Analysis of Student Mathematical Resilience in Pure Mathematics-Based Courses

Arta Ekayanti[1*,] Uki Suhendar[2], Erika Eka Santi[3]
Universitas Muhammadiyah Ponorogo
Corresponding Author: Arta Ekayanti arta_ekayanti@umpo.ac.id

A R T I C L E I N F O

A B S T R A C T

Mathematical resilience is a person's ability to handle difficulties in solving problems related to mathematical concepts. The purpose of this study is to analyze students' mathematical resilience in pure mathematics-based courses. This research is a quantitative qualitative research, with students of the Mathematics Education Study Program at Muhammadiyah University of Ponorogo who have and/or are taking pure mathematics-based courses in the odd semester of the 2022/2023 Academic Year as the research subject. Mathematical resilience's data was taken by using a questionnaire instrument. The results of the study show that classically the majority of students have moderate category of mathematical resilience. If viewed from each indicator, the results of the study show that in indicators 1, 2, 5 and 6 the majority of students have medium category resilience. While indicators 3, 4, 7 and 8, the majority of students are in the high category. In indicator 9, the number of students with high category mathematical resilience is the same as the number of students with moderate category of mathematical resilience

INTRODUCTION

Mathematics is a scientific discipline that underlies the development of other fields of science and is always used and utilized in everyday life (Azizah & Abadi, 2022). This is in line with the statement that mathematics is the basis for the development of other fields of science because mathematics has the power to be implemented in various aspects including technology (Suparni et al, 2021). Mathematics is the queen of sciences because mathematics grows and develops for mathematics itself and serves the development needs of other scientific disciplines (Marlina et al, 2021). Thus mathematics has an important role in the progress of various fields of science, technology and communication as is currently felt.

The importance of mathematics can also be seen from the position of mathematics in the curriculum in the world of education. The government has designated mathematics as a field of science studied from elementary school to university level. At the tertiary level, especially in the Mathematics Education study program, the study of mathematics focuses on two important parts, namely mathematics in terms of the scientific substance itself (pure mathematics) and mathematics from a pedagogical perspective, namely in terms of learning. However, mathematics is a field of science that is not easy to learn, various difficulties and obstacles in the learning process are often felt which affect students' enthusiasm for learning (Iman & Firmansyah, 2020). This is also felt by students at the college or student level, especially in pure mathematics. The difficulty in learning and mastering mathematics is very reasonable because mathematics is a field of science that requires students to think logically, systematically and reflectively, and requires diligent, thorough and serious effort.

To face the difficulties encountered in the learning process, resilience (flexibility) is needed (Hutauruk & Naibaho, 2020). This is in line with Maharani and Bernard (2018) who stated that difficulties in learning activities can be overcome with a serious, tenacious and confident attitude which is called resilience. Difficulties encountered by students can provide unpleasant experiences that cannot be avoided. Almost every individual experiences unpleasant experiences. This experience cannot be changed but its negative influence can be reduced or even eliminated. This is where the role of resilience lies, namely providing provisions for students to face difficult conditions that cannot be avoided.

Azizah and Abadi stated that resilience in mathematics learning is called mathematical resilience (Azizah & Abadi, 2022). Johnston-Wilder and Lee proposed mathematical resilience as an important concept that is acquired based on the mathematical experience of students who tend to be "angry" and have the potential to "fail" (Johnson-Wilder & Lee, 2010). According to Johnston-Wilder et al (2015) mathematical resilience can be developed in students who have had "bad" experiences with mathematics, by focusing strategically and explicitly in formal and informal educational environments (Johnston-Wilder et al, 2015). With mathematical experience, students build awareness and develop risk management and process management in mathematics learning. Mathematical

resilience is an important internal factor in mathematics learning apart from the ability to understand mathematics (Sugandi, 2017). Mathematical resilience is needed when students use mathematics, think and act mathematically, not just to achieve grades or pass certain subjects (Safitri et al, 2010).

Hutauruk (2019) explains the indicators that a student has mathematical resilience abilities. These indicators consist of several things, namely: (1) having the belief that mathematics is something valuable and worthy of being pursued and studied, (2) having the will and persistence in studying mathematics, despite experiencing difficulties, obstacles and challenges, (3) having confidence to yourself that you are able to learn and master mathematics, both based on an understanding of mathematics, the ability to create strategies, the help of tools and other people, and also the experience you have built and (4) have the nature of perseverance, never give up, and always give a positive response in learning mathematics. Of these four indicators, Hutauruk and Naibaho (2020) conducted further research to see the strongest factors in forming indicators that form mathematical resilience. The mathematical resilience-forming indicators obtained include:

(1) Have a willingness to learn and master mathematics.
(2) Realizing the importance of studying and mastering mathematics.
(3) Have confidence in being able to study and master mathematics.
(4) Be aware of the limitations you have in studying and mastering mathematics.
(5) Realizing the possibility of failure in efforts to learn and master mathematics.
(6) Realizing that mathematical knowledge is useful when studying science or topics other than mathematics.
(7) Able to overcome difficulties that arise in efforts to learn and master mathematics.
(8) Realizing that mathematical knowledge plays an important role in the future.
(9) Know the things needed to learn and master mathematics.

LITERATURE REVIEW

Much research has been conducted on mathematical resilience, including literature review research by Azizah and Abadi (2022) which shows the importance of mathematical resilience in mathematics learning. Resilience has an important role in learning activities. Several studies have shown the role of mathematical resilience in relation to several subjects, including mathematical statistics and basic mathematics. Different from previous research, this research will analyze students' mathematical resilience in pure mathematics courses in general, not from just one course. The existence of heterogeneous learning experiences is the basis for considering why this research was applied to students taking pure mathematics courses in general, not just one course. Furthermore, in this research, mathematical resilience-forming indicators will be used, the results of research by Hutauruk and Naibaho (2020).

METHODOLOGY

This research is a descriptive quantitative qualitative research to determine the mathematical resilience of students, in this case students, and to find out what students view regarding the strengths and weaknesses they have when participating in pure mathematics-based mathematics learning activities. The subjects of this research are students of the Mathematics Education Study Program at Muhammadiyah University of Ponorogo who have taken and/or are currently taking pure mathematics-based courses in the odd semester of the 2022/2023 Academic Year, with the object being studied, namely mathematical resilience. The instrument used in this research was a questionnaire. The questionnaire items used were adapted from indicators that form mathematical resilience in (Hutauruk & Naibaho, 2020) by taking points on variables that form mathematical resilience.

The data analysis technique in this research uses a qualitative and quantitative approach, each question is given a certain weight, according to the criteria (5 to 1 or 1 to 5). Then the total weight obtained is used to categorize students' mathematical resilience. The components needed to categorize mathematical resilience values in this research are:

1. Lowest value (Min)
2. Highest value (Max)
3. Ideal Mean, M= 0.5 (Max+Min)
4. Standard deviation, SD=1/6 (Max-Min)

After these values are obtained, the next step is to determine the categorization of students' mathematical resilience scores with the conditions as in table 1.

Table 1. Categorization Criteria

No	Interval	Category
1	X < M-1SD	low
2	M-1SD ≤ X < M+1SD	Currently
3	X ≥ 1SD	High

Identification of student mathematical resilience is reviewed classically and also per indicator by referring to the categorization criteria in Table 1.

RESULTS *AND* DISCUSSION

The data from this research were obtained from a questionnaire given to 59 respondents. Each student fills out a questionnaire according to their individual opinions and conditions. Based on the results of the respondent questionnaire that have been analyzed, data is obtained as in table 2:

Table 2. Classical Mathematical Resilience Data

No	Information	Score
1	Lowest Value (Min)	117
2	Highest Value (Max)	143
3	Mean Ideal (M)	130
4	Standard Deviation (SD)	4.33

In this way, the mathematical resilience categorization is obtained as in table 3.

Table 3. Mathematical Resilience Categorization Criteria (Classical)

No	Interval	Category
1	$X < 125.67$	Low
2	$125.67 \leq X < 134.33$	Currently
3	$X \geq 134.33$	High

Based on the criteria in table 3, the categorization based on mathematical resilience with reference to table 4 is as follows:

Table 4. Categorization of Students Based on Mathematical Resilience (Classical)

Category	Number of Students	Percentage (%)
High	16	27.12
Medium	26	44.07
Low	17	28.81

Based on the data in Table 4, it can be seen that the majority of students have moderate category mathematical resilience. The research results show that in solving pure mathematics-based problems, the majority of students have quite good motivation and still try to provide answers even though they are not the best or perfect answers. This is in line with research conducted by Ansori (2020) which shows that students with a medium level of resilience cannot provide good answers to the problems given, but students have quite good motivation. Furthermore, in order to obtain a more in-depth analysis of mathematical resilience, identification of students' mathematical resilience categories is not only carried out classically but also looked at and reviewed for each indicator. The data from the questionnaire results from the nine indicators of mathematical resilience in the research can be seen in Table 5.

Table 5. Mathematical Resilience Data in Terms of Nine Indicators

Category	Score each indicator								
	Ind. 1	Ind. 2	Ind. 3	Ind. 4	Ind. 5	Ind. 6	Ind. 7	Ind. 8	Ind. 9
Min	25	15	19	9	3	6	11	5	6
Maks	34	23	25	19	10	10	15	10	10
M	29.5	19	22	14	6.5	8	13	7.5	8
SD	1.50	1.33	1.00	1.67	1.17	0.67	0.67	0.83	0.67

It should be noted that the standard deviation value is a value used to determine the distribution of data in a sample and see how close the data is to the mean value. Based on the calculation results in Table 5, it can be seen that the standard deviation value in the data for each indicator of student mathematical resilience is lower than the average value. This shows that the mathematical resilience data for each indicator does not vary. Based on the data in Table 5, a categorization of student resilience was then created by referring to Table 1. The results of the categorization of student mathematical resilience can be seen in Table 6.

Table 6. Mathematical Resilience Data in Terms of Each Indicator

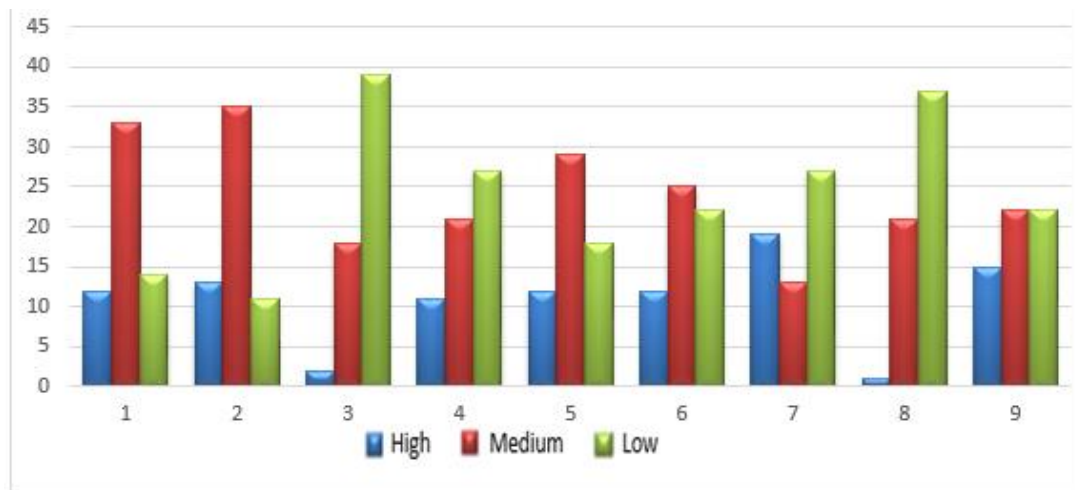| Category	Number of students for each indicator								
	Ind. 1	Ind. 2	Ind. 3	Ind. 4	Ind. 5	Ind. 6	Ind. 7	Ind. 8	Ind. 9
High	12	13	39	27	12	12	27	37	15
Medium	33	35	18	21	29	25	13	21	22
Low	14	11	2	11	18	22	19	1	22

Figure 1. Categorization of Students in Terms of Indicators of Mathematical Resilience

The data in Table 6 can be presented in graphical form as in Figure 1. In Table 6 and Figure 1 it can be seen that in indicator 1, indicator 2, indicator 5 and indicator 6 the majority of students have moderate category mathematical resilience. Meanwhile, in indicator 3, indicator 4, indicator 7 and indicator 8, the majority of students have high category mathematical resilience. As for indicator 9, students in the medium and high categories are in the same number.

The majority of students are in the medium category in indicator 1, namely having the desire to learn and master mathematics. In this case, the majority of students have a fairly good desire to learn and master mathematics. Based on the questionnaire that has been filled out by students, this condition can be seen from several student behaviors, including how students believe they are capable of developing knowledge about mathematics, students are able to bounce back from difficulties that make students discouraged. Also, students are able to look for other ways/strategies when they get stuck in solving mathematical problems. When students experience failure or get poor results on a mathematics test, students realize that studying harder is what is needed, and how students survive when they experience the confusion they feel when studying mathematics. In general, students can overcome/get through the above conditions well, but students still find it difficult to find other ways/strategies when they are stuck in solving mathematical problems.

As in indicator 1, the majority of students also have moderate category mathematical resilience in indicator 2, namely realizing the importance of studying and mastering mathematics. This condition shows that students believe that mathematics is useful for everyday life, mathematical thinking can help in several important ways. Students realize that mathematics can develop good thinking skills, which support success in various career fields. However, views regarding how mathematics influences opportunities and success in various aspects of life still need to be strengthened.

Unlike indicators 1 and 2, the majority of students are in the high category for indicator 3, namely having self-confidence in being able to study and master mathematics. Students are fully aware that everyone has made mistakes in studying mathematics. Students are also fully aware that not everyone has good abilities in mathematics, but they believe that in essence mathematics can be learned by anyone, and are optimistic that they will get better at mathematics if they keep trying. Apart from that, having assistance in learning mathematics is a normal thing, for example using paper (or other tools) to scribble in order to solve math problems is a normal thing.

For the fourth indicator, namely realizing the limitations they have in studying and mastering mathematics, the majority of students are in the high category for this indicator. This condition shows that students have a good view of the following things: how is the relationship between the ability to learn mathematics and mathematical talent, what is a person's authority to change a lack of intelligence in mathematics, how genetic factors influence mathematical ability and how a person's ability is related to test results? not according to expectations.

In indicator 5, the majority of students are in the medium category. Indicator 5 reads realizing the possibility of failure in efforts to learn and master mathematics. In this case, students need strengthening in terms of awareness of failures that may occur when studying mathematics.

Like indicator 5, the majority of students have mathematical resilience in the medium category for indicator 6, namely realizing that mathematical knowledge is useful when studying science or topics other than mathematics. In

this condition, students already have a fairly good view regarding mathematical knowledge in studying science on any topic, including more complex topics in other fields of study.

The majority of students are in the high category for indicator 7, namely being able to experience difficulties that arise in trying to learn and master mathematics. Students with this condition believe that difficulties in learning mathematics are normal. In fact, the difficulties that have been experienced are a means for a mathematician to be better at solving mathematical problems. Besides that, students have the spirit of trying hard when facing difficult mathematical problems.

Furthermore, the majority of students are also in the high category for indicator 8, namely realizing that mathematical knowledge plays an important role in the future. In this case, students are fully aware that mathematics plays an important role in their future and plays quite a big role in their efforts to achieve the goals they want to achieve.

As for indicator 9, namely knowing the things needed to learn and master mathematics, students in the high and medium categories have the same number in this category. In this condition, students have an open mind, that failure and mistakes in previous stages are necessary to be able to master mathematics. Besides that, difficulties and obstacles in solving mathematical problems can be resolved by discussion with other parties.

CONCLUSIONS AND RECOMMENDATIONS

Mathematical resilience is the ability to face difficulties in solving mathematical concept problems. The ability of mathematical resilience as one of the affective abilities for higher education levels is also in accordance with the KKNI curriculum in higher education. Mathematical resilience is an attitude shown by students in their learning process. Classically, the majority of students have mathematical resilience in the medium category. Meanwhile, if we look at each indicator of mathematical resilience, for indicators 1, 2, 5 and 6, the majority of students have moderate category resilience. Meanwhile for indicators 3, 4, 7 and 8, the majority of students are in the high category. In indicator 9, the number of students with mathematical resilience in the high category is the same as the number of students with mathematical resilience in the medium category

FURTHER STUDY

This research still has limitations, so it is necessary to carry out further research related to the topic of Analysis of Student Mathematical Resilience in Pure Mathematics-Based Courses in order to improve this research and add insight to readers.

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