Mathematical Resilience of Mathematics Education Students

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Abstract. Difficulties and obstacles in the process of learning mathematics can lead to unpleasant pressures and negative conditions. These negative pressures and conditions can be a bad experience for learners. Resilience is related to students' affective ability to deal with and be able to overcome obstacles and negative situations in the learning process, turning those negative situations into situations that support them. Resilient students are able to get better learning outcomes than they expect. This paper discusses the level of mathematics education students resilience based on four factors of mathematical resilience. Through this research, it was shown the correlated and the effect of indicators on student’s mathematical resilience, separately and simultaneously. Using Mathematical Resilience Scale obtained the result of the study which describes the resilience level of mathematics education students.

1. Introduction
There are various difficulties in the process of learning mathematics, especially in an effort to improve the mathematical ability to be achieved. The difficulties in studying and mastering mathematics are reasonable because mathematics is a lesson that requires students to think logically, systematically and reflectively, diligently, thorough and earnest effort [1][2]. Therefore, one aspect of learning that needs attention is the non-intellectual aspect [3], namely affective skills such as persistence, unyielding, inquisitive and confident, and understanding the role of mathematics in real life.

In the learning process, some students may have some unpleasant but inevitable experiences. Students have experienced failure and times of difficulties in the learning process. The experience is certainly irreversible, but its negative effects can be reduced or even eliminated by developing resilient learning abilities [4][5][6].

Resilience is the capacity of individuals to confront and respond positively to unpleasant conditions that are inevitable, and to take advantage of those unpleasant conditions into an opportunity for personal self-development [7][8]. There are seven domains that build resilience [5], namely (1) Emotion regulation, (2) impulse control, (3) Optimism, (4) Causal analysis, (5) Empathy, (6) Self-Efficacy, and (7) Reaching Out.

In the context of learning, resilience is a concept of the student's ability to deal with problems and learning barriers, which seem improbable and passed with good results [9]. Resilience is the affective ability of students to deal with, overcome, and become strong when faced some problems in the learning process. Resilience is not static, but may be increased or reduced. Resilience can be described as a "struggle" of a student in the face and overcome obstacles [10][23].
Resilience is an ability that allows students to deal with difficult situations, which may affect them negatively. Adverse situations that may arise when students are faced with the problem that made them give up in the learning process [11][21]. The situation may be related to problems that arise when the learning process occurs, or also relates to the environmental situation that negatively affects their learning effectiveness. Resilience allows students to find and use 'adaptive results' when dealing with the situation. This "adaptive results" gives defensive properties when faced with a negative situation, turning a negative situation into a situation that support them, even changing the students into resilient student against future problems that may arise [12][13].

In relation to mathematics, Jhonston-Wilder et.al. [14][22] suggests four correlated factors constructing the ability of mathematical resilience: (1) Value, the perception that mathematics is a subject that is valuable and worth studying. The more the students think math is valuable, the greater their motivation to learn and to cope with the difficulties that arise when studying it. (2) Struggle. A confession that struggle in math is universal even for people who have high-level math skills. A student, who becomes aware that struggling with math is a common thing to do, would have tolerance and durable in the face of obstacles. (3) Growth, a conviction that everyone can develop math skills and do not believe that some are born with or without the ability to learn mathematics. This factor refers to the belief that mathematical knowledge is not fixed and will always experience growth. Students will looking for a challenge and develop strategies to overcome barriers. (4) Resilience, is a orientation to produce a positive response when faced with a negative situation or difficulty in learning mathematics. According to Bandura, that social reality in general is fraught with difficulties, Finesse on knowledge and competence usually require a sustained effort in the face of difficulties and obstacles. Therefore, these factors combine two components, (1) the experience on some of the obstacles or barriers, and followed by (2) positive responses.

Thornton and Statton [15] identify five key-aspects of mathematical resilience: (1) having a growing mindset that is demonstrated through behaviors such as learning from mistakes; (2) having metacognition displayed through a willingness to reflect on answers and problem-solving processes; (3) have adaptability shown through a willingness to try new strategies or start over; (4) has an interpersonal aspect, can be shown from the effort to learn to ask intelligent questions because of the awareness of the lack of knowledge possessed; and (5) have a sense of purpose demonstrated by the desire of students to find the meaning of learning.

Johnston-Wilder and Lee [14][16] and Peatfield [17] characterize students who have mathematical resilience: (1) will survive when faced with difficulties, (2) be able to work with their peers, (3) have necessary language skills to express their understanding, and (4) realize that the more they work in math the more successful they will be.

From the various descriptions above, the authors describe four indicators of a student that have mathematical resilience is as follows:

1. Convinced that mathematics is valuable and necessary to learn and to be mastered
2. Have the will and perseverance in learning mathematics, despite the difficulties, obstacles and challenges.
3. Have confidence in themselves that they are able to learn and master mathematics, both based on an understanding of mathematics, the ability to create strategies, the aid of tools and others, and experience.
4. Has the nature of survival, never give up, and always give a positive response in learning mathematics.

2. Experimental Method
This research used a descriptive quantitative research design, where researchers measured the level of mathematical resilience of students at one of the universities in West Java, Indonesia. The student's mathematical resilience ability was measured by providing a few statements in one questionnaire, prepared on the basis of its indicators, where each statement had five scale options.
Each of the statements arranged clearly, simple, and unambiguous, so that the respondent can fill the scale with a clear and precise understanding. Statements was adopted from Mathematical Resilience Scale [12][18][19]. Each of these statements was translated by authors into Indonesian, and checked for accuracy of the translation by the linguist. Scores assigned to each grain scale using 1 to 4 scale. 1 represent the lowest resilient score, up to 4 represent highest resilient score.

The quantitative results obtained was then analyzed descriptively. Authors calculated the level of student’s mathematical resilience through mean and variance analysis, based on its indicators either simultaneously or separately. Then the authors saw the relevance of each indicator to the level of student’s mathematical resilience, by looked at the correlation between each indicators of mathematical resilience, also by looked at the correlation of all these indicators simultaneously to the student's mathematical resilience. Authors also saw the effect of each indicators on the level of student mathematical resilience, and the difference of effect between the influence of each indicators forming mathematical resilience.

3. Result and Discussion
The questionnaire of mathematical resilience was given to 36 respondents from two different classes. Each of respondent filled the scale by themselves on their own opinion. Table 1 shows the results data in measuring student’s mathematical resilience by its indicators.

| Indicators  | Mean  | Variance | Standard Deviation | Coef. of Variation |
|-------------|-------|----------|--------------------|-------------------|
| Indicator 1 | 3.136 | 0.570    | 0.755              | 4.154             |
| Indicator 2 | 3.118 | 0.712    | 0.847              | 3.680             |
| Indicator 3 | 2.965 | 0.856    | 0.925              | 3.205             |
| Indicator 4 | 2.934 | 0.640    | 0.800              | 3.667             |

Mean of indicator 1 had the highest value. At the 2nd place was indicator 2, followed by indicator 3 and indicator 4. It means that indicators of student’s mathematical resilience was dominated by indicator 1. Most of students convinced that mathematics is valuable and necessary to learn and be mastered. Then by indicator 2, its shows that students had will and perseverance in learning mathematics, despite the difficulties, obstacles and challenges. Mean of indicator 4 had the lowest value, means that less students have the nature of survival, never give up, and always give a positive response in learning mathematics.

Table 1 also shows that variance of indicator 3 had the highest value, means that student’s confidence that they are able to learn and master mathematics, both based on an understanding of mathematics, the ability to create strategies, the aid of tools and others, and experience, had the largest data distribution. Then from Coef. of variation column, shows that students had the most stable confidence in themselves that they are able to learn and master mathematics, both based on an understanding of mathematics, the ability to create strategies, the aid of tools and others, and experience. This indicator was the most stable than others indicators. Variance of indicator 1 had the lowest value, means that student’s convinced that mathematics is valuable and necessary to learn and to be mastered, had the smallest data distribution.
Table 2. Correlations of mathematical-resilience’s indicators

| Indicator 1 | Indicator 2 | Indicator 3 | Indicator 4 | Math Resilience |
|-------------|-------------|-------------|-------------|-----------------|
| Pearson Corr | 0.302 | 0.291 | 0.447* | 0.680* |
| Sig. (2-tailed) | 0.073 | 0.085 | 0.006 | 0.000 |

| Indicator 2 | Pearson Corr | 0.302 | 0.070 | 0.468* | 0.623* |
| Sig. (2-tailed) | 0.291 | 1 | 0.070 | 0.004 | 0.000 |

| Indicator 3 | Pearson Corr | 0.085 | 0.684 | 0.463* | 0.676* |
| Sig. (2-tailed) | 0.085 | 0.684 | 1 | 0.004 | 0.000 |

| Indicator 4 | Pearson Corr | 0.447* | 0.468* | 0.463* | 1 | 0.851* |
| Sig. (2-tailed) | 0.006 | 0.004 | 0.004 | 1 | 0.000 |

| Math Resilience | Pearson Corr | 0.680* | 0.623* | 0.676* | 0.851* | 1 |
| Sig. (2-tailed) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

* Correlation is significant at the 0.01 level (2-tailed)

Table 2 shows the correlation of each indicators of student’s mathematical resilience. This table shows some indicators had significant correlation and some did not. Based on Cohen’s correlation level [24], the correlation of each indicators shows at table 3.

Table 3. Level and Signification of Indicators Correlation

| Indicator 1 | Indicator 2 | Indicator 3 | Indicator 4 | Math Resilience |
|-------------|-------------|-------------|-------------|-----------------|
| Signification | Not Significant | Not Significant | Significant Moderate | Significant Strong |
| Level of Corr. | 1 | Not Significant | Significant Moderate | Significant Strong |

| Indicator 2 | Signification | Not Significant | Significant Moderate | Significant Strong |
| Level of Corr. | 1 | Not Significant | Significant Moderate | Significant Strong |

| Indicator 3 | Signification | Significant Moderate | Significant Strong |
| Level of Corr. | 1 | Significant Moderate | Significant Strong |

| Indicator 4 | Signification | Significant Strong |
| Level of Corr. | 1 | Significant Strong |

| Math Resilience | Signification | Significant Strong |
| Level of Corr. | 1 |

Table 3 shows that each of indicators had significant and strong correlations with student’s mathematical resilience. Students who had each of mathematical resilience indicators had significant and strong correlations with their mathematical resilience’s level. There wasn’t significant correlation between student’s convinced that mathematics is valuable and necessary to learn and to be mastered, with student’s will and perseverance in learning mathematics, despite the difficulties, obstacles and challenges. Also there wasn’t significant correlation between student’s convinced that mathematics is valuable and necessary to learn and to be mastered, with student’s confidence that they are able to learn and master mathematics, both based on an understanding of mathematics, the ability to create strategies, the aid of tools and others, and experience. Same as there wasn’t significant correlation between student’s will and perseverance in learning mathematics, despite the difficulties, obstacles and challenges, with student’s confidence that they are able to learn and master mathematics, both based on an understanding of mathematics, the ability to create strategies, the aid of tools and others, and experience. But there was significant correlation between student’s nature of survival, never give up, and always give a positive response in learning mathematics, with others student’s mathematics resilience’s indicators.
Table 4. Effect of Mathematical Resilience’s Indicators

| Student’s Math. Resilience | Indicator 1 | Indicator 2 | Indicator 3 | Indicator 4 |
|----------------------------|------------|------------|------------|------------|
| Sig.                       | 0.000      | 0.000      | 0.000      | 0.000      |
| $R^2$                      | 0.463      | 0.388      | 0.469      | 0.725      |

* Significant at the 0.05 level

Table 4 shows all sig. indicators’ > 0.05, it means that all indicators had significant effect on student’s mathematical resilience. It also shows the percentage of effect of each indicators on student’s mathematical resilience. It shows that indicator 4 had the greatest effect, means that 72.5% of student’s mathematical resilience level was influenced by student’s nature of survival, never give up, and always give a positive response in learning mathematics. Then 46.9% of student’s mathematical resilience level was influenced by student’s confidence that they are able to learn and master mathematics, both based on an understanding of mathematics, the ability to create strategies, the aid of tools and others, and experience; 46.3% of student’s mathematical resilience level was influenced by student’s convinced that mathematics is valuable and necessary to learn and to be mastered; and 38.8% of student’s mathematical resilience level was influenced by student’s will and perseverance in learning mathematics, despite the difficulties, obstacles and challenges.

Table 5. Sig. effect between each of indicators

| Indicators   | Indicator 1 | Indicator 2 | Indicator 3 | Indicator 4 |
|--------------|------------|------------|------------|------------|
| Indicator 1  | -          | 0.000      | 0.000      | 0.000      |
| Indicator 2  | 0.000      | -          | 0.018      | 0.004      |
| Indicator 3  | 0.000      | 0.018      | -          | 0.624      |
| Indicator 4  | 0.000      | 0.004      | 0.624      | -          |

* The mean difference is significant at the 0.05 level.

Table 5 shows that all sig. < 0.05, except for indicator 3 and indicator 4. It means that there were significant differences between each of indicators, except between indicator 3 and indicator 4. In other words, each of indicators had significant effect differences on student’s mathematical resilience, but for indicator 3 and indicator 4. Indicator 3 and indicator 4 had no significant effect differences on student’s mathematical resilience. In other ways, table 5 shows that indicator 1 and indicator 2 have significant effect in order to forming students mathematical resilience either separately or simultaneously if combined with indicator 3 and indicator 4. But, indicator 3 or indicator 4 had no significant effect in order to forming students mathematical resilience, either separately nor simultaneously because they had no significant difference effect on students mathematical resilience.

4. Conclusion
There were four indicators that form the student’s mathematical resilience. These four indicators had significant correlation in determining the ability of mathematical resilience, either separately or simultaneously. The four indicators also had significant effect on student’s mathematical resilience, where each indicators had significant effect differences, except for indicator 3 and indicator 4. So, students who had mathematical resilience have the four indicators of mathematical resilience. Otherwise, students who had these four indicators of mathematical resilience formers also qualified as a student who had good mathematical resilience skills.

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