

The characteristics of the mathematical mindset of junior high school students

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Abstract

The mathematical mindset of high school students is one of the important elements when learning mathematics. The mathematical mindset is an implicit theory of the flexibility and stability of human characteristics related to mathematical ability, intelligence, and talent. Through student responses obtained by filling out questionnaires, this study aims to investigate the characteristics of students' mathematical mindsets qualitatively. This study found that most of the junior high school students had the characteristics of a growth math mindset with a little bit of a fixed math mindset. Most students believe that mathematical abilities and intelligence can be changed, even though they find it difficult to face challenges and difficulties when learning mathematics.

Keywords: mathematical mindset, fixed mindset, growth mindset

INTRODUCTION

In recent years, research on self-theories in the field of education has grown very rapidly. One of the focuses of study in self theories that are of interest to researchers is the mindset. This theory was proposed by Dweck (1999, 2006, 2014) in which individual qualities such as intelligence and personality can develop through effort, perseverance, and persistence so that it can ultimately improve one's academic achievement. Therefore, a person's mindset can have an impact on their academic achievement.

Furthermore, Dweck (1999) states that the mindset is based on two basic assumptions of a person about intelligence. According to him, the condition of a person who believes that one's intelligence cannot be changed is called a fixed mindset, while the condition of a person who believes that intelligence can be increased with effort and perseverance is called a growth mindset. If it is associated with the achievement of academic success, the growth mindset positively influences academic success, while the fixed mindset tends to negatively predict academic achievement (Cury et al., 2006; Gouédard, 2021; Yuksel et al., 2021). However, several studies have shown a weak relationship between

mindset and academic achievement (Costa & Faria, 2018; Sisk et al., 2018). That is, a person can have a growth mindset in one area, but that person can also have a fixed mindset in other areas (Dweck et al., 1995). Thus, a person tends to have two types of mindset, namely a fixed mindset and a growth mindset, or what is called a mixed mindset (Glerum et al., 2019).

As with the concept of mindset in general, students' mindsets towards mathematics, or called mathematical mindsets (Boaler, 2018) are also based on two assumptions about mathematical intelligence. Daly et al. (2019) state that students who have a fixed mindset in mathematics believe that their mathematical abilities are innate and fixed (fixed mathematical mindset), while students who have a developing mindset in mathematics believe that their mathematical abilities can be developed with diligent practice and persistent. With regard to academic achievement in mathematics, several studies have shown that a growth mathematical mindset has a positive impact on student's success in achieving mathematics achievement (Bernardo, 2020; Bostwick et al., 2017, 2019; Claro et al., 2016; Kaya & Karokoc, 2022; Rahardi & Dartanto, 2021; Romero et al., 2014).

In 2018, PISA released the results of its research on the growth mindset of students in OECD countries. The

Contribution to the literature

- This study becomes the literature for mathematics education researchers that the role of the mathematical mindset in the process of learning mathematics is a very important factor.
- This study provides an overview of the four types of mathematical mindset of junior high school students, including a very strong fixed mindset (FF), a fixed-growth mindset (FG), a growth mindset with a little fixed mindset, growth-fixed mindset (GF), and a very strong growth mindset (GG).
- This study suggests that mathematics educators must pay attention to the students' mathematical mindset, including the mindset of the teacher so that it can encourage students to shift from a fixed mindset to a growth mindset in learning mathematics.

results of his study show that the majority of students in OECD countries have a growth mindset. This is evidenced by their responses ("disagree" or "strongly disagree") to the statement "your intelligence is something about which you cannot change much." On the other hand, at least 60% of students in Indonesia believe that their intelligence is something they cannot change on their own and it represents a fixed mindset (Avvisati et al., 2019). These results are also reinforced by the multilevel analysis study conducted by Kismiantini et al. (2021) on the release of the 2018 PISA results from Indonesian students, which stated that student gender, growth mindset, socioeconomic index, and cultural status were significant predictors of students' mathematics learning achievement. The results of the study also reported that female students had higher mathematics achievement than male students in Indonesia in terms of a student growth mindset. The more students' growth mindset increases, the students' mathematics achievement also increases. Thus, the results of this study indicate that the developing mathematical mindset of Indonesian students tends to be more developed in female students than male students, so it has an impact on the mathematics achievement of women, which is higher than that of male students.

Meanwhile, studies on mindsets related to gender (male and female) have been conducted by several researchers. For example, the study by Degol et al. (2018) shows that the growth mindset produces different effects on math achievement between male and female students so female students benefit more than male students in having a growth mindset. Furthermore, Sigmundsson et al. (2020) show that there are significant differences in mindset in terms of gender between male and female students. However, in another study, Macnamara and Rupani (2017) and Sigmundsson et al. (2021) show that there is no significant difference in the growth mindset of students in terms of gender differences. Therefore, in the context of learning mathematics, students' mathematical thinking patterns can be seen from differences in gender.

To see the characteristics of the student's mathematical mindset, both the fixed and the growth mathematical mindset can be based on several

dimensions. Dweck (2006) states that students' mindsets can be measured based on five dimensions, including the dimensions of challenges, obstacles/difficulties, effort, criticism/praise, and the success of others. Meanwhile, Chen et al. (2021) developed a growth mindset scale based on six dimensions, namely motivation, attitude, resilience, challenge, difficulty, and a positive mindset. In general, the two opinions are the same, but in this study to look at the characteristics of students' mathematical mindsets, it can be seen from the context of learning mathematics so that it can be formulated into six dimensions, including the dimensions of students' mathematical skills and intelligence, students' challenges in completing math assignments, students' difficulties in solving mathematics problems. learning mathematics, the importance of persistent effort in learning mathematics, the attitude to face criticism when learning mathematics, and the attitude to dealing with other people who have mathematical achievements.

In this study, the researcher will investigate the characteristics of the mathematical mindset of junior high school students. This study is very important both theoretically and practically. First, the results of the exploration are used to provide an overview of the characteristics of the mathematics mindset of junior high school students from the perspective of gender differences. Second, the characteristics of students' mathematical mindsets can be used as a basis for teachers to provide interventions in the practice of teaching mathematics in the classroom. The findings in this study can also encourage principals and education policymakers to develop students' mathematical mindsets through teachers in learning mathematics.

THEORETICAL FRAMEWORK

Mindset: Overview

Mindset is one of the focuses of the study of self-theories that is interesting and widely studied by researchers in the world. Dweck (2006) conducted a review of the results of nearly four decades of psychological research to describe the characteristics and impact of mindsets on success, academic achievement, and learning. Based on the study, he stated that mindset is an implicit theory about the flexibility and stability of

Table 1. Characteristics of habits with a fixed mindset and a growth mindset (Dweck, 2006)

| Category | Fixed mindset | Growth mindset |
|-------------------|---|--|
| Challenge | Avoid challenges so that their weaknesses are not exposed. | Selecting or assessing challenges to learn. |
| Obstacles | Give up in face of obstacles encountered & generally back down. | Remain afloat in face of obstacles encountered & generally do not back down. |
| Effort | The need to put in effort is seen as a negative. If one must try it is considered neither smart nor talented. | Working hard & exerting effort is path to results & success. |
| Criticism/praise | Assessing criticism as negative input even though it can build yourself better & praise as an acknowledgment of your talents. | Assessing criticism/praise as an encouragement to try/learn. |
| Success of others | Success of others is a threat & makes sad & angry. | Success of others as a source of inspiration & learning. |

human characteristics related to ability, intelligence, and talent.

Dweck (2007) categorizes a person's mindset into two categories, namely a growth mindset and a fixed mindset. The growth mindset is a person's belief that abilities, intelligence, and talents can be developed through effort, perseverance, and teaching. Someone who has a growth mindset considers that challenge is an opportunity to learn, trying to rise from failure, criticism/suggestion is a means to make improvements, and the success of others as a source of inspiration and motivation for success (Dweck, 2007). On the other hand, a person with a fixed mindset believes that abilities, intelligence, and talents are innate and largely unchangeable. Therefore, people with a fixed mindset tend to avoid making mistakes, do not like challenges, are anti-criticism, and think that other people's success is due to luck (Dweck, 2007).

Mathematical Mindset

Several studies show that mathematics is one of the subjects considered difficult for most students (Capuno et al., 2019; Gafoor & Kurrukan, 2015; Mainali, 2022). When students cannot do mathematics, they often assume that mathematics is a subject that is a frightening specter throughout their lives (Boaler, 2018). Students with this view are students who have a high level of math anxiety when faced with difficult math tasks (Shi et al., 2022). As a result, they are better off retreating and not daring to complete the existing challenges so that their mathematical abilities cannot develop and improve. Therefore, the student's view shows that students have a certain mindset toward mathematics subjects, in this case, called the mathematical mindset (or math mindset) (Boaler, 2018).

Like the general mindset review, the mathematical mindset is also based on two assumptions about mathematical intelligence. Daly et al. (2019) stated that students who have a fixed mathematical mindset believe that their mathematical abilities are innate and permanent, while students who have a growth mindset in mathematics believe that their mathematical abilities can be developed with diligent and persistent practice. Thus, there are different characteristics related to the fixed math mindset and the growing math mindset.

Fixed Mathematical Mindset vs. Growth Mathematical Mindset

In general, Dweck (2006) describes the characteristics of a fixed mindset and a growth mindset in terms of five dimensions, including challenges, obstacles, efforts, criticism/praise, and the success of others. The five-dimensional characteristics of the fixed mindset and growth mindset are described in **Table 1**.

Meanwhile, Chen et al. (2021) developed a growth mindset scale based on six dimensions, namely motivation, attitude, resilience, challenge, difficulty, and a positive mindset. A person is considered to have a growth mindset if the person has characteristics, including the motivational dimension, where a person's motivation comes from inner wants and needs, not from extrinsic rewards; the attitude dimension, which means a person has confidence in IQ, talent, achievement, and hard work; dimension of resilience, is a belief in solutions when facing difficulties, problems, and new changes; the grit dimension signifies individual perseverance and perseverance; the difficulty dimension indicates that an unpleasant problem can be solved unfavorably, and the positive mindset dimension shows feelings of self-confidence and openness with a strong belief in oneself to solve a problem.

In this study, the characteristics of the mathematical mindset can be adapted from the opinion of Chen et al. (2021) and Dweck (2006) with six dimensions, including the dimensions of students' mathematical skills and intelligence, students' challenges in completing math assignments, students' difficulties in learning mathematics, the importance of persistent effort in learning mathematics, attitudes towards criticism when learning mathematics, and attitudes towards other people who have math achievement (**Table 2**).

Mathematical Mindset and Gender

Several researchers have conducted studies on mindsets related to gender (male and female). In his study in quantitative analysis, Degol et al. (2018) show that the growth mindset produces different effects on math achievement between male students and female students so that female students benefit more than male students in having a growth mindset. Furthermore,

Table 2. Characteristics of fixed and growth mathematical mindset

| Category | Fixed mathematical mindset | Growth mathematical mindset |
|-------------------------------------|---|---|
| Mathematical ability & intelligence | Mathematical skills & intelligence cannot be changed. | Mathematical skills & intelligence can be changed. |
| Challenge | Avoiding complex math problems so that their weaknesses are not known to others. | Complex problems are solved as a means of learning. |
| Obstacles | Give up on solving difficult problems & generally do not want to be done. | Never give up solving difficult questions & generally keep working until you find the answer. |
| Effort | Do not want to try to learn math or solve math problems persistently & optimistically. | Strive & persevere in learning mathematics or solving math problems until you find solution successfully. |
| Criticism/praise | Assessing criticism as negative input even though it can build yourself better & praise as an acknowledgment of your talents. | Facing criticism/suggestions when learning mathematics as a means of improvement. |
| Success of others | Other people’s math learning achievements are a threat & make you sad & angry. | Other people’s mathematics learning achievements as a source of inspiration & learning. |

Sigmundsson et al. (2020) show that there are significant differences in mindset in terms of gender between male and female students. However, in another study, Macnamara and Rupani (2017) and Sigmundsson et al. (2021) show that there is no significant difference in the growth mindset of students in terms of gender differences. Meanwhile, Kismiantini et al. (2021) on the release of the 2018 PISA results from Indonesian students stated that student gender, growth mindset, socioeconomic index, and cultural status were significant predictors of students’ mathematics learning achievement. Thus, in context of learning mathematics, the characteristics of students’ mathematical mindset can be seen from the differences in gender.

Research Question

Based on the literature review, this study aims to investigate the characteristics of the mathematical mindset of junior high school students in Yogyakarta-Indonesia. Two questions were asked:

1. What are the characteristics of the mathematics mindset of junior high school students in general?
2. What are the characteristics of the mathematics mindset of junior high school students based on gender?

METHOD

Research Design

To find out the characteristics of the mathematical mindset of junior high school students, a survey study was conducted by distributing questionnaires based on the dimensions of the mathematical mindset. This study was conducted to answer these two research questions.

Participant

The participants of this study were junior high school students living in urban and rural areas in the province of Yogyakarta, Indonesia. A total of 1,074 students (452 male students and 622 female students) from nine public and private junior high schools filled out questionnaires

Table 3. Characteristics of research participants (n=1,074)

| | | Frequency | Percentage (%) |
|--------|---------|-----------|----------------|
| School | Public | 860 | 80.1 |
| | Private | 214 | 19.9 |
| Gender | Male | 452 | 42.1 |
| | Female | 622 | 57.9 |
| Class | VII | 580 | 54.0 |
| | VIII | 216 | 20.1 |
| | VIII | 278 | 25.9 |

in this survey activity. A total of 860 students came from public junior high schools and 214 students from private junior high schools. Of these students, there were 580 grade VII students, 216 grade VIII students, and 278 grade IX students. The characteristics of the participants in this study can be seen in **Table 3**.

Student Mathematics Mindset Questionnaire

To obtain information about the characteristics of students’ mathematical mindsets, the researcher developed a questionnaire that was distributed through a google form. The mathematical mindset questionnaire in this study was developed based on the mindset measurement scale developed by Chen et al. (2022) and Dweck (2006), which consists of six dimensions, including mathematical skills and intelligence, challenges, difficulties, efforts, criticisms, and other people’s success. Each dimension of the mathematical mindset is reduced to 20 statements that students need to respond to in order to obtain a category of student mindset characteristics. Ten statements investigated the characteristics of the students’ fixed math mindset, and the other ten statements investigated the characteristics of the growth math mindset.

Dimensions of mathematical expertise and intelligence, there are two statements that discuss students’ beliefs about mathematical skills and intelligence. The challenge dimension contains four statements about students’ beliefs about facing challenges when learning mathematics, especially in completing math tasks. The business dimension contains four statements that discuss students’ attitudes in dealing with student difficulties when learning

mathematics, including when faced with failure. The business dimension contains three statements that discuss the importance of persistent effort in learning mathematics. There are three dimensions of criticism that discuss students' attitudes when facing criticism from others when learning mathematics. Dimensions of other people's success there are four statements that discuss students' attitudes towards other people who have mathematical achievements (Appendix A).

Dweck (2006) categorizes students' mindsets into two categories, including a fixed mindset and a growth mindset. In another study, Glerum et al. (2019) and Sun (2019) categorizes students' mathematical mindsets into three categories, a fixed mindset, a growth mindset, and a mixed mindset of a fixed mindset and a growth mindset. The study of Barger et al. (2022) classifies a person's mindset into five categories, including fixed mindset, moderate mindset, wrong growth mindset, business mindset, and extreme flexibility mindset. In this study, the researchers proposed four categories of students' mathematical mindsets, including a very strong fixed mindset (FF), a fixed-growth mindset (FG), a growth mindset with a little fixed mindset, growth-

fixed mindset (GF), and a very strong growth mindset (GG) (Table 4). Next, the analysis of the characteristics of the mathematical mindset of students in the form of four groups is analyzed and described based on the dimensions of the mathematical mindset based on the gender differences of students.

All statements in this questionnaire use a four-point scale, from "strongly agree", "agree", "disagree", and "strongly disagree". For statements that exhibit the characteristics of a fixed math mindset, the scores from "strongly agree" to "strongly disagree" are 1 to 4. To determine the characteristics of the student's mindset, the researcher looked at the pattern of student responses when responding to the statements given. The pattern of student responses can be seen from the answers chosen from "strongly agree" to "strongly disagree" to statements that identify a fixed mindset or a growth mindset. Students who respond, "strongly agree" or "agree" to all statements that identify a fixed mindset, then these students have a very strong fixed mindset (FF). In contrast, students who responded "strongly agree" or "agree" to all statements identifying a growth mindset, these students had a very strong growth

Table 4. Framework for categorizing students' mathematical mindset

| Mindset dimension (Dweck, 2006; Chen et al., 2002) | Category | | | |
|--|--|--|--|---|
| | Fixed-fixed mindset (FF) | Fixed-growth mindset (FG) | Growth-fixed mindset (GF) | Growth-growth mindset (GG) |
| Mathematical ability & intelligence | Students firmly believe that mathematical ability & intelligence cannot be changed. For example, I strongly agree that mathematical ability & intelligence cannot be changed. | Students believe that mathematical ability & intelligence cannot be changed. For example, I agree that mathematical ability & intelligence cannot be changed. | Students believe that mathematical abilities & intelligence can be changed. For example, I do not agree that mathematical ability & intelligence cannot be changed. | Students strongly believe that mathematical abilities & intelligence can be changed. For example, I strongly disagree that mathematical ability & intelligence cannot be changed. |
| Challenge | Students are not very sure that challenges that arise when learning mathematics, especially in solving math problems, can be faced. For example, I strongly agree that completion of difficult & complex math tasks/problems is not easy to determine. | Students are not sure that challenges that arise when learning mathematics, especially in solving math problems, can be faced. For example, I agree that completion of difficult & complex math tasks/problems is not easy to determine. | Students believe that challenges that arise when learning mathematics, especially in solving math problems, can be faced. For example, I do not agree that completion of difficult & complex math tasks/problems is not easy to determine. | Students are very sure that challenges when learning mathematics, especially in solving math problems can be faced. For example, I strongly disagree that completion of difficult & complex math tasks/problems is not easy to determine. |
| Obstacle | Students are very unsure that students are able to face difficulties that come with learning mathematics, including when faced with failure, & generally retreat. For example, I strongly agree that mistakes that occur when solving math problems keep a person from learning. | Students do not believe that students are able to face difficulties that come with learning mathematics, including when faced with failure, & generally retreat. For example, I agree that mistakes that occur when solving math problems keep a person from studying. | Students believe that students are able to face difficulties that arise when learning mathematics, including when faced with failure, & move on to face it. For example, I do not agree that mistakes that occur when solving math problems prevent someone from studying. | Students strongly believe that students are able to face difficulties that arise when learning mathematics, including when faced with failure, & move on to face it. For example, I strongly disagree that mistakes that occur when solving math problems keep someone from learning. |

Table 4 (Continued). Framework for categorizing students' mathematical mindset

| Mindset dimension (Dweck, 2006; Chen et al., 2002) | Category | | | |
|--|---|--|--|--|
| | Fixed-fixed mindset (FF) | Fixed-growth mindset (FG) | Growth-fixed mindset (GF) | Growth-growth mindset (GG) |
| Effort | Students do not believe that learning mathematics requires persistence, especially in solving complex math problems & are pessimistic that there is always a solution. For example, I totally agree that doing constant practice is the best way to learn math material. | Students do not believe that learning mathematics requires persistence, especially in solving complex math problems & are pessimistic that there is always a solution. For example, I agree that doing continuous exercise is the way best for studying math material. | Students believe that learning mathematics requires a persistent attitude, especially in solving complex math problems, & is optimistic that there is always a solution. For example, I agree that with diligent & diligent study, ability one's mathematics can develop. | Students strongly believe that learning mathematics requires a persistent attitude, especially in solving complex math problems, & is optimistic that there is always a solution. For example, I totally agree that with diligent & diligent study, ability one's mathematics can develop. |
| Critique | Students are not sure & have a negative attitude that criticism submitted by others when learning mathematics can be material for improvement. For example, I strongly agree that we do not benefit from someone's an input/criticism towards completion of a math task/problem that has been done. | Students are less sure & have a negative attitude that criticism submitted by others when learning mathematics can be material for improvement. For example, I agree that we do not benefit from someone's input/criticism on completion of math assignments/problems that have been done. | Students are confident & have a positive attitude that criticism submitted by others when learning mathematics can be material for improvement. For example, I agree that someone's advice on results of solving math assignments/problems can be improve quality of work assignments or questions math. | Students are very confident & have a very positive attitude that criticism submitted by others when learning mathematics can be material for improvement. For example, I strongly agree that advice given by someone on results of completing math assignments or questions can improve quality of work assignments or questions math. |
| Success of others | Students have a very negative attitude that other students' achievement in learning mathematics can be self-motivated & inspirational & is considered to be due to luck. For example, I totally agree that everyone's math achievement is different, so we do not need to follow other people's math success. | Students have a negative attitude that other students' achievement in learning mathematics can be self-motivated & inspirational & is considered to be due to luck. For example, I agree that everyone's math achievement is different, so we do not need to follow other people's math success. | Students have a positive attitude that other students' mathematics learning achievements can be self-motivated & inspiring. For example, I agree that everyone can be successful in learning math if they study hard & persevere. | Students have a very positive attitude that other students' achievement in learning mathematics can be self-motivated & inspiring. For example, I strongly agree that everyone can be successful in learning mathematics if they study hard & persevere. |

mindset (GG). Meanwhile, students who responded, "strongly agree" or "agree" to most statements identifying a fixed mindset and a small percentage responded "disagree" and "strongly disagree" to statements that identified a growth mindset, then these students had a fixed mindset with a little growth mindset (FG). Next, students who responded, "strongly agree" or "agree" to a small number of statements identifying a fixed mindset and most of the others responded with "disagree" and "strongly disagree" to statements that identified a growth mindset, then the student had a growth mindset and grow with a bit of a fixed mindset (GF).

Data Analysis

The research data were analyzed quantitatively and qualitatively. Quantitative data analysis uses Microsoft Excel software and is presented in percentage form. While the qualitative data analysis used in this study, specifically to determine the characteristics of the mathematical mindset, is to use thematic analysis following the stages; become familiar with the data, generate initial code, search for themes, review themes, define and name themes, and write reports (Braun & Clarke, 2006). First, researchers read the initial data to obtain an overview or familiarity with the questionnaire data. Next, the researcher coded the responses given.

Table 5. Categories of junior high school students' mathematical mindset

| Category | Frequency | Percentage (%) |
|----------|-----------|----------------|
| FG | 241 | 22.4 |
| GF | 782 | 72.8 |
| GG | 51 | 4.7 |
| Total | 1,074 | 100.0 |

Note. FF: Fixed-fixed mindset; FG: Fixed-growth mindset; GF: Growth-fixed mindset; GG: Growth-growth mindset; & FF: 0%

The results of the research subject responses were given a score based on the questionnaire scoring scale. After the code is given, then the code is used to determine the themes that show the characteristics of the mathematical mindset. Each of these themes is reviewed for compliance with the codes used to compile the theme (Minihan et al., 2022).

Next, the themes that show the characteristics of the mathematical mindset are used to determine the mathematical mindset categories of the research subjects in each dimension based on the mathematical mindset categorization framework (Table 4). In the final stage, after the characteristics of each dimension of the students' mathematical mindset are identified, then it is used to conclude the categories of the mathematical mindset of each research subject in general.

RESULTS

The Characteristics of Mathematical Mindset

Characteristics of the student's mathematical mindset can be seen from the questionnaire data, which identifies the dimensions of the mindset including mathematical skills and intelligence, challenges, difficulties, efforts, criticism, and other people's success. In general, the mathematical mindset category of students shows a tendency for a growing math mindset with a little bit of a fixed math mindset (GF), followed by a fixed mindset with a little bit of a growing math mindset, a small percentage of a strong math mindset. Meanwhile, the category of students who have a strong fixed mathematical mindset does not exist (Table 5).

When students are given a statement about their beliefs about their mathematical skills and intelligence, more than 60% of students tend to believe that their mathematical intelligence can change. This is in line with the opinion of 90% of students who tend to believe that one's mathematical abilities can grow and develop by studying diligently. When students are faced with challenges when learning mathematics, we find that more than 60% of students tend to be pessimistic when solving difficult math problems. However, more than 80% of students tend to believe that persistence in dealing with difficult math problems can teach an attitude of never giving up. Around 90% of students also tend to believe that difficult math problems can be solved creatively. Even so, about 76% of students tend to

believe that solving difficult math problems is not easy to determine.

Regarding difficulties when learning mathematics, about 60% of students tend to be lazy to learn difficult math material. However, more than 90% of students tend to believe that difficult math problems can still be solved. About 80% more students also tend to believe that mistakes that occur when solving math problems make someone able to learn. This is also in accordance with the opinion of around 90% of students who tend to believe that failure when solving math problems makes a person study more persistently.

By studying hard and diligently, about 98% of students tend to believe that their math skills can improve. However, about 90% of students tend to believe that doing continuous practice is the best way to learn math material. In addition, we found that more than 76% of students tend to think that failure in learning mathematics does not make them quit but requires more effort.

In terms of responding to criticism, we found that more than 65% of students tend to believe that criticism given by others on the completion of math assignments can be useful. In addition, more than 90% of students tend to believe that suggestions given by others can improve the quality of their work on math assignments. Furthermore, more than 83% of students tend to be brave enough to ask others for advice regarding their math assignments and they do not feel shy.

Next, regarding students' attitudes towards mathematics achievement achieved by other students, more than 85% of students tend to have a positive attitude that the way of learning of students who excel in mathematics can be followed. However, about 55% of students tend to think that mathematics learning achievement varies from one student to another, so it is not easy to follow the success of other students. On the other hand, about 98% of students tend to believe that anyone can be successful in learning mathematics on the condition that they have to work hard and persevere. However, about 50% more students tend to think that other students' math achievements in mathematics are often due to luck (Table 6).

The Characteristics of Students' Mathematical Mindset Based on Gender

Based on the questionnaire data, the students' mathematical mindset can be described based on their gender. From the data on filling out the mathematical mindset questionnaire, as many as 1,074 students participated in the survey, which there were 452 male students and 622 female students. Regarding the category of mathematical mindset, students in the FG category include 122 (26.99%) male students and 118 (30.23%) female students. Students in the GF category include 310 (68.58%) male students and 473 (76.05%)

Table 6. Characteristics of students' mathematical mindset (Category: FM/GM/FF/FG/GF/GG)

| Dimension | Characteristics of mindset | Category |
|-------------------------------------|---|----------|
| Mathematical ability & intelligence | Tend to believe that their mathematical intelligence can change. | GM |
| | Tend to believe that one's mathematical abilities can grow & develop by studying diligently. | GM |
| Challenge | Tend to be pessimistic when solving difficult math problems. | FM |
| | Tend to believe that persistence in dealing with difficult math problems can teach an attitude of never giving up. | GM |
| | Tend to believe that difficult math problems can be solved creatively. | GM |
| | Tend to believe that solving difficult math problems is not easy to determine. | FM |
| Obstacle | Tend to be lazy to learn difficult math material | FM |
| | Tend to believe that difficult math problems can still be solved. | GM |
| | Tend to believe that mistakes that occur when solving math problems allow someone to learn. | GM |
| | Tend to believe that failure when solving math problems makes a person learn to be more persistent. | GM |
| Effort | Tend to believe that students' mathematical abilities can be developed by studying hard & diligently. | GM |
| | Tend to believe that continuous practice is the best way to learn math. | FM |
| | Tend to assume that failure in learning mathematics does not make students retreat but requires more active efforts. | GM |
| Critique | Tend to believe that criticism given by others on completion of math tasks can be useful. | GM |
| | Tend to believe that suggestions given by others can improve quality of results of solving math tasks. | GM |
| | Tend to be brave to ask others for advice regarding math assignments & they do not feel shy. | GM |
| Success of others | Tend to have a positive attitude that learning method of students who excel in mathematics can be followed. | GM |
| | Tend to assume that mathematics learning achievement varies from one student to another, so it is not easy to follow success of other students. | FM |
| | Tend to believe that everyone can be successful in learning mathematics on condition that they must work hard & diligently. | GM |
| | Tend to assume that other students' achievement in mathematics is often due to luck. | FM |
| Conclusion | Most are in the GM category than the FM category. | GF |

Table 7. Categories of students' mathematical mindset based on gender

| Mindset category | Gender | n | Percentage (%) |
|------------------|--------|-----|----------------|
| FG | Male | 122 | 26.99 |
| | Female | 118 | 30.23 |
| | Total | 240 | |
| GF | Male | 310 | 68.58 |
| | Female | 473 | 76.05 |
| | Total | 783 | |
| GG | Male | 20 | 4.43 |
| | Female | 31 | 4.98 |
| | Total | 51 | |

Note. Total n=1,074; Male=452; & Female=622

students. The GG category students included 20 (4.43%) male students and 31 (4.98%) female students (Table 7).

In general, the mindset characteristics of male and female students are not much different. Male and female students, if given a statement about their beliefs about mathematical skills and intelligence, about 57% of male students and 70% of female students tend to believe that their mathematical intelligence can change. About 90% of male and female students also tend to believe that one's mathematical abilities can grow and develop by studying diligently. When students are faced with challenges when learning mathematics, we find that around 57% of male students and 60% of female students tend to be pessimistic when solving difficult math

problems. However, more than 90% of male and female students tend to believe that persistence in dealing with difficult math problems can teach a never-give-up attitude. Around 87% of male students and 90% of female students also tend to believe that difficult math problems can be solved creatively. However, about 70% of male students and 69% of female students tend to believe that the solution to difficult math problems is not easy to determine.

Regarding difficulties when learning mathematics, about 58% of male students and almost 59% of female students tend to be lazy to learn difficult math material. However, more than 90% of male and female students tend to believe that difficult math problems can still be solved. Around 72% of male students and 80% of female students tend to believe that mistakes that occur when solving math problems make a person able to learn. This is also in accordance with the opinion of more than 90% of male students and female students tend to believe that failure when solving math problems makes a person study harder.

By studying hard and diligently, about 95% of male students and almost 100% of female students tend to believe that their math skills can improve. However, more than 90% of male students and 96% of female students tend to believe that continuous practice is the best way to learn mathematics. Also, we found that more

Table 8. Characteristics of the mathematical mindset of male and female students (Category: FM/GM/FF/FG/GF/GG)

| Dimension | Characteristics of mindset | Percentage (%) | | Category |
|-------------------------------------|---|----------------|--------|----------|
| | | Male | Female | |
| Mathematical ability & intelligence | Tend to believe that their mathematical intelligence can change. | 57 | 70 | GM |
| | Tend to believe that one's mathematical abilities can grow & develop by studying diligently. | 90 | 90 | GM |
| Challenge | Tend to be pessimistic when solving difficult math problems. | 57 | 60 | FM |
| | Tend to believe that persistence in dealing with difficult math problems can teach an attitude of never giving up. | 90 | 90 | GM |
| | Tend to believe that difficult math problems can be solved creatively. | 87 | 90 | GM |
| | Tend to believe that solving difficult math problems is not easy to determine. | 70 | 69 | FM |
| Obstacle | Tend to be lazy to learn difficult math material. | 58 | 59 | FM |
| | Tend to believe that difficult math problems can still be solved. | 90 | 90 | GM |
| | Tend to believe that mistakes that occur when solving math problems allow someone to learn. | 72 | 80 | GM |
| | Tend to believe that failure when solving math problems makes a person learn to be more persistent. | 90 | 90 | GM |
| Effort | Tend to believe that students' mathematical abilities can be developed by studying hard and diligently. | 95 | 100 | GM |
| | Tend to believe that continuous practice is the best way to learn math. | 90 | 96 | FM |
| | Tend to assume that failure in learning mathematics does not make students retreat but requires more active efforts. | 95 | 98 | GM |
| Critique | Tend to believe that criticism given by others on completion of math tasks can be useful. | 57 | 58 | GM |
| | Tend to believe that suggestions given by others can improve quality of results of solving math tasks. | 90 | 90 | GM |
| | Tend to be brave to ask others for advice regarding math assignments & they do not feel shy. | 66 | 78 | GM |
| Success of others | Tend to have a positive attitude that learning method of students who excel in mathematics can be followed. | 85 | 86 | GM |
| | Tend to assume that mathematics learning achievement varies from one student to another, so it is not easy to follow success of other students. | 59 | 52 | FM |
| | Tend to believe that everyone can be successful in learning mathematics on condition that they have to work hard & diligently. | 96 | 98 | GM |
| | Tend to assume that other students' achievement in mathematics is often due to luck. | 50 | 54 | FM |
| Conclusion | Most are in the GM category than the FM category. | | | GF |

than 95% of male students and more than 98% of female students tend to think failure in learning mathematics does not make them quit but requires more effort.

In terms of responding to criticism, we found that about 57% of male students and 68% of female students tend to believe that criticism given by others on the completion of math tasks can be useful. In addition, more than 90% of male and female students tend to believe that suggestions given by others can improve the quality of work on math assignments. Furthermore, about 66% of male students and 78% of female students tend to dare to ask others for advice regarding their math assignments and they do not feel embarrassed.

Next, regarding the attitudes of male students towards mathematics learning achievement achieved by other students, about 85% of male students and 86% of female students tend to have a positive attitude that the learning method of students who excel in mathematics can be followed. However, about 59% of male students and 52% of female students tend to think that mathematics learning achievement varies from one student to another, so it is not easy to follow the success

of other students. In addition, about 96% of male students and 98% of female students tend to believe that anyone can be successful in learning mathematics with the condition that they must try hard and persevere. However, about 50% of male students and 54% of female students tend to think that other students' achievement in mathematics is often due to luck (Table 8).

DISCUSSION

In general, the students' mathematical mindset was in the category of developing mathematics mindset with a few fixed mindsets, including the mathematical mindset of male students and female students. In looking at mathematical abilities and intelligence, students tend to believe that their mathematical intelligence can change. This fact is also reinforced by that by studying diligently, students believe that students mathematical abilities can grow and develop. In this case, Dweck (2006) states that students who have the characteristics of a growth mindset believe that their

mathematical abilities and intelligence can grow and develop.

However, in facing challenges and difficulties in learning mathematics, students believe that when faced with complex math problems they feel pessimistic and lazy to solve the problem properly, including feeling that the question is not easy to determine. That is, they still lack confidence in their mathematical abilities. This fact is experienced by most students when studying mathematics, that mathematics is a difficult subject to learn, especially in solving complex problems (Capuno et al., 2019; Gafoor & Kurrukkan, 2015; Mainali, 2022). However, students realize that these complex problems can actually be solved in various creative ways. This means that complex math problems are actually not necessarily really difficult to solve, but creative solutions are indeed needed so that they are easy to solve. Regier and Savic (2019) state that complex math problems do require mathematical creativity in solving them so that various solutions can be obtained.

One thing that is quite encouraging is related to the attitude of students in experiencing mistakes and failures in learning mathematics, students believe that the mistakes and failures they experience are a means to study harder and have the attitude not to back down in learning it. Dweck (2006) states that students who have a growth mindset think that mistakes and failures are a means for self-evaluation and learning so the next step is to try to move forward even better.

In addressing the importance of active effort in learning mathematics, students believe that it can make their mathematical abilities develop. This shows that students have a growth mindset. However, most students think that the effort they make seems to be monotonous, that is, they only practice (for example solving math problems) continuously. In fact, there are many other ways to learn mathematics other than just practicing questions continuously. For example, learning mathematics by playing through multimedia (Pan et al., 2022; Rebollo et al., 2022). This attitude of most students shows that students still have a very strong fixed mindset.

Next, most of the students believe that the criticism and suggestions given to them when learning mathematics can make their mathematics task completion better. They are also confident to ask for advice and opinions from others about the results of their work to be better. This fact is in accordance with the opinion of Dweck (2006), that criticism and suggestions from others should be a means to improve ourselves even though sometimes it makes us feel uncomfortable and stick with the opinions we have. Seeing this fact, in responding to criticism and suggestions, students have a growth mindset character.

In responding to the success of others, especially when they see other students excel in mathematics, most

students consider that success can be imitated. However, they realized that each student's success in learning mathematics is different, including that the success of others can also be influenced by luck. That is, they have a growth mindset character, but related to their attitude towards the success of different people and the success achieved is a factor of luck, they have a fixed mindset. Dweck (2006) states that one's success can be a source of inspiration and motivation. Dweck (2006) also states that with diligent effort, one can achieve success as others have.

CONCLUSIONS

In this study, it was found that most of the students had a growth mindset in mathematics with a little fixed mindset, both male and female students. The characteristics of students' growth mindset appear when students believe that mathematical abilities and intelligence can grow and develop. Students also believe that complex problems can be solved in various creative ways. The attitude of students in experiencing mistakes and failures in learning mathematics, students believe that the mistakes and failures they experience are a means to study harder and have the attitude not to back down in learning it. In addressing the importance of active effort in learning mathematics, students also believe that it can make their mathematical abilities develop. In addition, most students believed that the criticism and suggestions given while studying mathematics could improve their math assignments. They are also confident to ask for advice and opinions from others about the results of their work to be better. In response to their friends who excel in mathematics, most students consider that success can be imitated.

The characteristics of the fixed mathematical mindset can be seen from students' beliefs in facing challenges and difficulties when learning mathematics, they feel pessimistic and lazy to solve complex math problems, including feeling that the questions are not easy to determine. In addition, most students assume that the effort in learning mathematics is monotonous, that is, they only practice continuously. They also assume that each student's success in learning mathematics is different and can be influenced by luck.

Limitations

This study has limitations, especially in how the profile of the mathematical mindset develops that students actually have one by one in their daily lives. This study only looked at the students' responses when obtaining statements in the questionnaire. There is a need for further studies that explore their mathematical mindset profile, especially in the application of the mindset they have in learning math activities every day.

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APPENDIX A

Table A1. Mathematical mindset questionnaire

| No Statement | Criteria | | | |
|---|----------|---|----|----|
| | SA | A | NA | SD |
| Mathematical skills and intelligence | | | | |
| 1 A person’s mathematical intelligence cannot be changed. | | | | |
| 2 A person’s mathematical ability can grow and develop by studying diligently. | | | | |
| Challenge | | | | |
| 3 I am pessimistic when completing difficult math problems. | | | | |
| 4 Persistence in facing the challenges of math tasks teaches an unyielding attitude. | | | | |
| 5 Difficult math tasks can be solved creatively. | | | | |
| 6 The completion of difficult math tasks is not easy to determine. | | | | |
| Obstacle | | | | |
| 7 Laziness appears when studying difficult math subject. | | | | |
| 8 I believe that difficult math tasks can still be solved. | | | | |
| 9 Mistakes that occur when solving math problems make someone not study. | | | | |
| 10 Failure to solve math problems makes a person study harder. | | | | |
| Effort | | | | |
| 11 By studying hard and diligently, one’s mathematical abilities can develop. | | | | |
| 12 Doing constant practice is the best way to learn math material. | | | | |
| 13 Failure in learning mathematics shows the need for even more active efforts. | | | | |
| Critics | | | | |
| 14 We do not benefit from someone’s criticism of the completion of a math task that has been done. | | | | |
| 15 Suggestions given by someone on the results of completing a math task can improve the quality of the work result of the math task. | | | | |
| 16 Asking others for advice about completing a math task that is being done is a shameful thing. | | | | |
| The success of others | | | | |
| 17 We can follow the way of learning of others who excel in mathematics. | | | | |
| 18 Everyone’s math learning achievement is different, so we do not need to follow other people’s math learning success. | | | | |
| 19 Everyone can be successful in learning math if they study hard. | | | | |
| 20 The success of a person’s achievement in mathematics is often due to luck. | | | | |

Note. SA: Strongly agree; A: Agree; NA: Not agree; & SD: Strongly disagree

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