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Why is Math Difficult? : Beliefs That Affecting Students' Mathematics Skills

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Abstract: This research aims to describe the factors that influence students' beliefs that mathematics is difficult and how to change students' beliefs that mathematics is not difficult. This research method used a Systematic Literature Review with a qualitative approach. This data was obtained from the thematic analysis of several books and articles discussing 'intelligence", "mathematics," and "mindset" those researchers obtained from Google Scholar. The research results showed that parents, teachers, and peers influence students who think intelligence did not change and could be changed. Apart from that, with a fixed mindset, someone might think that mathematics was difficult because the task given was difficult, assume that if the achievement was low, then mathematics was also low, lack motivation after experiencing failure, and mathematics could not be completed if done for a long period. Parents had the biggest influence on students' mindsets. Genes and socioeconomic background were not the reason. Parental parenting patterns that prioritized performance over process influenced students' thinking patterns. Another biggest influence was the teacher. Like parents, teachers who assess based on performance rather than process would make students lose self-confidence when they fail. Teachers who supported their students to surrender to their situation also made students unmotivated to study mathematics more deeply. Collaboration between teachers, parents, and peers is needed to change a fixed mindset to a growth mindset. Constructive feedback is needed so students are always oriented towards a process without results.

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Introduction

The more complex life is, the more knowledge and skills are needed to deal with the times and the problems that follow. Mathematics is one of the doors to various knowledge and skills needed today. Lifelong learning and personal growth are both underpinned by mathematics. Both in terms of a particular field of knowledge (knowledge of mathematics) and terms of moral education. We can find applications of mathematics in nature, research, machinery, banking, technology, building architecture, data processing, and others (Hodaňová & Nocar, 2016). If the nation's generation is not equipped with adequate mathematics skills, it will limit them from studying other essential subjects, limit their job opportunities, and limit them from having quantitative abilities (Li & Schoenfeld, 2019). Students are expected to have adequate mathematics skills or become experts in mathematics, at least in the use of mathematics for problems in everyday life.

Talking about students who should have expertise in mathematics, what exactly is expertise? Expertise comes from the word "expert". Expert refers to efforts to learn from experience (Ericsson, 2014). We can refer to someone as an expert if they have acquired special knowledge or abilities demonstrating mastery of a particular field through training and experience (Ericsson, 2014). Experts are considered mysterious and sometimes revered,

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just like geniuses, as they often perform at levels far above those achieved by less skilled individuals or even believe they can. When people start working in a field, they must make decisions based on the rules they have learned and the knowledge they have acquired through previous training. Experts with extensive experience are able to handle challenging situations and make complex decisions.

Becoming an expert does not come automatically. Expertise does not come instantly like the talent that comes from God. Indeed, expertise can come from talent, but talent that is not trained continuously will be well-spent. The key to improving skills is deliberate practice, which is carrying out training assignments set by teachers with clear and defined improvement goals (Bruning et al., 2011). Unexpected study results, namely expertise gained from deliberate practice, are better than actual talent (Johnson et al (Bruning et al., 2011). Even so, talent undoubtedly fosters faster development, and some experts still believe that natural talent and desire determine one's ultimate success (Winner in Bruning et al., 2011).

Practice aside, it takes a long time to become proficient. Regardless of intellectual aptitude, it takes between 5 and 10 years or approximately 10,000 hours to gain real experience in the field (Alexander; Ericsson; Lajoie in Bruning et al., 2011). For students, it is unnecessary to study a field such as mathematics for 5-10 years to become an expert. Understanding the concepts, rules, and principles in mathematics and being able to apply them in everyday life is an expert in mathematics according to what students have learned. It is just that learning and understanding takes a long time. One reason to become an expert in a field takes a long time, namely that most of the declarative and procedural information needed to master a subject is obtained over a long period (Bereiter & Scardamalia; Novick & Bassok in Bruning et al., 2011). On the other hand, the expertise possessed can also be reduced. Talents and abilities can gradually disappear over time. As a result, highly talented people will eventually lose to less talented people if they do not practice (Bruning et al., 2011). It can be said that people will reach the highest level of skill by practicing regularly, practicing with a skilled mentor, and doing it for a long time.

However, because they did not study mathematics in depth, many Indonesian students are still not mathematicians until now, which is evidenced by the low PISA results in the mathematics domain (OECD, 2019). The fact that mathematics is usually considered difficult is one of the reasons why students are reluctant to study it in depth (Fritz et al in Li & Schoenfeld, 2019), many people agree that "it doesn't matter if people are not good at mathematics" (Rattan, Good, et al., 2012). It is common in America that people's weaknesses must be accepted as long as they focus on developing and maximizing their strengths (Rattan, Good, et al., 2012). Such a doctrine makes people not try to develop themselves because they have received what is a gift from God. Because they believe they no longer need to study mathematics, many students give up the subject once they no longer face the dreaded subject. Giving up mathematics or not prioritizing mathematics may seem acceptable to individuals who see it as a "choice." However, it would do a great disservice to society if such beliefs continued to be passed down through generations.

Much of our behavior is shaped by unconscious beliefs about key aspects of learning, such as intelligence and knowledge. Beliefs of this type are often called implicit beliefs because they represent unconscious personal beliefs about the world that develop slowly over time. Our implicit beliefs significantly influence our perception of ourselves as learners and how we behave in the classroom (Dweck; Hofer; Schraw; Sinatra in Bruning et al., 2011). Two types of implicit theory are proposed in their framework. The first is called the incremental theory or the growth mindset, which assumes that intelligence can be changed

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and increased gradually. In contrast, individuals who adhere to entity theory or are called fixed mindsets tend to believe intelligence is unchangeable and cannot be changed. A fixed mindset contributes to the beliefs of students who feel they cannot understand mathematics because it is difficult. Some people who adhere to *a* fixed mindset believe that mathematics abilities are the least likely to change than other fields (Jonsson et al., 2012). Research shows that the theory of students' implicit abilities influences their motivation, learning, and achievement outcomes (Blackwell et al., 2007). This study aims to describe the factors that influence students' beliefs that mathematics is difficult, then how to change students' beliefs that mathematics is not difficult. With this article, it is hoped that it can provide a reference for teachers and parents in helping students get rid of the belief that mathematics is difficult.

Research Method

This research method employed a Systematic Literatur Review with qualitative approach. Qualitative approach according to Nurdin & Hartati, (2019) the qualitative approach is research that begins with data, uses pre-existing theory as a basis for the explanation, and ends with theory. This research chose books and articles as text documents. Researchers selected document samples using purposive sampling techniques in the Google Scholar database that were appropriate to the research objectives. The articles and books used for the sample discuss "intelligence," "mathematics," and "mindset" because this research aims to find out the factors that cause students' perception that mathematics is difficult and how to change this opinion by changing the fixed mindset and growth mindset. Found 23 articles that met the requirements. Automatic text document research can be considered reliable because it has ready-to-use data according to (Silverman, 2014). Thematic analysis was used to analyze the articles found Vaismoradi et al. (2016) explain that thematic analysis research brings out the core content hidden in the text and breaks it down into several categories, such as themes and subthemes. Classifying data according to theme categories without changing the text's meaning is the researcher's task.

Results and Discussion

After analyzing several articles and books found with the keyword's "intelligence", "mathematics", and "mindset", the following are the themes and codes that researchers found regarding the factors that influence students to think mathematics is difficult.

Theme	Results found
factors that influence students' perception that mathematics is difficult	family
	teacher
	influence of peers
	the task given is difficult (challenging)
	low achievement
	due to a lack of motivation after failing
	the tasks cannot be done in a short time
change fix mindset to growth mindset	Challenges, efforts, and mistakes are highly appreciated
	Teaching students new knowledge about the developing brain and a new view of talent as a dynamic thing that can be developed
	Through the process of proper praise and feedback
	Encourage the student's view that intellectual development can be controlled
	Reward effort and improvement while not stressing the genuine

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	ability
	Emphasize the process, not the product, of learning
	Emphasize that mistakes are a normal and healthy part of learning
	Based on the assessment, no group

The following is a description of each theme found in books and articles that discuss the relationship between intelligence and mindset.

The fixed mindset that the difficulty of learning mathematics is because of the family

Heredity is a common reason students blame their situation for not understanding mathematics (Dweck and Leggett in Bruning et al., 2011). Those with a fixed mindset judge other people's intelligence as innate, not acquired through previous life experiences (Scherr et al., 2017). The example that the author takes from the book Bruning et al., 2011), shows students' opinions after working on difficult questions. Akira stated: "Failing mathematics is not a surprise. No one in my family can do mathematics". Akira probably thought that most of a person's abilities come from genes. Akira is innocent; indeed, it is very common to believe that mathematics ability is an innate gift that only some people have (Boaler; Jonsson et al on Sun, 2019). On the other hand, Alonzo said, "At first, I found it difficult, but eventually, I went to the mathematics lab, and the work I did there really helped me! Alonzo thinks that his ability in mathematics is earned by effort. Besides genes, socioeconomic background is also why students give up on mathematics. People from lower socioeconomic backgrounds may believe that being unable to do mathematics is a fixed mindset because they cannot take mathematics courses and have a low status in society by (Rattan, Savani, et al., 2012). This was refuted by Bruning et al. (2011) found no relationship between innate characteristics and a person's ability to develop skills.

Skills development is related to family mindsets that can affect children's mindsets (Jose & Bellamy; Muenk in Haimovitz & Dweck, 2017). If parents apply a fixed mindset that they do not need to learn mathematics because it is not essential for the future, then children will have that mindset, too. However, some parents have a growth mindset and do not apply it to their children, so their children adhere to a fixed mindset (Haimovitz & Dweck, 2017). Parents who praise their children for good mathematics results will have a fixed mindset that has a negative impact on efforts to get good results, such as cheating. It is different with parents who praise the results; children will see their intelligence as something they can develop. Children will focus on learning, not prioritizing grades, and they dare to take on difficult assignments because they are oriented to how much they understand mathematics material. They persist longer, enjoy the task more, and ultimately get better results than children with a *fixed mindset* (Haimovitz & Dweck, 2017).

Parents can also influence their children's mindset when helping students with mathematics homework (Mcnabb, 2021). Parents who help without telling the concepts used make students have a fixed mindset that the school's main goal is to get good grades, not to know the process of solving problems. When parents have high mathematics anxiety and often help their children with homework, students will learn less about mathematics. At the same time, it can cause mathematics anxiety at school, so students form a fixed mindset (Distefano et al., 2020). Anxiety and *a* fixed mindset cause children to develop a dislike for mathematics and lead to thoughts that mathematics is difficult (Distefano et al., 2020).

The fixed mindset that the difficulty of learning mathematics is because of the teacher

Apart from the family, teachers also contribute to forming students' fixed mindsets. Teachers must be careful in managing the classroom environment because situational factors

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affect students' interest and motivation in learning (Durik & Harackiewicz; Hidi & Renninger in Bruning et al., 2011). Teachers who adhere to a fixed mindset will conclude that students who cannot do mathematics from the start will always be unable to do mathematics Kamins and Dweck (in Hwang et al., 2019) found that praise and criticism focusing on outcomes rather than student efforts or processes likely foster a fixed mindset. That way, the teacher indirectly states that only naturally intelligent students will succeed in their class. The teacher usually entertains them for their shortcomings. For example, it entertains that not everyone can do mathematics, entertains students that they have strengths that can be strengthened, and accepts their weaknesses. The teacher's goal is to want students not to be disappointed in their situation, which can reduce student motivation and performance to try for the future (Rattan, Good, et al., 2012). Likewise, with students who can do mathematics from the start, teachers will always believe they can solve all the problems (Haimovitz & Dweck, 2017). When viewed from the difference at the beginning of class entry to the final exam, Rheinberg found that when teachers have a fixed mindset, initially low-achieving students will eventually become low-achieving students. However, when teachers have a growth mindset, many students, initially as low achievers, move up to moderate or even high achievers (Dweck, 2010).

Teachers who adhere to a fixed mindset will praise students based on their intelligence, not the process, so they will be embarrassed to be able to one day get a low score. To avoid embarrassment, they stay away from challenges, limit their efforts, and try to avoid or hide mistakes (Dweck, 2008). Therefore, educators, parents, and society must communicate that we value and admire challenging pursuits, hard work, and learning from mistakes (Dweck, 2008). Teachers should cultivate a growth mindset by praising the process, not the results. Children receiving process praise are likelier to display tough response patterns (Haimovitz & Dweck, 2017). Teachers with a growth mindset will discuss how struggle, effort, and negative emotions such as frustration are natural and useful parts of the learning process (Haimovitz & Dweck, 2017). Teachers also improve their mindset by placing students responsible for solving problems and working even harder (Haimovitz & Dweck, 2017). It is wrong if we make them fall asleep with easy questions without the need for effort or mistakes in doing so. It is better if we give easy questions first to motivate them to be enthusiastic in solving the following questions, then give difficult questions to develop thinking skills.

Fixed mindset mathematics is difficult because of the influence of peers

As students get older, they will spend more time with classmates and peers, increasing the influence students have on one another. According to King King (2019), students may begin to identify more with peers and classmates than with teachers because they spend more time together. Teachers may not realize that learned attitudes can be inherited from peers or adults (Mcnabb, 2021). Peer support describes individuals who help each other reciprocally, talk about their problems, and receive sympathy and guidance from their peers (Qi et al., 2022). If they blame or justify each other's answers without knowing the strategy and process, it will trigger the growth of a fixed mindset in students if they do not get good and proper praise from their peers. Peer praise is an effective tool once teachers have taught appropriate feedback skills and have trained a growth mindset in their classes; feedback that focuses on process rather than outcome can improve students' mindsets and, as a result, increase their motivation and belief in the growth mindset (Zhang et al., 2020). When students begin using growth mindset techniques in class, teachers must use peer feedback. The intended feedback is to focus on the peer-to-peer process so that it can improve growth attitudes and increase

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academic motivation. So when teachers can cultivate the abilities students need, students can increase their growth mindset and become more motivated and effective academic students by receiving positive feedback (Mcnabb, 2021).

The fixed mindset that it is difficult to learn mathematics because the task given is difficult (challenging)

The assignments are always challenging, which is also why students don't want to study mathematics. Those who view knowledge as absolute certainty and focus knowledge on the value they get are more likely to become frustrated and defensive when faced with a challenging task (Bruning et al., 2011). When faced with challenges or challenging tasks, they will find it difficult to persist because they believe they do not have the necessary skills and expertise to succeed, and they will stop trying when they start to feel like they are failing (Bruning et al., 2011). They would avoid assignments where he was shown to be incompetent. They want to be in a comfort zone where they can ask questions according to what they have learned. They do not want to expand their knowledge by learning new things independently. It is different with students who view knowledge as always developing. They will be ready to face challenges and try to solve problems (Dweck, 2008). At the time of the mathematics test, fixed mindset students will view the test as a measure of their intelligence, not measuring their skills and knowledge. Difficult mathematics test questions will threaten the intelligence of fixed-mindset students. They tend to see their difficulties as a bad reflection of their intelligence. If success means they are smart, failure implies they are not (Haimovitz & Dweck, 2017). As a result, they will think they cannot do mathematics, and that cannot be changed when they get unsatisfactory results (Stone in Haimovitz & Dweck, 2017).

The fixed mindset that the difficulty of learning mathematics is due to low achievement

Surrender to abilities that are indeed low and the belief that abilities cannot be changed is one of the reasons students do not want to learn mathematics, and, in the end, it becomes difficult for them. Low-achieving students see their success or failure as a direct consequence of their fixed intellectual abilities but do not see their abilities as something that can be developed. Surprisingly, high-achieving students are equally likely to support *a* fixed mindset compared to low-achieving students (Hwang et al., 2016). A fixed mindset is detrimental to low achievers but not high achievers. High-achieving students will always feel that they can solve all their problems easily.

The fixed mindset that the difficulty of learning mathematics is due to a lack of motivation after failing

Lack of motivation also causes students to feel that mathematics is difficult because they are not motivated to study mathematics. Individuals refuse to engage after failing a task with the assumption that they will fail again (Bruning et al., 2011). After failing an unsolvable problem, students who have a fixed mindset begin to doubt their abilities, and a third of them state that they will not be able to solve problems that were previously solved correctly (Gál et al., 2020). These students believe that their intellectual proficiency directly determines whether they succeed or fail, but they do not believe their proficiency can be controlled (Bruning et al., 2011). Schleider et al. (2015) found that psychological distress predicts fixed mindset support for future distress so that students fear that they will fail again in the future.

The fixed mindset that it is difficult to learn mathematics because it cannot be done in a short time

There is an assumption that limited failure is tantamount to permanent failure. For example, if a mathematics problem cannot be solved within 30 minutes, the problem will

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never be solved Bruning et al., 2011). Schoenfeld in Bruning et al. (2011) reports that even experienced students when asked to solve mathematics problems, will limit 5-10 minutes with the assumption that if they pass that limit they have not found a solution, then the problem cannot be solved.

How to change a fixed mindset to a growth mindset

Weiner in Bruning et al. (2011) states that intelligence is an internal, stable, and uncontrollable trait, which is a view that is quite consistent with the beliefs of entity theorists. In contrast, other theorists believe that intellectual ability can be changed because it is partly under the learner's control (Ackerman & Lohman, 2006). In the end, a person's definition of intelligence will determine whether intelligence is constant or not. Intelligence can be changed if intelligence means the ability to adapt successfully to the environment. As an example, we describe learning strategies that are known to help enhance learning, which helps individuals make better and more efficient use of their cognitive resources. With this, success in learning depends on how a person can use or utilize his resources rather than the many resources within him.

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Besides, one's intelligence can be changed, and one's abilities can be increased and honed. How to? For example, a student who previously had the opinion that he would not be able to outperform other students because he felt inadequate, had no talent, or was not descended from mathematicians. We can provide motivation and understanding more repeatedly to problems or material in learning that he is not good at. In addition, parents can enroll their children in tutoring as additional learning for their children besides receiving knowledge from teachers at school. Then, teachers at school can pay more attention to observing how students learn or their learning styles without discriminating against other students. With this, it is hoped that students will be able to be more confident and believe that they are able to solve problems without copying the work of other students and minimize students' anxiety about something that was previously considered scary for these students. Based on Dweck (2008) here's how to change the fixed mindset to *a* growth mindset:

1) Challenges, efforts, and mistakes are highly appreciated
   Educators, parents, and the community need to communicate that we value and admire challenges, hard work, and learning from mistakes. If errors are viewed positively, receive corrective attention, and are used to provide feedback to students, students learn more than when errors are viewed negatively (Poplin, 1988).
2) Teaching students' new knowledge about the developing brain and a new view of talent as a dynamic thing that can be developed
   The brain is often considered fixed, unable to develop. Likewise, talent is seen as a permanent thing that will bring success in the future. So, when educators introduce areas

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of study, they need to emphasize that skills in these areas are acquired through teaching and personal application.

3) Through the process of proper praise and feedback
   A teacher's feedback or praise can cause a change in the way students view their abilities and can change their mathematics mindset (Mcnabb, 2021). In addition to designing mathematics content, teachers need to design emotional experiences for parents so that parents feel comfortable helping their children with homework, teachers must provide direction about subject matter and how to encourage mental development to increase students' growth mindset (Distefano et al., 2020).

Here is another way to change a fixed mindset to a growth mindset based on Bruning et al. (2011).

1) Encourage the student's view that intellectual development can be controlled
   Encouraging students' views that intellectual performance can be controlled can lead to adaptive types of behavior.
2) Reward effort and improvement while not stressing the genuine ability
   Students must have different abilities. Teachers should praise when students have tried to improve their skills.
3) Emphasize the process, not the product, of learning
   Focusing on the learning process is a feature of the growth mindset. Research shows that the feedback obtained about the learning process is essential for students.
4) Emphasize that mistakes are a normal and healthy part of learning
   Everyone makes mistakes when learning a new skill. It is better if the teacher teaches students that mistakes can be viewed positively, which will later receive corrective attention to find the best strategy.
5) Based on the assessment, no group
   Most evaluations in education, particularly among high school and college students, refer to norms (the performance of each student compared to the average performance of the group). Encouraging individualized standards (eg, portfolio evaluation) is more likely to promote the development of a learning orientation and makes individual students feel more appreciated and cared for by educators.

In addition to the points already mentioned, Edwards in Bruning et al. (2011) also finds that beliefs obtained through affective persuasion are more easily changed through affective means, while beliefs obtained through cognitive persuasion are more quickly changed through cognitive means. Examples of cognitive persuasion are students whom the teacher and affective persuasion tell the geometrical characteristics. These students know the spatial characteristics themselves from directly touching, seeing, and observing geometric shapes.

Another way to change a fixed mindset to a growth mindset is to design homework accompanied by steps to do it. DiStefano et al. in Mcnabb (2021) explain that dividing the steps will assist parents in building an understanding of the mathematics process because these guidelines provide ways to give examples, ask questions, and provide feedback, all of which support parents in helping children -their children develop a growth mindset. Kessinger (in Mcnabb, 2021) states that open mathematics classrooms allow parents to observe their children's learning and observe the techniques used by the teacher in class. The teacher demonstrates student problems or strategies for parents to use at home during face-to-face meetings. Hence, teachers need to open lines of communication with parents so that parents understand how to build a growth mindset in their children.

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Conclusion

The results of this study showed that the factors that cause students to feel that mathematics was difficult, then how to change students' beliefs that mathematics was not difficult. The theory of Dweck and Leggett describes beliefs with two types of theory: entities (fixed mindset*)* maintain the belief that intelligence is fixed; incremental (growth mindset) believe that intelligence can be changed. Factors influencing students' mindsets were family, teachers, peers, tasks given are difficult (challenging), low achievement, lack of motivation after failure, and cannot be done quickly. The family's style played the biggest role in forming a child's mindset. Besides the family, the teacher was the second biggest factor that shapes a child's mindset. The feedback that builds *a* growth mindset is needed so students are always process-oriented, not results. In general, the measure of a student's success in school is the assessment standard. That way, students who score below their standards assume that they have low abilities, which is a natural trait. Therefore, to form students' confidence in their abilities, teachers can rely on predetermined assessment standards and the student's success. Success is when the student succeeds in being better than before, even though he has yet to reach the standard.

Recommendation

The teacher must provide rewards and motivation to these students and compare the success of these students with previous successes so that they believe that their abilities are starting to improve and do not feel pessimistic. It is hoped that teachers, families, and students can work together to create a growth mindset for their students' future success. This research is only limited to a literature study. There needs to be further research involving many research subjects to determine the factors influencing students' mindsets about mathematics.

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