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Detection of College Students' Anxiety in Carrying Out Mathematical Argumentation about Geometry Problems

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***Abstract*. Students often feel anxious when dealing with mathematical problems, especially the problem of proving. This study aims to detect student anxiety when doing mathematical arguments about geometry problems. They construct arguments about proving congruence of triangles, which showed a series of reason structures with definitions, axioms, characteristics, and theorems. Three students who programmed geometry courses participated in task-based interviews focusing on determining object characteristics of geometry problems. The Toulmin argumentation model was used to analyze their mathematical arguments in solving problems. Four components related to the structure of argumentation have been identified, such as the availability of data, delivered warrants with the use of media, declared claims, and Backing with clarification. Besides, the questionnaire was also applied to identify their anxiety when arguing mathematics. They already looked highly anxious when they began to see silently, turned to friends, tried to remember by looking up, sweating, stress, and worried.**

***Keywords: anxiety, argumentation, solving problems, proving steps, task-based interviews*.**

INTRODUCTION

The elementary, high school and college students experience mathematical learning anxiety. Fear of teachers or lecturers, dislike of mathematics, lack of understanding, or forgetting previous concepts may be the cause of this anxiety. In Geometry courses, students feel anxious when facing assignments and answering non-routine questions. The emergence of mathematical strain can influence the development and learning achievement of explicit material that is related and will be studied [1].

Furthermore, behavior and learning achievement in mathematics also affect their motivation. Based on previous studies, students who experience low or high difficulties also show mathematical anxiety. If their level of accurate stress is not too high, the ability to understand the concept is easy to be done[2]–[4].

Students have learning experiences that are different from one another, even though they learn the same courses and performs the same learning activities. The pace of learning can also cause different learning experiences. Quick thinking students are able to think fast because they remember initial information or knowledge so that in receiving new information or knowledge, they will be more adaptable in the scheme. On the other hand, the less fortunate and slow thinking students forget the fundamental understanding or previous concepts, so it is difficult to adjust to new information. Adaptation in the form of a process of assimilation and accommodation in their cognitive is related to the level of intellectual ability and level of maturity of thinking. According to Piaget's theory, in the formal operational period which is the highest level of mental knowledge [5] - [7], but in learning, they also naturally show anxiety by feeling tense, trembling, sweating, disturbed concentration, and others. There are also those who do not appear to be anxious, even enthusiastic about the learning experience, along with assignments, discussions, and experiments that must be carried out an evaluation.

Geometry is one of the subjects studied by students. The students often find it difficult because they need to construct steps of proof according to definitions, axioms, theorems, and traits. Sometimes students are still confused and have difficulty in choosing proof steps when the object image is not based on what they have learned before. Usually, they learn objects that already exist in the textbooks or handouts given during the lecture. Anxiety begins to arise when learning begins when working on tasks, and fear disappears at the end of education. This anxiety may occur because they find it difficult to connect between definitions, axioms, and theorems as reasons for compiling the steps in proving. In learning using multimedia, it is showing that it can overcome anxiety and difficulties in learning mathematics. Learning that displays the visualization of objects with narratives and audio additions can overcome their fear of mathematical material that is felt very difficult [8] - [10].

Learning geometry is not complicated; all that is needed is how to arrange a series of definitions, axioms, theorems, and traits such as those learned in other mathematical material. In this study, the geometry problem that is often experienced by students is about triangular congruence. According to some students who

have learned about congruence, there are easy things and challenging things in compiling evidence about whether two triangles can be said to be congruent or not. The easy thing is when we still remember the definition and nature of flatness, congruence theorems, and alignment theorems. Then we can arrange the steps of proof by using that information, so it is organized coherently and transparently. The tricky thing that we found is when we forget them, we must use which definition or theorem to compile the evidence. These things can also trigger students to feel anxious when starting the next learning, although they do the tasks together. Besides, they also feel worried and ultimately are not actively involved in classroom activities.

Although proof is a challenge for students, mathematical arguments also have an essential role in stimulating critical and creative thinking. The scientific evidence used in this study was the Toulmin model consisting of six parts [11] - [13]. The first part is Data, which is a known fact and used to prove. The second one is a Claim, which is a statement that is argued or determined. The third is a warrant, general statement or hypothesis that logically bridge between Claim and Data. Fourth is qualifiers, the statement that limits an argument proposing the conditions under which the case is correct. Fifth, Rebuttal, the counter-argument is showing the state when general discussions do not apply. Finally, Backing, a statement supporting Warrant. All these parts can be done or only some of them so the composition of the student's mathematical arguments can be known. Furthermore, students can also arrange part by part according to their reasoning, as presented in the following diagram.

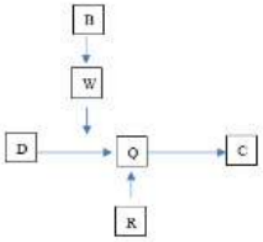

Figure 1. Diagram of Toulmin's Model

The purpose of this study is to detect the anxiety of students when doing mathematical arguments about Geometry problems in triangular congruence material. Knowing students' anxiety will make it easier for lecturers to design active and enjoyable Geometry learning. Students are guided to compile mathematics arguments to fulfill six parts of the Toulmin model so that the concept is easier to understand and can describe similar problems.

METHOD

The researchers wanted to detect the anxiety of students when constructing mathematical arguments. The aim was to some issues while having mathematical arguments using triangular congruence. Therefore, researchers applied a type of qualitative exploration research [14]. The research subjects were the third-semester student of the Mathematics Education Program at Wijaya Kusuma University Surabaya, 2018/2019 academic year. The main instrument in this study was the researchers themselves. Additionally, there were supporting instruments in the form of task-based interviews and questionnaires.

Assignments had been given to students requiring them to prove triangle congruency. During the task, the subjects were interviewed about the mathematics argument process according to the Toulmin model with six parts, namely 1) data; 2) claim; 3) warrants; 4) qualifier; 5) rebuttal, and 6) blocking.

Known: $PR = QS, PS = QR$. Evidence: $m\angle PRQ = m\angle QSP$.

Figure 2: Instrument for Research

Also, a questionnaire was conducted to identify subjects' anxiety when working on the task from the beginning to the end. The questionnaire consisted of reaction components, based on Barlow (Tisngati&Meifinai, 2014), namely: 1) subjective emotional components; 2) cognitive components; 3) psychological reactions; and 4) behavioral responses. The following are indicators of mathematics anxiety.

Table1.Indicators of mathematics anxiety

No	Aspect	Indicator
1	Objective emotional component	Fear of something that will happen Feel the tension in something that will happen Fear/worry when having a task
2	Cognitive parts	Think negative about yourself Forget what you have learned Unsatisfactory learning outcomes
3	Psychological reactions	Heart pounding or trembling Stress to certain conditions Heartburn or frequent urination
4	Responses in the form of behavior	Avoid certain situations Want to get out of class Easily disturbed concentration

Furthermore, mathematics anxiety levels carried out by the subjects are categorized based on several levels. The following are categories of mathematics anxiety levels.

Table2.Mathematics anxiety levels

No	Fulfillment of Aspects	Math Anxiety Level
1	All aspects	Very high
2	Three aspects	High
3	Two aspects	Medium
4	One aspect	Low

RESULT

Based on the results of the task-based interviews with three students, all three showed different mathematical arguments. The following are the results of the arguments of the three students based on the Toulmin model.

Table 3. Result of Mathematical Argumentation

Parts	AA	MJ	LS
Data	There are two pairs of the same side, PS = QR and PR = QS	There are two pairs of the same side, PS = QR and PR = QS	There are two pairs of the same side namely PS = QR and PR = QS
Claim	2. The angle of PRQ is equal to the corner of QSP (due to triangle congruence)	The angle of PRQ is equal to the angle of QSP	2. The angle of PRQ is equal to the angle of QSP
Warrant	- Build PQRS is a rectangle (definition of a square) - Large angles on rectangles are all equal in size (definition of a rectangle) - PRQ triangle is congruent with triangle QSP (S-Sd-S theorem)	The length of the PQ side in the PRQ triangle is equal to the side length of PQ in the triangle QSP (reflective properties)	3.- Build PQRS is a rectangle (definition of a rectangle) - Large angles on rectangles are all equal (calculation of angles with arcs) - Corners divided by diagonals show four kinds of edges that are equal in size (calculation of angles with arches)
Qualifiers		- The magnitude of the angle P is equal to the magnitude of the angle Q (right angle)	
Rebuttal		- PRQ triangle is congruent with triangle QSP (S-Sd-S theorem)	
Backing	- Rectangular characteristics have two pairs of parallel sides, and all four angles are equal, right angles - The S-Sd-S theorem is the flap angle theorem flanked by two adjacent sides that are congruent between two triangles.	The magnitude of the PRQ angle is not necessarily the same as the QSP angle	Rectangular characteristics have two pairs of parallel sides, and all four angles are equal, right angles

Of the three AA, MJ, and LS students, they showed differences in doing mathematical arguments. First, AA did four parts correctly and had systematic argumentation with the right reasons according to definitions and theorems. Second, MJ did six parts of the argument correctly using the properties and theorems. However, his works were accompanied by the use of arc media. Third, LS did four parts in argumentation correctly and used arc media more as the reason. She often applied media because they were helpful during the interview to help direct her in completing the task.

Table 4. Result of College Students Anxiety

No	Parts	AA	MJ	LS
1	Objective emotional component		Fear/worry when getting a job	- Looks tense when there is a task - Fear/worry when getting a task
2	Cognitive component		Forgot what they have learned	- Forgot what they have learned - Unsatisfactory learning outcomes
3	Psychological reaction	Hands shaking slightly	- Hands trembling - Looks sweaty	- Heart palpitations, trembling - Looks stressful
4	Response in the form of behavior		The concentration is easily disturbed	- Looks looking up while thinking - Tends to be quiet and turn to his friends
Conclusion of Anxiety Levels		Low	High	High

MJ and LS students showed a high level of anxiety. It could be seen from several signs, including emotional, cognitive, psychological, and behavioral. Whereas AA had low stress indicated by slight trembling hands, the student can argue mathematics well. In general, they stated that the problem of proof made them somewhat worried that they were wrong in arranging their steps systematically. The students found it challenging to determine the reasons to determine definitions, axioms, or theorems because they sometimes forgot.

CONCLUSION

Based on the results of the study, it can be concluded that the anxiety in carrying out mathematical arguments about proving geometry problems, especially triangular congruence material, is at a high level. This anxiety is indicated by feeling tense, afraid/worried, looking stressed, turning to friends, tend to be quiet, and sweat. Whereas in the case of mathematical arguments, most students do four parts such as conveying data, submitting claims, mentioning warrants using media, and can explain Backing with a good clarification.

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