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UNEARTHING MATHEMATICS ANXIETY: A QUALITATIVE EXPLORATION OF STUDENT EXPERIENCES

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Abstract

Mathematics anxiety is a pervasive issue that impacts students of all ages and backgrounds, potentially hindering their mathematical learning and overall academic success. This qualitative research aims to gain understanding of mathematics anxiety by exploring the lived experiences and perceptions of students. Utilizing phenomenological approach, which used interviews and thematic analysis, the research digs deep into the factors contributing to mathematics anxiety and coping mechanisms employed by higher education students whose ages range from 18-22 years. Findings reveal that mathematics anxiety is a multifaceted phenomenon influenced by self-perceptions, personal experiences and preparation. Coping strategies range from seeking social support to self-regulation techniques. The study contributes valuable insights into the subjective nature of mathematics anxiety and provides a foundation for designing effective interventions and support systems to address this issue in educational settings.

Keywords – Anxiety, Higher education, Mathematics, Qualitative.

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1. Introduction

The world is changing, and so with how education is provided. In addition, people start to recognize the large number of individuals struggling with mathematics. This is because many countries and schools aim for better rankings as mentioned (Salmi, 2021). Many learners struggle with learning math, and overcoming it seems impossible. Devine, Fawcett, Szűcs and Dowker (2012) have suggested that a substantial number of students in educational settings wrestle with this issue, while Luttenberger, Wimmer and Paechter (2018) argue that it poses a grave threat to their self-esteem.

Cognitive-Behavioral Theory (CBT) (Beck, 1976) can help explain this phenomenon by suggesting that students who struggle with math may develop negative thought patterns and self-doubt. This reinforces the belief that they are inherently bad at math, which further diminishes their self-esteem. These negative thought patterns contribute to the anxiety that students feel, making it difficult for them to overcome their math struggles.

The presence of math anxiety can serve as a difficult barrier to succeed in mathematics, potentially impeding one's academic and professional aspirations. Scholarly research has emphasized how careers in mathematics and science, despite their intellectualities, are perceived as less appealing due to the prevalence of math anxiety. This dislike of mathematics has been observed across different generations, as evidenced by Sparks (2011), Alday and Panaligan (2013), and Mutodi and Ngirande (2014). Self-Efficacy Theory (Bandura, 1977) is pertinent here, as students who experience math anxiety may develop a low sense of self-efficacy, believing that they cannot succeed in math. According to Bandura, individuals with low self-efficacy are less likely to engage in tasks they perceive as difficult, which in turn reinforces the avoidance behavior often seen in students who are anxious about math.

Beyond self-efficacy, Attribution Theory (Weiner, 1985) explains the roots of math anxiety. Math anxious students frequently attribute their struggles to internal, stable factors like a perceived lack of innate ability to do math ("I am not just good in math"). These attributions promote feelings of helplessness, and reinforces anxiety.

Additionally, the Zone of Proximal Development (ZPD) and Scaffolding (Vygotsky, 1978) offer strategies that are practical in nature to address anxiety. Students with math anxiety may feel burdened and overwhelmed when tasked outside their comfort zones. Scaffolding – provides temporary support to help these students succeed within their ZPD – can reduce anxiety through incremental achievements, fostering confidence and encouraging persistent learning.

Moreover, Expectancy-Value Theory (Eccles & Wigfield, 2002) helps explain how students' expectations for success and the value they place on math influence their engagement in the subject. In the Philippine context, students' negative attitudes and preconceptions about math as an overwhelming or irrelevant contribute to their poor performance and heightened anxiety (Laguador, 2014; Lee-Chua, 2005). Students with low expectancy and perceived value for math are less likely to engage in the subjects, creating a sickening cycle of disengagement and poor performance.

Despite its importance, math anxiety continues to thrive among students. This suggests that students' success in math requires addressing their emotional and psychological challenges and barriers in addition to their cognitive development (Johnston-Wilder, Lee and Mackrell, 2021; Code, Merchant, Maciejewski, Thomas & Lo, 2016).

Mathematics anxiety has left its mark on students across various educational contexts, including postsecondary institutions, even in the South African context. Studies conducted by Khatoon and Mahmood (2010) reveal the prevalence of math anxiety among Egyptian college students, while Abo-Hamza and Helal (2013) report that over 33% of adults in the United States experience math-related fear or anxiety. Unfortunately, schools fail to address the emotional dimensions of the learning process, like anxiety, which leads to challenges in creating a solid foundation in basic mathematics (Mutodi & Ngirande, 2014).

Given this background, mathematics anxiety has become a focus of numerous academic investigations and research activities over the years. Thus, it is essential to dig deeper into the core factors contributing to this phenomenon. Similarly, the qualitative paradigm in mathematics anxiety assessment has not been given much attention. While quantitative models use numerical data for analysis, qualitative research examines personal feelings and opinions of individuals. This study is intended to identify what features are involved in causing math anxiety from a qualitative perspective. By doing so repeatedly over time, researchers can come up with common themes or patterns that occur among those who suffer from math dread, thereby providing deep insights into their inner world.

The primary objective of this qualitative investigation is to look into the mathematics anxiety experienced by students in a higher education setting. Specifically, this study sought to explore the causes of mathematics anxiety through students' engagement and experiences in the subject and discern students' approaches to muddling through anxiety. To guide the conduct of the study, it has premised that negative

past experiences and misconceptions about mathematics contribute to anxiety. As such, students with high levels of anxiety employ various strategies and techniques to get through this. Thus, it is believed that a supportive learning environment and adaptive teaching strategies could somehow play significant roles in alleviating mathematics anxiety, and could possibly lead to improving their confidence and performance in the subject.

2. Methodology

For this study, a qualitative research design to investigate student's perception and management of math anxiety was used. The framework posits negative thinking and emotional responses towards mathematics as the underlying causes of this condition. In order to comprehend what it means for humans to live with the fear of numbers, the researcher followed a phenomenological approach during data collection. This kind of investigation aims at finding out about individuals' most basic understandings by hearing their stories about those things they have experienced Creswell (2009).

The study involved 21 participants: seven male and 14 female higher education students enrolled in a state university in the Philippines. The participants were selected based on specific inclusion criteria: has reported to have significant difficulty in learning mathematics, has demonstrated persistent anxiety related to mathematical tasks, and has voluntarily agreed to participate in the study. The sample size is small to ensure manageability but ensuring diversity among participants. This allowed for an in-depth exploration of their lived experiences while maintaining the feasibility of data collection and analysis.

However, detailed demographic information, such as age, academic standing, and field of study, was not provided, which limits the ability to assess the representativeness and generalizability of the findings. The research was conducted at a state university in the Philippines. Purposive sampling was employed to select participants who met specific inclusion criteria and possessed diverse experiences with math anxiety. This sampling technique, as outlined by Creswell (2009), involves selecting participants strategically to provide the researcher with the most valuable insights for understanding the research problem and topic, since the participants are those who have high to very mathematics anxiety, and have confirmed their difficulty in learning the subject.

The data for this research was gathered through face-to-face semi-structured interviews and focus group discussions to ensure credibility of findings. Interviews per student lasted for about 1.5 to 2.5 hours to ensure depth of discussions and exchange of conversations between the researcher and the participant. In such a way, it was possible to get exhaustive information from the participants about their experiences. On the other hand, in depth interviews lead to more elaborative discussion on how mathematics causes fear among individuals plus ways they have applied in overcoming this fear. These recordings come from those discussions.

Transcript analysis consisted of a full investigation of the obtained transcripts. To achieve a reflective comprehension of the subject matter, the researcher was indulged in several complete readings of the transcripts. By identifying key ideas linked to how the subjects expressed themselves, the obtained information was reframed so as to resemble it as much as possible. This was aimed at moving from individual instances by participants into some broad empirical patterns thereby leading to some themes.

In order to study the data, the researcher has employed a thematic analysis technique whereby transcripts were coded systematically for recurrent themes and patterns that were identified using the same research question which included qualitative model of mathematics anxiety by concentrating on uncovering cognitive as well as emotional processes leading to math anxiety. It followed the six-step process: familiarization, coding, creating themes, reviewing themes, defining and naming themes, and writing up. First (familiarization), the researcher becomes deeply familiar with the data. It involves reading and re-reading the transcripts, listening to recordings and taking notes of initial ideas. Second (coding), important features of the data were labeled. Each code represents meaningful piece of information to the research question. Next (creating themes), in this step, the research looked for

patterns among the codes and groups, and group these together to form themes. Then, themes were reviewed. The researcher checked if the themes are relevant and accurately represent the data. Some themes were combined, refined and discarded depending on the data gathered. After this, each theme is defined and named to capture its essence. The researcher writes a brief explanation of each theme to ensure clarity. Lastly, findings were presented in a structured manner. The researcher explains each theme, provided supporting quotes from participants, and discusses how the themes answer the research question. This method was preferred over other approaches to explore mathematics anxiety because it allows deep exploration or personal experiences, emotions and perceptions, which are necessary to understand this phenomenon.

Table 1 provides an overview of the number of comments associated with the theme. This helps in understanding the distribution and emphasis of participants' responses across different aspects of the study.

Unit of Analysis	Number of comments	Description
Causes of Mathematics Anxiety		
Theme 1: "Eh kasi ang Math ganito": Undesirable views about math		This theme emphasizes the prevalent negative perceptions and views of students often hold towards mathematics. It underscores the tendency of students to see math as worthless, is just for those who are smart and gifted, is hard to learn and could bring boredom.
• Subtheme 1: Math has no practical worth	3	
• Subtheme 2: Math is elitist	3	
• Subtheme 3: Math brings forth difficulty	5	
• Subtheme 4: Math is dreary	3	
Theme 2: "Eh kasi sa Math ganito": Negative experiences about math		This theme encompasses the challenges and negative experiences of students while learning mathematics, which could either hinder their academic growth or could affect their confidence in learning the subject.
• Subtheme 1: Math elicits fears and panic	4	
• Subtheme 2: Math fosters a sense of unfittedness	3	
• Subtheme 3. Math is taught by terrors	4	
• Subtheme 4: Mathematical answers are similar	2	
• Subtheme 5: Math is taxing	3	
Theme 3: "Eh sa Math, dapat ganito": Poor math preparations	3	Poor mathematics preparations in the context of learning mathematics refer to inadequate readiness of students which could negatively impact their engagement in the subject.
Muddling through Mathematics Anxiety		
Theme 1. Turning difficulties into countless opportunities	4	Students' strategy to muddle through mathematics anxiety emphasizes their efforts in turning mathematics difficulties into opportunities. This requires a shift, transforming moments of struggles for personal and academic growth. This mindset encourages students to view challenges not as unbeatable but as valuable learning,
Theme 2. Altering scary math moments into surprises	3	Despite the difficulties that students experience throughout their learning, they are able to transform these into enjoyable and surprising moments.
Theme 3. Shifting boredom into fun times	3	This theme highlights transforming students' perceptions of math from a dull, monotonous subject into an engaging and enjoyable experience.

Table 1. Unit of Analysis, Comments and Descriptions of Data Gathered

Throughout the study, ethical considerations were strictly addressed and followed. These included obtaining informed consent from participants to safeguard participants' confidentiality and anonymity, and to ensure safety among participants. Moreover, it important to acknowledge certain limitations of this study, such as potential biases in data collection and analysis procedures, as well as the possibility that participants' experiences with math anxiety may have been constrained or varied. Nonetheless, this research has the potential to significantly contribute to our understanding of the cognitive and affective mechanisms that underlie mathematics anxiety, as well as further elucidate the qualitative model of this condition.

3. Results

The following discussions present the salient points and observations in the research conducted.

3.1. Causes of Mathematics Anxiety

The following themes emerged in the discussions and interviews conducted amongst the participants:

3.1.1. Theme 1: *"Eh Kasi Ang Math Ganito":* Undesirable Views About Math

The term "eh kasi ang math ganto" is a Filipino expression that emphasizes the undesirable views of the students towards mathematics. There are a thousand reasons why the learners would form negative attitudes toward math. Some of these negative views are born from personal experiences, such as poor performance in studies or demoralization inflicted upon by the teachers held by a student as being responsible for his underperformance, while the common factor behind such pessimism is misconceptions towards this subject (Legarde, 2022).

Students might think that math is meant for certain people only, for instance, boys or kids who are naturally gifted in the discipline. They can have bad attitudes if they believe so (Hwang & Son, 2021). On the other hand, feeling like they have to do really well; failing which they would end up being stressed out while learning the subject and ultimately making it difficult for them, being stressed and having less enjoyment in learning makes it worse though.

In the course of various interviews with students, these negative perceptions about mathematics were found to be prevalent.

Subtheme 1: Math has no practical worth. For students, math seems to be an obscure discipline; unpractical, full of theory and unrelated to their lives; hence they are put off by it. They reason that its applications are less clear than those of other disciplines. Frequently, mathematics appears to use unambiguous terms which everybody can explain but in the sense of mathematics, such terms will acquire a different meaning.

Several students' remarks corroborate their belief that mathematics is abstract and lacks tangible real-world applications.

> "Math has no practical applications." – P10; "Where do you use x and y? I don't see the importance of Math in my everyday life. I don't even utilize this when buying in the market." – P13; "Math isn't clear; not just like English subject that is easy to comprehend." – P8

Subtheme 2: Math is elitist. People may believe that mathematics is exclusively for the elitist or those who are gifted or smart. But, this could be wrong as mathematics can be valuable to any individual. It serves as a tool for problem-solving, critical thinking, and logical reasoning, which are valuable skills for everyone, irrespective of their career dreams and interests. Moreover, mathematics plays a significant role in many professions and industries, making it indispensable for students from all backgrounds and abilities.

However, it's crucial to recognize that this belief has plagued some students:

> "I believe, Math is just appropriate for those who can understand various math concepts, it is just right for the brainy ones." – P1; "See those in the class honors list in high school, they seem are the ones

good in Math. – P7; "When one is good in Math, basically he is good in all subjects. I have proven that in all my years in school." – P14

Subtheme 3: Math brings forth difficulty. Many learners often encounter difficulties when dealing with mathematics, perceiving it as a challenging subject. For some, the struggle begins with fundamental arithmetic skills, creating a barrier to their understanding of math. Without a strong grasp of these foundational skills, progressing to more complex mathematical concepts can prove daunting.

This theme is further elaborated in the responses of students as follows:

"...I fear about taking math tests. I hate and fear solving math problems." – P11; "I am a visual learner. I want to always see the teacher. I need illustrations when learning and it makes it difficult for me to learn math because I see no visuals." – P2; "To be honest, yes, I felt difficulty in learning mathematics nowadays." – P12; "Yes, because every time I encountered math subjects specially the problem are combination of variable, numbers and exponents. I can follow the discussion and answer in a single time but when it comes to examination, I forgot all. Honestly, I'm very slow learner if it talks about math but at least today (face to face) I slightly understand math." – P14; "Some said that college algebra is very difficult which is why it makes me scared for some reason and yes they're correct, it is difficult as I expected." – P17

Subtheme 4: Math is dreary. Mathematics can pose challenges for some students, leading to feelings of discouragement and frustration due to difficulties in comprehension or progress. These negative experiences can contribute to a pervasive perception of math as a boring or difficult subject. Another factor contributing to the perception of math as boring is the way it is taught. When math instruction lacks engagement and becomes monotonous, it can further reinforce this belief.

The verbalizations of students highlight their boredom in learning the subject:

"Math is boring. I really hate learning it. One more, we always learn about numbers since first grade, now that I am in college, I still learn about numbers. I do not see a difference, rather I get bored more each math subject I take." – P20; "Math is boring. We always solve problems." – P22; "Math is boring, and the teacher is boring, too." – P1

3.1.2. Theme 2: *"Eh Kasi Sa Math Ganito":* Negative Experiences About Math

The phrase "eh kasi sa Math ganito" is a Filipino phrase that further exemplifies the negative experiences of students in the subject. Negative experiences with mathematics can significantly hinder a person's academic journey and leave lasting impressions on their perception of the subject for years. Many individuals harbor unfavorable sentiments towards mathematics, stemming from various sources such as the anxiety or apprehension they feel when confronted with mathematical concepts or the challenging experiences they've had with math instructors, among others.

Subtheme 1: Math elicits fears and panic. Mathematics can induce fear and panic in some individuals, and this emotional response can be attributed to various underlying factors (Brewster & Miller, 2023). One prominent reason is the prevailing perception about math as a challenging and tough subject which demands a high level of skill and comprehension. This perception alone can create feelings of anxiety and stress, particularly among those who have previously encountered difficulties with math or have doubts about their proficiency in the subject.

Mathematics as a subject that invokes feelings of fears and panic can be elicited in the following verbatim responses of participants:

"When I hear the word Math, I feel like I melting." – P4; "I do not have an embarrassing nor a scary experience in Math. Probably, we are not just compatible. I fear math because of the formula, so when I can't follow, I could probably be wrong. I fear of failing." – P2; "Just like in love, it's difficult to court,

I get busted at time. In math, I get failed many times." – P6; "…seems my brawn was shaking when in math class especially when I am called by the teacher to recite or solve problem on the board…" – P8

Subtheme 2: Math fosters a sense of unfittedness. Some people may feel like they don't belong in math or feel excluded from the subject because of their gender, ethnicity, or background. Some students may feel intimidated by math because they lack confidence in their ability to understand the material. They may feel like they are not smart enough or capable of learning math.

Based from the verbal responses of students, mathematics fosters a sense of unfittedness, unbelongingness for some. This could be attributed in their verbalizations:

"When in Math class, those who are good are the ones called to recite. AT times, I feel like I don't belong, I am isolated." – P12; "Math is survival of the fittest. Those who can solve are those that emerge, those cannot are submerged. – P2; "Math is for boys." – P11

Subtheme 3. Math is taught by terrors. Teachers are critical to students' mathematics learning. They provide the instruction, guidance, and support that students need to succeed in mathematics and to develop a deep understanding of the subject matter.

However, while some students may have had positive experiences with math teachers who were supportive and engaging, others may have had negative experiences with teachers who were intimidating or unsupportive. A negative experience with a math teacher can be a significant source of frustration and discouragement for students.

Participants' responses during the interview vividly describe how mathematics is taught:

"My high school math teacher is a terror. Mistakes are not allowed. Everything has to be correct and perfect. There is no room for wrong answers. I fear asking questions." – P13; "I can't forget it because math subject is our second subject in the morning and when our teacher enter into our class he always looked angry." – P19; "I hate math because I hate terror math teachers. I always feel tensed when in math class because the teacher is not friendly and always in a bad mood." – P9; "Our math teacher is full of surprises. He gives surprise quizzes and exams, or even graded recitation activities. This tenses me a lot. He seem like a perfectionist, he always wants a correct answer." – P10

Subtheme 4: Mathematical answers are similar. It's possible that some students may feel that math answers are similar or repetitive, particularly if they are working through a series of problems or exercises that involve similar concepts or procedures. However, it's important to recognize that math is a complex and challenging subject that requires a deep understanding of a wide range of concepts and skills.

During the interview conducted, students enunciated that mathematical answers seem repetitive and are similar, which may somehow affect their appreciation of the subject. This is apparently expressed in their responses:

"…funny right? Then, she lets us solve and gets mad when we have the same answers. As expected…" – P6; "In the math activities and homework given, our teacher wants us to arrive different answers. I do not see the logic. Of course, we can't do that. One problem, one answer." – P1

While some math problems or exercises may involve similar concepts or procedures, the specific context and details of each problem can vary significantly, which can require students to apply their knowledge and skills in different ways. Additionally, math problems may require students to use different strategies or approaches to solve them, which can also make them more challenging and engaging (Gurat, 2018).

Subtheme 5: Math is taxing. Math is often considered to be a challenging and demanding subject, particularly for students who struggle with math concepts or have difficulty with math skills. Some students may find

math to be taxing or frustrating because it requires them to think critically and solve problems in a logical and systematic way.

Verbalizations of participants asserted their experience about math being a taxing subject:

> "But it's not that I don't like mathematics. The reason why I don't love it is because it really stresses me out every time there is a problem or equation needed to be solved." – P16; "Everything is just the same." – P4; "Math is repetitive. Everything is done in repetition. The same concepts are learned." – P5

3.1.3. Theme 3: *"Eh Sa Math, Dapat Ganito":* Poor Math Preparations

The Filipino phrase "eh sa Math, dapat ganito" emphasizes the poor preparation activities of students. Students who prepare poorly for math might frequently develop math anxiety. When presented with mathematical tasks or scenarios, math anxiety is a prevalent psychological disorder that is characterized by feelings of stress, fear, and apprehension. Math anxiety can be caused by a variety of variables, but one major one is insufficient preparation.

When faced with math-related issues, students are more likely to feel anxious if they lack core understanding or feel unprepared or insecure in their math skills because of past academic setbacks or lack of comprehension. The fear of failing a math test or not understanding a concept can be a significant source of anxiety for students.

> "I don't feel reviewing for mathematics exams, even in math quizzes." – P1; "I am not motivated and interested in Math, it's not my cup of tea." – P7; "What is difficult about Math are the concepts taught. With this, how will I be able to learn when in the first place, I do not understand the concepts? So, how will I prepare for exams? For math class?" – P15

3.2. Muddling through Mathematics Anxiety

Math anxiety can be managed by using a variety of coping mechanisms to reduce stress and enhance math performance. Creating a positive outlook and having faith in one's capacity to learn and improve in the subject is one of the first stages. Further, participants identified some strategies they used to muddle through their mathematics anxiety. These are presented in the following themes:

3.2.1. Theme 1. Turning Difficulties into Countless Opportunities

Turning mathematics difficulties into opportunities is a mindset shift that can empower individuals to overcome challenges and grow in their math skills. Further, exploring a variety of learning resources, such as textbooks, online tutorials, and educational apps can provide different perspectives and explanations, making it easier to grasp difficult concepts.

Mathematics difficulties may not disappear overnight, but with persistent effort and a positive attitude, one can make steady progress. By viewing mathematics difficulties as opportunities for growth and learning, individuals can not only improve their math skills but also develop valuable problem-solving abilities and a resilient mindset that can benefit them in various aspects of life.

> "Learning mathematics is difficult and very challenging. The challenges I experienced is that I really couldn't understand how to use a formula. But with the help of YouTube and other applications, it helped me understand it at least a little." – P19; "The challenges I had encounter in learning (the) subject mathematics during the pandemic is it so hard to solve the problem because I didn't understand the given example or the given problem so, I don't know how to solve. My friend help me understand the lessons in mathematics." – P21; "…but some of my batch mates help me to solve and answer especially my classmate that (who are) genius in math." – P17; "Probably, it is in the mindset. When you feel it is difficult, it becomes even more difficult. But when the mindset is positive, everything turns well.." – P5

3.2.2. Theme 2. Altering Scary Math Moments into Surprises

By implementing certain strategies and fostering a positive attitude toward math, students can transform their math experiences from scary to surprising and even enjoyable.

> "Even at times I am anxious about Math, I still participate in the math activities. I am surprised that I can go with the class. I can solve problems. I can recite. At least, even it is difficult, I try to conquer my fears." – P2; "I celebrate small wins. When I pass an exam or a quiz, I treat myself with a sumptuous snack or meal. It's an indirect way of motivating more myself." – P18; "In our circle of friends, we have a deal: whoever gets the lowest score, he will have to treat the rest. This seems challenging and enjoyable. So far, I am surprised, I have not lost yet." – P22

3.2.3. Theme 3. Shifting boredom into fun times

While math can be challenging and boring for some learners, it is an important subject that is critical for success in many areas of life. With the right teaching and support, students can develop the skills and confidence they need to succeed in math and beyond. The use of various technologies and applications that are readily available could turn boredom into fun and enjoyable learning experiences for learners.

> "In the current time, math is easy to teach since teachers have a lot of resources and materials available. Videos can already be presented in class, this adds color to the discussion and could alter boredom." – P7; "Interactive games are also available. This can be utilized by math teachers. Me, I use Photomath, it's an application I downloaded in my phone, I used this to solve some math problems." – P20. "I do stretching outside the classroom whenever I feel bored in math class. This keeps me back on track." – P14.

4. Discussions

Discussions on interpretations and implications of results are presented in the following paragraphs.

4.1. Causes of Mathematics Anxiety

Mathematics is widely known for its abstract nature, requiring learners to use intuition, logic, and problem-solving abilities. However, Cresswell and Speelman (2020) point out that the subject content can be difficult to visualize or understand unless the learner has a solid foundation and is proficient in the skills required. For many students, this difficulty stems from not being able to see the connection between mathematics and the real world. In such cases, students who struggle mentally to represent numbers and shapes may not be able to make sense of mathematical concepts (Susac, Bubic, Vrbanc & Planinic, 2014). The Cognitive Theory (Sweller, 1988) explains that the working memory of humans has limited capacity. This means that students may struggle in grasping math concepts if their cognitive load is too high; this may seem overwhelming to them. Thus, it is important to reduce their load by making clear examples and using scaffolding to explain abstract ideas.

Despite its abstract nature, mathematics plays an essential role in various fields such as science, engineering, finance, and technology. It serves as a valuable tool for problem-solving and critical thinking. Moreover, in daily life, mathematics is crucial for tasks such as calculating bills, measuring distances, and making informed decisions (Sachdeva & Eggen, 2021). The perception that mathematics is reserved for a select few, and that not everyone can benefit from a solid mathematical education, remains prevalent (Kolar-Begovic, Kolar-Super & Matic, 2017). However, when math becomes accessible and engaging, students can be equipped with the skills and knowledge necessary to succeed both in academics and in life outside the classroom. An inclusive approach to teaching mathematics can break down barriers of elitism, contributing to a more equitable educational system. Moreover, the Expectancy-Value Theory (Eccles & Wigfield, 2002) supports this. This emphasizes that students are likely to engage in learning if they see its value and believe that they can succeed in the subject.

Research has shown that mathematical skills can be developed through practice and effective learning strategies, even for individuals who may not initially have a natural aptitude for the subject (Mazana, Montero & Casmir, 2019). By focusing on building a strong foundation in mathematical concepts and cultivating effective study habits, anyone can improve their math skills and grow more confident in their ability to understand and apply them. Embracing a broader perspective on mathematics and its accessibility ensures that individuals from diverse backgrounds and abilities can harness the empowering and practical aspects of mathematical education (Acharya, Kshetree, Khanal, Panthi & Belbase, 2021). The Self-Efficacy Theory (Bandura, 1977) highlights the importance of one's confidence in his abilities, as higher self-efficacy means greater persistence and improved performance in mathematics.

Mathematics can be particularly challenging for some learners for a variety of reasons. As an abstract subject, it requires the use of logic, reasoning, and problem-solving skills, which can be difficult for students who have not been exposed to these skills in other areas of their education (Yeh, Cheng, Chen, Liao & Chan, 2019). Additionally, math problems often require students to visualize nonconcrete concepts, which can be a significant challenge for those who have difficulty understanding spatial relationships or visualizing three-dimensional objects (Rahmawati, Dianhar & Arifin, 2021). Since each student has unique learning preferences, some may benefit from analytical or verbal approaches, while others may thrive with a more visual or hands-on methodology. Recognizing these diverse learning styles is crucial for educators, who must adapt their teaching strategies to meet individual needs. Gardner's Theory of Multiple Intelligences (Gardner, 1983) explains the importance of fitting teaching methods to cater different intelligences and individual differences. This approach creates a more inclusive and effective learning environment, where all students have the opportunity to succeed in mathematics.

While many students find mathematics engaging and rewarding, others may perceive it as boring or unhelpful. For these students, it can be useful to make the content more interesting and applicable to their daily lives. Additionally, seeking extra support and resources can help them succeed in math (Aguilar, 2021). However, for some students who find math boring, the perception that it is not useful (Kolar-Begovic et al., 2017) can be an obstacle. To combat this, teachers must employ effective teaching strategies that connect math to real-world applications, promote critical thinking, and spark curiosity and interest in the subject (Kumar, 2023). The Attribution Theory (Weiner, 1985) suggests that students who struggle in math are less likely to engage in the subject, and there is a need to reshape their attributions to encourage them to participate and succeed.

Math anxiety is a common issue that negatively impacts attitudes toward the subject and leads to poor academic performance. Zanabazar, Deleg and Ravdan (2023) identified that factors such as prior math experiences, gender, and academic pressure contribute to math anxiety in college students. Social pressure has also been found to exacerbate math anxiety (Kim, Shin & Park, 2023). Math anxiety goes beyond simple nervousness about math-related tasks; it can cause irrational feelings of fear even when there is no real cause for concern (Sokolowski & Ansari, 2017). Negative experiences in both home and school settings can also contribute to the development of math anxiety (Khasawneh, Gosling & Williams, 2021). Cognitive-Behavorial Theory (Beck, 1976) explains how negative thought patters associate with past experiences. With this, math anxiety is reinforced and create barriers in learning.

Gender-related stereotypes and biases significantly impact women's pursuit of math-intensive STEM careers, particularly during formative educational stages. Cultural influences and psychological factors shape their interests and beliefs, necessitating targeted interventions to promote equity and encourage female participation in these fields (Wang, Degol & Degol, 2017). To address this issue, it is essential to challenge and disrupt these gendered expectations to create a more inclusive and supportive math learning environment (Oppermann, Brunner, Eccles & Anders, 2017). While math requires logical thinking and problem-solving skills, it is not limited to any specific group of people. With the right teaching and support, anyone can develop these skills. The Social Identity Theory (Tajfel & Turner, 1979) helps explain

how group identity and social expectations influence individual behavior, which can perpetuate gender stereotypes in math.

People's perceptions of math teachers vary widely. While some may view teachers as ineffective or even intimidating, it is important to recognize that a teacher's efficacy depends on several factors, such as their instructional strategies, interpersonal skills, and the unique needs of the learners (Le, Janssen & Wubbels, 2017). Teachers play a critical role in introducing mathematical concepts, creating a supportive learning environment, and fostering a growth mindset and love of learning in students (Keiler, 2018).

To enhance student engagement and reduce math anxiety, research highlights the effectiveness of active learning strategies such as problem-based learning (Oktaviani, 2024), collaborative learning (Viscu, 2024) and real-world applications (Hetmanenko, 2024). Teachers who incorporate technology, such as dynamic geometry software, digital simulations, and interactive assessments, have been shown to improve students' conceptual understanding and motivation (Attard & Holmes, 2019). Additionally, culturally responsive teaching methods, which integrate students' backgrounds and experiences into math instruction, have been found to enhance comprehension and interest in the subject (Porter, 2021).

Moreover, teachers establish clear expectations, offer guidance to help students overcome challenges, and create opportunities for collaborative learning. By encouraging students to take risks, ask questions, and explore new ideas, teachers help them understand that math is both challenging and rewarding and can be mastered through effort and persistence (Kihwele & Mkomwa, 2022). ZPD (Vygotsky, 1978) and scaffolding strategies can further explain how teachers can provide temporary support to help those students struggling in mastering difficult concepts.

Some teaching methods, however, may not be effective for all students, particularly those who struggle with math (Cardino & Ortega de la Cruz, 2020). For instance, a lecture-based approach may not provide adequate support for students who require more individualized instruction. A math teacher's ability to engage students, explain concepts clearly, offer assistance when needed, and foster a positive learning environment plays a significant role in their effectiveness (Koskinen & Pitkäniemi, 2022).

Abstract concepts and symbolic notation in mathematics can be challenging for many students. Unlike other subjects, math requires the understanding of non-intuitive ideas, which can make it seem more difficult. Furthermore, math is cumulative; each concept builds on the previous one. Struggling with basic ideas can make it harder to understand later material (Lodge, Kennedy, Lockyer, Arguel & Pachman, 2018). Mathematics also requires critical thinking and problem-solving abilities, which can be mentally demanding and require sustained focus (Su, Ricci & Mnatsakanian, 2016).

Many studies have explored the issue of poor math preparation among students. Factors contributing to this include access to quality math education, learning disabilities, language barriers, socioeconomic factors, and motivation (Marks, Mesite, Fox & Christodoulou, 2022). For example, research has shown that students from low-income families tend to have weaker math skills compared to their peers from higher-income families, even when controlling for factors such as race and parental education level (Soares, Evans & Patel, 2018). Additionally, students with learning disabilities are more likely to struggle with math compared to their peers without learning disabilities.

4.2. Muddling through Mathematics Anxiety

Collaborative learning, as supported by research, encourages students to work together to solve math problems (Abd-Algani, 2021). In such collaborative settings, peers can offer different perspectives, explanations, and insights. Turning to classmates for help transforms math difficulties into opportunities for social learning and knowledge exchange, fostering a supportive environment for all students.

Research by Korterink (2014) and others highlights the importance of a growth mindset, the belief that abilities can be developed through effort and perseverance, in overcoming challenges in any field, including mathematics. This mindset is closely linked to neuroplasticity, the brain's ability to adapt and

grow through learning and practice. By embracing a growth mindset, students can view math difficulties not as barriers but as opportunities for cognitive growth and improvement.

One of the challenges students face in education is educational performance, which can be influenced by factors such as the difficulty of the topic, ineffective teaching strategies, or lack of understanding, all of which may erode students' confidence (Al-Salkhi, 2013). These challenges can hinder students' progress and lead to feelings of frustration, but recognizing the importance of overcoming these barriers is crucial. As Sokolowski and Ansari (2017) emphasize, mathematics is essential in everyday life—for activities such as traveling, managing finances, and tracking time. Therefore, learning math in school is not only fundamental to academic success but also vital for students' everyday functioning.

It is essential to transform math anxiety into calmness and turn intimidating experiences into fun and rewarding moments. Research shows that the environment plays a significant role in shaping the learning process. For more equitable outcomes, it is important to consider how math classrooms reflect the diversity of students, acknowledge their unique ways of thinking, and utilize their approaches to math as assets to build upon. Furthermore, honoring students' contributions can create a more inclusive and motivating classroom environment (Inclusive Mathematics Environments Early Career Fellowship, 2020).

In an article published in Edutopia (2017), Liljedahl explains that a classroom culture that does not encourage independent thinking can hinder students' ability to engage with and solve problems. He argues that students in such environments often wait for teachers to intervene and guide them through difficulties, rather than taking initiative to explore solutions on their own. To address this issue, it is crucial to create a learning environment that encourages students to think critically, engage with problems, and seek solutions independently.

To foster this type of environment, teachers can help students develop a growth mindset by providing opportunities to apply math in real-world contexts, highlighting its relevance to future careers and daily life. By promoting a diverse and inclusive learning environment, educators can help students develop a more positive and accurate view of mathematics, making the subject feel more accessible and relevant. Additionally, it is important to address the academic pressure and stereotypes surrounding math, ensuring that students are encouraged to approach learning with confidence and curiosity. A balanced and inclusive approach to education values a wide range of subjects and skills, ultimately helping students succeed in mathematics and beyond (Inclusive Mathematics Environments Early Career Fellowship, 2020).

5. Conclusions

The perspectives and experiences that students have with math are extremely diverse. For some people, mathematics is an academic discipline that they enjoy and excel in; they get a sense of satisfaction from resolving mathematical issues and equations. However, a considerable number of learners struggle with anxiety regarding mathematics, which can act as a significant impediment to their learning. This anxiety is frequently caused by unfavorable perceptions of mathematics, unfavorable experiences with mathematics, or inadequate preparation for mathematics, all of which could put pressure on the individual to perform well academically.

Students who are struggling with the problems of mathematics might develop coping strategies to help them deal with these issues. These mechanisms include transforming terrifying math moments into enjoyable times, boring math moments into tranquil times, and changing monotony into excitement. In light of this, it is necessary that efforts be made to make mathematics education more accessible, relevant, and engaging in order to assist learners in developing confidence and achieving success in mathematics.

The in-depth exploration of coping strategies that students employ to manage mathematics anxiety, particularly in the context of higher education in the Philippines, provides a unique cultural and

educational perspective that expands the existing body of knowledge relative to the research topic. This specific study delved into the emotional and cognitive mechanisms not previously emphasized in literature.

To address mathematics anxiety effectively, future research may explore intervention programs that integrate learning approaches, psychological support and curriculum revisions. Additionally, policymakers may need to design a curriculum that is flexible and math-centered. This could accommodate different learning styles and reduce rigid, high-pressure testing environment for learners. Teachers may also be equipped with strategies that provide supportive and engaging instruction catering students' needs. The use of gamification and other interactive tools may be made more accessible for mathematics anxious students.

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References

Abd-Algani, Y.M. (2021). The effect of the collaborative learning technique on students 'educational performance in math. *Journal for the Mathematics Education and Teaching Practic*es, 2(2), 81-91. Available at: https://dergipark.org.tr/en/download/article-file/2170315

Abo Hamza, E., & Helal, A. (2013). *Maths anxiety in college students across majors: A cross-culture study.* https://tinyurl.com/4fv3zkf6

Acharya, B.R., Kshetree, M.P., Khanal, B., Panthi, R.K., & Belbase, S. (2021). Mathematics Educators' Perspectives on Cultural Relevance of Basic Level Mathematics in Nepal. *Journal on Mathematics Education,* 12(1), 17-48. https://doi.org/10.22342/jme.12.1.12955.17-48

Aguilar, J.J. (2021). High School Students' Reasons for disliking Mathematics: The Intersection Between Teacher's Role and Student's Emotions, Belief and Self-efficacy. *International Electronic Journal of Mathematics Education,* 16(3), em0658. https://doi.org/10.29333/iejme/11294

Alday, R., & Panaligan, A. (2010). The effects of e-learning in mathematics to college students: The Philippines experience. In D. Gibson & B. Dodge (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2010* (pp. 2629–2633). Chesapeake, VA: AACE. https://tinyurl.com/5ejxjzea

Al-Salkhi, M. (2013). *Academic achievement and modelling of factors affecting it.* Amman: Al-Radwan for Publishing and Distribution.

Attard, C., & Holmes, K. (2019). Technology in early years mathematics classrooms. *Technology-enabled Mathematics Education* (49-68). Routledge. https://doi.org/10.4324/9781351189392-4

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review,* 84(2), 191-215. https://doi.org/10.1037/0033-295X.84.2.191

Beck, A.T. (1976). *Cognitive Therapy and the Emotional Disorders.* International Universities Press.

Brewster, B.J., & Miller, T. (2023). Reflections on mathematics ability, anxiety, and interventions. *International Electronic Journal of Mathematics Education,* 18(2), em0729. https://doi.org/10.29333/iejme/12822

Cardino, J.M., & Ortega de la Cruz, R.A. (2020). Understanding of learning styles and teaching strategies towards improving the teaching and learning of mathematics. *LUMAT: International Journal on Math, Science and Technology Education,* 8(1), 19-43. https://doi.org/10.31129/lumat.8.1.1348

Code, W., Merchant, S., Maciejewski, W., Thomas, M., & Lo, J. (2016). The Mathematics Attitudes and Perceptions Survey: an instrument to assess expert-like views and dispositions among undergraduate mathematics students. *International Journal of Mathematical Education in Science and Technology,* 47(6), 917-937. https://doi.org/10.1080/0020739x.2015.1133854

Creswell, J.W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Creswell, C., & Speelman, C.P. (2020). Does mathematics training lead to better logical thinking and reasoning? A cross-sectional assessment from students to professors. *PloS One,* 15(7), e0236153. https://doi.org/10.1371/journal.pone.0236153

Devine, A., Fawcett, K., Szűcs, D., & Dowker, A. (2012). Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety. *Behavioral and Brain Functions,* 8, 33. https://doi.org/10.1186/1744-9081-8-33

Eccles, J.S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology,* 53, 109-132. https://doi.org/10.1146/annurev.psych.53.100901.135153

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. Basic Books.

Gurat, M. (2018). Mathematical Problem-Solving Heuristics among Student Teachers. *Journal on Efficiency and Responsibility in Education and Science,* 11(3), 53-64. https://doi.org/10.7160/eriesj.2018.110302

Hetmanenko, L. (2024). The role of interactive learning in mathematics education: Fostering student engagement and interest. *Multidisciplinary Science Journal,* 6, 2024ss0733. https://doi.org/10.31893/multiscience.2024ss0733

Hwang, S., & Son, T. (2021). Students' Attitude toward Mathematics and its Relationship with Mathematics Achievement. *Journal of Education and E-learning Research,* 8(3), 272-280. https://doi.org/10.20448/journal.509.2021.83.272.280

Inclusive Mathematics Environments Early Career Fellowship (2020). *Creating More Inclusive Learning Environments in Mathematics.* Available at: http://studentexperiencenetwork.org/wp-content/uploads/2020/07/Creating-More-Inclusive-Mathematics-Environments.pdf

Johnston-Wilder, S., Lee, C., & Mackrell, K. (2021). Addressing Mathematics Anxiety through Developing Resilience: Building on Self-Determination Theory. *Creative Education,* 12(09), 2098-2115. https://doi.org/10.4236/ce.2021.129161

Keiler, L.S. (2018). Teachers' roles and identities in student-centered classrooms. *International Journal of STEM Education,* 5, 34. https://doi.org/10.1186/s40594-018-0131-6

Khasawneh, E., Gosling, C., & Williams, B. (2021). What impact does maths anxiety have on university students? *BMC Psychology,* 9, 37. https://doi.org/10.1186/s40359-021-00537-2

Khatoon, T., & Mahmood, S. (2010). Mathematics anxiety among secondary school students in India and its relationship to achievement in mathematics. *European Journal of Social Sciences*, 16, 75-86. https://tinyurl.com/4xx463bp

Kihwele, J.E., & Mkomwa, J. (2022). Promoting students' interest and achievement in mathematics through "King and Queen of Mathematics" initiative. *Journal of Research in Innovative Teaching & Learning,* 16(1), 115-133. https://doi.org/10.1108/jrit-12-2021-0083

Kim, J., Shin, Y., & Park, D. (2023). Peer network in math anxiety: A longitudinal social network approach. *Journal of Experimental Child Psychology,* 232, 105672. https://doi.org/10.1016/j.jecp.2023.105672

Kolar-Begovic, Z., Kolar-Super, R., & Matic, L. (2017). *Mathematics Education as a Science and a Profession.* Available at: https://files.eric.ed.gov/fulltext/ED577935.pdf

Korterink, B.A. (2014). *Mindset: the new psychology of success.* Available at: https://www.amazon.com/Mindset-Psychology-Ms-Bibianne-Korterink/dp/1503279464

Koskinen, R., & Pitkäniemi, H. (2022). Meaningful Learning in Mathematics: A Research Synthesis of teaching Approaches. *International Electronic Journal of Mathematics Education,* 17(2), em0679. https://doi.org/10.29333/iejme/11715

Kumar, N. (2023). Innovative teaching strategies for training of future mathematics in higher education institutions in India. *Futurity Education,* 3(1). https://doi.org/10.57125/fed.2023.25.03.02

Laguador, J. M. (2014). Examination of influence and intention towards Lyceum of the Philippines University and career choice of general engineering students. *International Journal of Management Sciences*, 3(11), 847-855. https://ideas.repec.org/a/rss/jnljms/v3i10p11.html

Le, H., Janssen, J., & Wubbels, T. (2017). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education,* 48(1), 103-122. https://doi.org/10.1080/0305764x.2016.1259389

Lee-Chua, Q. N. (2005). *Developing a problem-solving culture in the Philippines*. Ateneo de Manila University.

Legarde, M.A.A. (2022). Working with mathematical problems: an analysis of students misconceptions and its impact on mathematics learning. *International Journal of Advanced Research,* 10(03), 25-33. https://doi.org/10.21474/ijar01/14358

Liljedahl, P. (2017). Building a thinking classroom in math. *Edutopia.* https://www.edutopia.org/article/building-thinking-classroom-math

Lodge, J.M., Kennedy, G., Lockyer, L., Arguel, A., & Pachman, M. (2018). Understanding Difficulties and resulting Confusion in Learning: An Integrative review. *Frontiers in Education,* 3. https://doi.org/10.3389/feduc.2018.00049

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. *Psychology Research and Behavior Management,* 11, 311-322. https://doi.org/10.2147/prbm.s141421

Marks, R.A., Mesite, L., Fox, A.B., & Christodoulou, J.A. (2022). *Early Reading and Math Developmental Trajectories: Examining Influences of Specific Learning Disabilities and Socioeconomic Status.* https://doi.org/10.31234/osf.io/c4r7q

Mazana, M.Y., Montero, C.S., & Casmir, R.O. (2019). Investigating Students' Attitude towards Learning Mathematics. *International Electronic Journal of Mathematics Education,* 14(1), 207-231. https://doi.org/10.29333/iejme/3997

Mutodi, P., & Ngirande, H. (2014). The influence of students' perceptions on mathematics performance: A case of a selected high school in South Africa. *Mediterranean Journal of Social Sciences*, 5(3), 431. https://doi.org/10.5901/mjss.2014.v5n3p431

Oktaviani, D. (2024). Penerapan Metode Pembelajaran Berbasis Proyek Dalam Meningkatkan Kemampuan Pemecahan Masalah Matematika Di Sekolah Menengah. *Jurnal Nakula : Pusat Ilmu Pendidikan, Bahasa dan Ilmu Sosial,* 2(3), 21-24. https://doi.org/10.61132/nakula.v2i3.736

Oppermann, E., Brunner, M., Eccles, J.S., & Anders, Y. (2017). Uncovering young children's motivational beliefs about learning science. *Journal of Research in Science Teaching,* 55(3), 399-421. https://doi.org/10.1002/tea.21424

Porter, P.D. (2021). Using culturally responsive teaching and data-driven instruction in mathematics to create equity and equality. *Research Anthology on Culturally Responsive Teaching and Learning* (793-817). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-7998-9026-3.ch043

Rahmawati, Y., Dianhar, H., & Arifin, F. (2021). Analysing students' spatial abilities in chemistry learning using 3D virtual representation. *Education Sciences,* 11(4), 185. https://doi.org/10.3390/educsci11040185

Sachdeva, S., & Eggen, P. (2021). Learners' critical thinking about learning mathematics. *International Electronic Journal of Mathematics Education,* 16(3), em0644. https://doi.org/10.29333/iejme/11003

Salmi, J. (2021). Are universities better off without rankings? In *The Promise of Higher Education* (301-308). Springer. https://doi.org/10.1007/978-3-030-67245-4_46

Sparks, S. (2011). *Researchers probe causes of math anxiety*. Phys.org - News and Articles on Science and Technology. Available at: https://phys.org/news/2011-05-probe-math-anxiety.html

Soares, N., Evans, T., & Patel, D.R. (2018). Specific learning disability in mathematics: a comprehensive review. *Translational Pediatrics,* 7(1), 48-62. https://doi.org/10.21037/tp.2017.08.03

Sokolowski, H.M., & Ansari, D. (2017). Who Is Afraid of Math? What Is Math Anxiety? And What Can You Do about It? *Frontiers for Young Minds,* 5, 57. https://doi.org/10.3389/frym.2017.00057

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257-285. https://doi.org/10.1207/s15516709cog1202_4

Su, H., Ricci, F., & Mnatsakanian, M. (2016). Mathematical teaching strategies: Pathways to critical thinking and metacognition. *Journal of Research in Education and Science (IJRES),* 2(1), 190-200. Available at: https://files.eric.ed.gov/fulltext/EJ1105157.pdf

Susac, A., Bubic, A., Vrbanc, A., & Planinic, M. (2014). Development of abstract mathematical reasoning: the case of algebra. *Frontiers in Human Neuroscience,* 8, 679. https://doi.org/10.3389/fnhum.2014.00679

Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In W. G. Austin & S. Worchel (Eds.), *The social psychology of intergroup relations* (pp. 33-47). Monterey, CA: Brooks/Cole.

Viscu, I. (2024). Optimizing the educational environment for implementing active learning methodologies. *Acta et Commentationes, Sciences of Education,* 37(3), 97-105. https://doi.org/10.36120/2587-3636.v37i3.97-105

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes.* Harvard University Press.

Wang, M.-T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational Psychology Review,* 29(1), 119-140. https://doi.org/10.1007/s10648-015-9355-x

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review,* 92(4), 548-573. https://doi.org/10.1037/0033-295X.92.4.548

Yeh, C.Y., Cheng, H.N., Chen, Z.H., Liao, C.C., & Chan, T.W. (2019). Enhancing achievement and interest in mathematics learning through Math-Island. *Research and Practice in Technology Enhanced Learning/Research and Practice in Technology Enchanced Learning,* 14, 5. https://doi.org/10.1186/s41039-019-0100-9

Zanabazar, A., Deleg, A., & Ravdan, M. (2023). A study of factors causing math anxiety among undergraduate students. *International Journal of Innovative Research and Scientific Studies,* 6(3), 578-585. https://doi.org/10.53894/ijirss.v6i3.1609

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