
STUDENT EVALUATION MATHEMATICAL EXPLANATION IN DIFFERENTIAL CALCULUS CLASS

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ABSTRACT

This study aimed to determine that the failure of students to evaluate mathematical explanations based on mathematics is influenced by sociomathematical norms, teaching authority, and classroom mathematics practice. The research method used is the case study method. The research data were obtained from inside and outside the research class. The data in the research class were in the form of field notes, video recordings of the class, video recordings of student group work, and student work. Data outside the research class is the result of interviews with three interview subjects. By studying the three evaluation methods students used in evaluating explanations, it was found that each student applied a different evaluation method at different times. The three evaluation methods contributed to some of the difficulties students experience in evaluating their mathematical descriptions. The results indicate that the failure of students in evaluating explanations is not solely due to errors in choosing the method, approach, or learning model used but can be caused by sociomathematical norms, authority, and classroom mathematics practices applied in the classroom.

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INTRODUCTION

One of the essential parts of reforming mathematics education in the mathematics education study program is to teach students to reason and communicate well mathematically. It is intended that these students become mathematics educators who can serve their students in carrying out mathematics learning activities properly and can assess or measure the level of learning success of these students with specified procedures (Sagala, 2005). Mathematical reasoning and communication can be developed by mathematics learning activities that do not emphasize the teaching system of referring to procedures and teacher-centered and viewing the performance of correct procedures as evidence of the effectiveness of mathematics learning (Fatimah, 2020). Mathematics learning not only aims to make someone master the procedure but also develop various mathematical abilities applicable in everyday life. Mathematical reasoning and communication skills are part of the five standards that describe mathematical competencies described in the Principles and Standards for School Mathematics in 2000. The five standards referred to are problem-solving, reasoning and proof, communication, connection, and representation (NCTM, 2000). According to Qohar & Sumarmo (2013), mathematical communication is a way for students to express and interpret mathematical ideas verbally or in writing, either in the form of pictures, tables, diagrams, formulas, or demonstrations. According to Basir (2015), mathematical reasoning can be used as a foundation in understanding and doing mathematics as well as an integral part of problem-solving. Reasoning is different from thinking; mathematical reasoning is the most crucial part of thinking that involves forming generalizations and describing valid conclusions about ideas and how they are related (Turmudi, 2008).

Differential calculus is one of the subjects studied by the students of the mathematics education study program. This course is a course that can be a suitable means for students to develop mathematical abilities. Matter in differential calculus involves the derivative of a function. In the differentiation process, the activities involve analyzing the rate of change in quantity and making predictions about its behavior. To be able to analyze correctly, students need adequate mathematical skills. Mathematics reasoning skills and mathematical communication are two mathematical abilities that are indispensable in understanding the material of differential calculus. With mathematical reasoning, students can formulate proof and check the truth of an argument against a mathematical problem being solved and draw

conclusions properly and correctly (Rizqi & Surya, 2017). Besides, mathematical communication skills provide opportunities for students to express rational reasons for a statement, model mathematical problems into mathematical models, and illustrate mathematical ideas into a relevant description (Masykur, Syazali & Utami, 2018).

There are many ways to help and encourage students to communicate and reason mathematically. One way is to give students the opportunity and responsibility to evaluate mathematical explanations based on mathematics itself (for example, whether the explanation is valid or makes sense based on mathematics?). Students must be able to question their explanations as well as the explanations of others based on mathematics. Unfortunately, students rarely evaluate mathematical explanations but often turn to knowledgeable lecturers or classmates to solve a problem. Students rarely explain a problem solution. This also happened to the first semester students of the Mathematics Education Study Program of UNIKA, Santu Paulus Ruteng. In differential calculus courses, many students have not been able to evaluate the mathematical explanations they make. Many students are still hesitant to explain their work and also question their classmates' explanations.

There are several reasons why students in the early semester were unable to evaluate mathematical explanations: the mathematics teaching and learning activities in secondary schools are teacher-centered, in which the teacher still holds the authority as the sole evaluator in learning activities; students reject the role of evaluating mathematics on their own because they do not like it; students refrain from evaluating because they cannot evaluate the explanation. Even this is still a habit for these students when they become students in their early semesters.

Evaluating mathematical explanations in differential calculus courses can be a very complex activity, given the complexity of the components that make up the explanation. To evaluate mathematical explanations, we must understand the author's mathematical thinking and determine whether the mathematics presented in the explanation is convincing or justified. Therefore, it takes more than developing an understanding of the material differential calculus, but also being fluent in providing explanations following the norms prevailing in the class, the authority, and the practice of the mathematics classroom. The norms in question are the sociomathematical norms that apply in the class. Sociomathematical norms are normative behavior of students in mathematics class, which is a way to participate in all mathematics

activities in the class community (Kadir, Jafar, Jazuli, & Ikman, 2018). Sociomatematic norms are social norms related to the nuances of mathematics because sociomathematical norms specialize in learning mathematics rather than other learning. If students talk mathematics, they must be learning about mathematics (Piccolo, Harbaugh & Carter, 2008). Sociomatematic norms are linked explicitly to mathematical argumentation, which is how students carry out interaction and negotiation to understand mathematical concepts such as understanding what kind of arguments can be accepted mathematically (Sulfikawati, Suharto, & Kurniati, 2016). The authority referred to in this study is the authority of teachers/lecturers in dominating all learning processes, causing low student activity, which results in low student/student ability to evaluate mathematical explanations based on mathematics, which leads to low mathematics learning outcomes (Sumaryati et al., 2013)). Classroom mathematics practice is a learning practice applied in mathematics classrooms that includes all mathematics learning processes from beginning to end of learning (Pramudya et al. 2020).

This study aimed to better understand how authority, classroom mathematics practice, and sociomathematical norms can prevent students from evaluating mathematical explanations based on mathematics.

METHOD

This research is limited to the student's evaluation of mathematical explanations in the differential calculus class, so the researcher uses the case study method. This method was chosen so that researchers get several things that contain the various difficulties of students in evaluating the mathematical explanations contained in the differential calculus class.

According to Polit & Beck (2004), case study research is a form of qualitative research based on human understanding and behavior based on human opinion, and subjects in research can be individuals, groups, agencies, or communities. The research steps used were adapted from the steps proposed by Rahardjo (2017). First, selecting themes, topics and cases, in this step the researchers selected cases in the field of interest and from the results of observations in the differential calculus class. Second, reading the literature, in this stage the researchers read all sources of information related to the predetermined research topic. Third, the formulation of the focus and research problems, this stage aimed to make the researchers concentrate on one point: the center of attention. Fourth, data collection was carried out in the research classroom consisting of 21 students. The data consisted of field notes, video

recordings taken in class, video recordings of student group work, student work, and data outside the classroom, namely data from interviews from three students who were taken after the researcher classified the 21 students in the class into three small groups based on their level of confidence and ability in their performance in the classroom and in mathematics as a whole. Fifth, data improvement; in this stage, the researchers read the entire data by referring to the formulation of the problem posed. The data were considered perfect if the problem statement was believed to be answered with the available data. Sixth, data processing; in this stage, the researchers checked the correctness of the data, compiled the data, carried out coding, classified data, and corrected unclear interview answers. Seventh, data analysis, the researchers read the entire transcript to obtain general information from each transcript. The general information was compiled to take specific information; from this specific information, general patterns are known. The data was then grouped based on the sequence of events, categories, and typology.

RESULT AND DISCUSSION

In this section, the interviews of the three research subjects are explained. The form of the evaluation method used by the three students are also described.

Subject 1

Background. Subject 1 is a student who has a positive view of mathematics. When asked about his experiences in learning mathematics, he said:

"I liked math from an early age because my parents always helped me learn math (arithmetic) from an early age."

Because of his fondness for mathematics, his motivation to learn mathematics is very high. At the beginning of the lecture, Subject 1 admitted that he had difficulty keeping up with the rhythm of the lecture. This is due to the unfamiliar learning situation and the different teaching methods of the lecturers from those experienced in high school. Initially, he did not like how lecturers taught that they did not directly provide material and explained the correct way to solve some problems. He said:

"If the lecturer does not directly explain the material and how to solve the questions, it will take much time, and we will not understand the material."

However, at the end of the calculus lecture, Subject 1 admitted that learning from experience was more meaningful than just providing material and memorizing it.

Evaluation Method. The evaluation method used by subject 1 has three distinctive features. *First*, he used his lecturer to evaluate his explanation by listening to the explanation, using the feedback given by the lecturer in commenting on his work, and then explaining it in classroom mathematics practice when the lecturer approved it. Evidence of this subject using lecturers' expressions to evaluate their explanations can be found through interviews where he said:

"I hold the principle that whatever my lecturer says is absolute truth. When the lecturer asked me the truth of my work over and over again, I would think that my job was wrong, even though this is not necessarily the case".

Second, he used classroom mathematics practice to evaluate his work and explanation by showing his work in a mathematics classroom in front of all class members. The proof of this subject using classroom mathematics practice in evaluating the correctness of its explanation is identified in the interview where he said:

"... I will ask questions and see the expressions of my friends and lecturers in understanding my explanation. When their expressions are good/happy, then I am sure my work is correct, but when they show confused expressions, I will worry that my work is wrong, and I start to see every concept I use....".

Third, Subject 1 also used the authority given by his lecturer in evaluating his explanation. When the lecturer allowed him to present his work in front of the class members, he believed that the explanation was correct; this can be known through the results of an interview where he said:

"I believe my job is right when the lecturer gives the opportunity to account for the results in front of all class members."

Based on several evaluation methods used by Subject 1 above, it can be said that Subject 1 can evaluate his explanation/work when there is an expert/expert in the class, namely the lecturer himself. When there is no expert guiding, Subject 1 will have difficulty evaluating his work. This also shows that classroom mathematics practice is very influential for subject 1 in evaluating mathematical explanations.

Subject 2

Background. Subject 2 is one of the students who started to like mathematics when taking mathematics lessons in junior high school. When asked about his experiences and views on mathematics, he said:

"At first, I did not like mathematics because I did not understand the material being studied, and the teachers who taught mathematics tended to be tough and coercive in teaching math material, so I did not like mathematics. I liked mathematics when I entered junior high school in grade VIII because the teacher taught math material in a fun way".

Evaluation Method. In answering some of the questions in the interview, Subject 2 said:

"Initially, I preferred the lecturer to tell us the concepts used in solving problems and immediately give an assessment of my work. I do not like wordy things. Usually, I judge whether my work is right or wrong through comments from my lecturers and classmates, whom I think have good abilities. Sometimes even though my work is right, I do not feel confident when I see the expression from the lecturer, even though the lecturer is only testing my understanding. Even though my lecturer's expression showed a "negative" reaction (which I saw), he did not immediately blame my work but asked, "why do you use this concept, why not this one? Why should this be done?". At the beginning of the lecture, I really did not like this method, but at the end of the lecture, I realized the benefits of the method used by my lecturer. So I disagreed with my friend, who said that the method used by my lecturer was not suitable. Besides all that, I like to attend lectures because the class situation is very relaxed, not tense, and the lecturer considers us to be discussion partners. However, it is not uncommon for me to still be unable to evaluate my differential calculus work".

Furthermore, when asked further about how he evaluated his work, he said that he still used the expressions of lecturers, friends, and the answer key given to evaluate his work until now. Even though, he liked how the lecturers helped them evaluate their work, he still did not have the confidence to make a correct assessment of her work. From the results of this interview, it can be seen that Subject 2 used classroom mathematics practice and the authority used by the lecturer as a way to evaluate the truth of his explanation/work.

Subject 3

Background. Subject 3 is a student with a unique thought about choosing a mathematics education study program. When asked about his experiences and views on mathematics, he said:

"I did not like mathematics until now because I found it very difficult to understand

math material and how to teach teachers that were difficult to understand. However, I aspire to become a math teacher. My goal arose because I wanted to help students who have difficulties like me in learning mathematics. I also want to make them understand that mathematics will not be difficult to understand if we persistently study and study it repeatedly. Because these ideals make me always motivated to study mathematics even though I have to work hard "

Evaluation method. In evaluating his explanation, this subject used classroom mathematics practice, as indicated by the results of the interview, where this subject said:

"I usually evaluate my work by asking the teacher/lecturer, classmates, and the math books used. Even though my math skills are inadequate, I still try to solve the practice questions following the concepts explained by the lecturer. When the learning method used by the teacher is what I expected, it will really help me evaluate the explanation. Sometimes, I like the method used by the teacher/lecturer in lectures, but it all depends on the level of difficulty of the material we are studying. I do not like it when the lecturer says, "ok, today you are divided into several groups and discuss some things." This method will not make it easier for me to understand the material, especially since the level of material in the lecture process is higher. When I do not understand the material, it will be difficult for me to evaluate my work. I prefer the lecturers to explain the material to be studied rather than discuss the material ourselves and discover essential concepts ourselves "

Besides, this subject also used sociomathematical norms in its evaluation. This was indicated by the interview answer given by this subject, in which he said:

"Usually, to evaluate mathematical explanations, I first think about the reasons for each of these steps being used in solving a problem. The explanation must also be clear and valid. When the reason is invalid, the explanation is rather difficult to follow; then, I believe that the explanation is wrong. In addition, an explanation must be simple, and conclusions can be drawn. If not, then I would doubt the explanation given either by friends or by the lecturers"

Based on the interviews with the three subjects above, it can be concluded that the three subjects experience difficulties or make mistakes in evaluating mathematical explanations. Subject 1 experience difficulties when the lecturer does not evaluate his

explanation and does not express what he expected. In addition, this subject also make mistakes in evaluating when the lecturer does not give him the authority or opportunity to explain or present his work in front of class members. When the lecturer does not give the opportunity, this subject think that his work is incorrect, even though this is not always the case. Subject 2 experience difficulties in classroom mathematics practice when the lecturer and his friends do not comment on their work. Besides, this subject incorrectly evaluate his work when he misreads the expression of the lecturer when viewing or examining his work. Subject 3 have difficulty evaluating the explanation when the learning method used is not what he expected. In addition, when the explanation is complicated and difficult to understand, this subject immediately say the explanation is wrong. This is fateful because a complicated and not coherent explanation is not necessarily wrong.

CONCLUSION

Based on the data from interviews with three research subjects, it can be concluded that the application of authority, sociomathematical norms, and mathematics practice in the classroom has an impact on students' evaluation abilities and can contribute to the failure of students to evaluate mathematical explanations based on mathematics. If the teacher applies sociomathematical norms that contain excessive authority or teacher-centered learning in classroom mathematics practice, it will negatively impact the students. The negative impact can be in the form of low evaluation ability of students or in assessing or evaluating their math work. Another impact can be in the form of student difficulties in solving mathematics problems.

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