimes not directly related to learning, but has an indirect relationship. Various conditions need to be well known by teachers, including mathematics teachers to design appropriate learning strategies.

2. Method

The study was completed for 2 (two) years, from 2016 until 2018. There are about 200 students from seven schools that consist of three senior high schools and four junior high schools those became the objects of research. The schools were the private and public school in Manokwari regency West Papua, Indonesia. Each school is at least an instruction on mathematics class which is the object of study.

The research method used in this study is a case study, using interview and observation technique to gather data. A case study is a type of research methodology that concentrations on a single unit of research subject, such as one individual, one group, one institution, or one project. The purpose of study is to arrive at a detailed description and understanding of the case. Case studies use some instruments to collect data and information, such as interviews, observation, and archives [7]. The case study research can include both single- and multiple-case studies [8]. In this study the method used was a single case study. Data collection instruments used are interviews, observations, and archives.

Students are the main research subject in conducting interviews. Interviews are also done with mathematics teachers and pre-service mathematics teacher who did field practice to support the results of the study. The discussions were implemented using interview guides, which consists of several questions. Questions for the students were about their activities during mathematics instruction in the classroom, what do they think before and when doing this, and why is this done? To the mathematics teacher was asked what he/her knew about his/her student activities in the classroom, solutions for the student activities, and suggestions are given to overcome these problems. To the pre-service mathematics teachers were asked about how the mathematics teacher taught in the classroom, response of the student activities, and some others profound question.

Observations was carried out to observe student activities during learning and use student learning activity videos. The observation was also carried out through analysis of the lesson plan of pre-service mathematics teacher approved by the teacher. Secondary data were obtained from various sources, such as student reports, textbooks (psychological and mathematics education books), and some data from the ministries of education and culture.

In order to guarantee the validity of the data obtained in the study, researchers conducted data triangulation. Triangulation according to Tanujaya and Mumu, is a data validity checking technique that utilizes something other than that data for the purpose of checking or comparing the data. Triangulation can be done in several aspects, namely: method, time, place, data source, researcher, and theory [5]. In this research, data obtained then triangulated through intensive interviews with student's classmate, some other teachers, and some other pre-service mathematics teachers.

3. Result and discussion

Student thinking activities are mathematics students' thinking which is carried out before, during, or after classroom learning activities. But in this study, the students' thinking activities observed were

student' thinking during the classroom activities. There are two groups of students regarding the thinking activities, positive thinking and negative thinking. Students who think positively who support learning activities, while students who think negatively, who are students who have the potential to inhibit the learning activities.

3.1. Negative thinking student

Negative thinking students consist of two groups, passive and active students in a mathematics classroom. The students are classified as both of groups have several reasons. The first group of students who belong to negative thinking student is those who while learning always thinking about time to leave a classroom. They are the group of students who are not sufficiently concentrated during instruction. They are anxious when the teacher was running the instruction. They do not understand the lessons. They also don't want to try to understand the lesson. For them, mathematics is a difficult lesson and will never be understood. The main reason is they do not master the prerequisite lessons well.

On the other hand, the teacher concentrations on delivering of a lesson. The teacher organizes the teaching just to pursue the target curriculum. They pay attention to smart students only. If there are students who have understood the subject matter, then the teacher continues on the subject matter next.

Mathematics is a lesson that has any connections among subjects. Students who don't understand the previous lecture well will cause the student not to be able to follow the lesson correctly. This happens because the teacher doesn't know what students know and what students don't know. To understand students well, one way that can be done according to Tanujaya is teachers have to conduct a daily assessment. Daily assessment can be done using various assessments depending on the characteristics of students and components of learning subject [9].

Homework is a useful assessment that can be used by the teacher to find out what is known and unknown to students. Although some education experts state that homework is affecting students in negative ways because it is just adding stress to students. Students are doing it when they are tired. But homework that is given correctly and has a specific purpose is beneficial. Also, it should be emphasized that homework must be done by the students themselves without cheating from others. Moreover, Jackson stated that don't just do the homework, learn it [10].

Passive students in the classroom can be improved in their mathematical knowledge by providing additional lessons. They were assigned to read and work on the previous subject, including the pre requisite subject. Lesson study is one of the learning approaches that teachers can be implemented to overcome this problem too.

Lesson study initiating in Japan is rapidly becoming one of the most implemented model of teacher professional development worldwide [11], has been improved into several instruction design around the world [12], and its usefulness in encouraging student and teacher learning has been widely documented [13]. Lesson study is a teaching – learning approach for collaborative cycles in which teachers: analyze curriculum content and teaching materials; plan classroom instruction; and observe, discuss and reflect on the classroom instruction, using data collected during observation to draw out recommendations for teaching and learning [14].

In other cases, students who seem passive but are different from the previous passive students, they understand what is being explained. The students look passive, so as not to be called arrogant. They also sometimes do this because they are afraid of being scolded by the teacher if they are too active. They sometimes have experienced traumatic cases, scolded by teachers or have friends who have been reprimanded by teachers in class.

They are also classified as students who think negatively because they are not too actively involved in classroom activities. They are intelligent students but always aloof. They sometimes are lost in thought and just take a minute to concentrate on the lesson. After understanding the lesson, their mind is no longer aimed at what is taught. The students should be used as peer tutors for their friends. Teachers should take the initiative to ask them to help other students.

On the other hand, some students look like an active person, but only imitative active. Students or groups of students, in this case, give the impression as an active student in classroom activities. They asked a lot, involved in discussions including answering teacher's questions. They do all that to make it look smart by the teacher and friends. However, the questions asked are sometimes absurd and have nothing to do with the lesson.

This group of students has high motivation, but the learning motivation is low. They think that they have got to perform correctly in front of their friends and teachers. They asked a lot to cover up some of their limitations, including not understanding the lesson well. For students in this group, teachers should support and courage their abilities in speaking. They need to be taught how to ask questions properly. Teachers should not disruption their spirits.

3.2. *Positive thinking student*

Students who have positive thinking are students who have good knowledge of the lessons and students who have passion to learn. Students who master the lesson can support the lesson, but on the contrary, they can interfere with the instruction if they are not managed appropriately. Students who have the passion for learning are students who are aware of their limitations and are primarily aimed at learning. They are students who are active in learning.

In the first group, they are students who have understood the lesson. They are students who are dominant in classroom activities. They asked many questions to the teacher in instruction. The questions tended to be only to test the teacher, not to know something they did not know. They are also dominant in the discussion. They do not want to hear the opinions of other friends and tend to underestimate what is said by friends and even the views of teachers.

They are classified as students who think positively because actually, they want lessons to take place effectively and efficiently. They do not like teachers repeating lessons that are already known. Their weakness is not being able to control themselves well.

In this group of students, teachers must well-prepared before instruction. Teachers should use the students in instruction, especially as peer tutors. If they have not activities, they tend to disrupt the instruction. Many disruptions they will do. In their thoughts, what the teacher teaches is too easy. They want to show their existence in class to other friends.

In this group of students, the teacher should give them different exercises compared to other students. Problems that require higher order thinking skills (HOTS) can be used as alternative learning strategies to increase the knowledge of these students. Three components as indicators in HOTS are critical thinking, creative thinking, and systems thinking [15, 16].

The second group is the students who have the ideal thought. They always think about how lessons can be running well. They understand every lesson. They usually help a slow-learning friend, also support the teacher by explaining the subject matter to a friend. Teachers can use any learning strategies for students belonging to this group. They can be used as peer tutors if they are in a heterogeneous class.

The peer tutoring method is someone or several students who are appointed by the teacher as a teacher's help in conducting guidance to classmates. This method is a student learning activity by utilizing classmates who have more ability to help their friends in carrying out an action or understanding a concept [17]. Tutoring has been found to be a useful tool for academically underprepared and high-risk students. The improved passing rate in the remedial courses and increased the mean scores for the first-time takers [18].

The last group is a group of students who have not mastered the lessons well, but they want to learn. They always ask a lot of things. Unlike the previous group, what they propose is what they don't know. For students in this category, the teacher must be patient because their questions seem repetitive. They are slow to learn, but they are students who want to learn.

In contrast to students who have mastered the lessons, students in this group generally have sincere questions, though sometimes seem inconsequential. They are not able to make questions properly. Teachers should pay particular attention to them.

4. Conclusion

Based on the studied can be concluded that there are two groups of students, those who have positive and negative thinking. Students who think positively tend to be active, confident and have high motivation. But they tend to be dominant so that it can disrupt the instruction process. On the other hand, students who think contrary tend to be inactive. Students who are inactive are caused by low ability, lack of courage and poor perception of teachers. All groups of the students need help from teachers through different teaching strategies.

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