Journal of Education and Learning (EduLearn)
Vol. 20, No. 1, February 2026, pp. 608~621
ISSN: 2089-9823 DOI: 10.11591/edulearn.v20i1.22738

Development of three-dimensional resiliency theory in solving mathematical problem

Roar Callaman[1], Daisy Palompon[2]
[1]College of Education, University of Southeastern Philippines, Davao City, Philippines
[2]College of Nursing, Cebu Normal University, Cebu City, Philippines

Article Info

Article history:

Received Jul 10, 2024
Revised Feb 10, 2025
Accepted Mar 19, 2025

Keywords:

Mathematical problem
Problem solving
Resilience theory
Theory development
Three-dimensional resilience theory

ABSTRACT

This study aims to develop a theory to understand how students cultivate and apply resilience in solving mathematical problems. Specifically, it integrates cognitive, emotional, and social dimensions of resilience to create a holistic framework. Using a deductive theory development approach, the study starts with an existing theory, formulates hypotheses, and tests them through data collection and analysis. Seven axioms were formulated leading to three propositions: i) students with higher levels of mathematics resilience will demonstrate greater persistence and effort when faced with challenging mathematical problems; ii) psychological, cognitive and social factors are influential to a student's resilience in solving mathematical problems; and iii) developing a growth attitude, fostering a supportive learning environment, and providing appropriate teacher scaffolding can help all to build mathematical resilience and problem-solving success. From these propositions, the three-dimensional resilience theory in mathematical problem solving is formulated. This theory recognizes the interplay of psychological, social, and cognitive factors. Future research could focus on testing it in various educational settings, such as different grade levels, cultural contexts, or educational systems, to assess its generalizability and robustness.

This is an open access article under the CC BY-SA license.

Corresponding Author:

Roar Callaman
College of Education, University of Southeasrn Philippines
Inigo St., Bo. Obrero, Davao City, Philippines
Email: racallaman@usep.edu.ph

1. INTRODUCTION

In the filed of education, academic resilience emerges as a vital factor in the journey of the student. It represents their ability to confront academic setbacks, manage anxiety, and withstand the pressures of their studies. In the present classrooms and broader communities, students struggle with a lot of challenges, and without appropriate support, these issues can lead to pressure and stress. If left unaddressed, these pressures can manifest as poor academic performance and an increased risk of dropping out [1]. The significance of academic resilience per se, becomes even more apparent in the face of extreme conditions, such as those posed by the COVID-19 pandemic [2]. Hence, developing coping strategies that help students succeed academically during such challenging times is the core of academic resilience.

In the context of mathematics, despite being a crucial subject that is essential for success in many different fields, still, many students struggle; and even those who do well may experience setbacks from time to time. This is evident in the 2018 programme for international student assessment or Programme for International Student Assessment (PISA) result of which Filipino students ranked second-lowest among the 79 participating countries, indicating a low level of students' mathematical problem-solving skills [3]. One factor that can help students overcome these challenges is mathematical resilience. Research has shown that mathematical resilience is positively associated with mathematical achievement and other aspects of life [4]. This is the key in developing coping strategies that will help achieve academic success during the pandemic [2]. This is probably due to the fact that resilient students are more likely to persevere during difficult situations and ask for assistance when necessary. They are also more likely to have a positive attitude towards mathematics, which can motivate them to learn and grow.

Furthermore, the core of mathematical resilience is in developing confidence in the face of uncertainty and being able to study the intricacies of mathematics [5]. As a matter of fact, the majority of the literature offers a thorough discussion of the idea of problem-solving resilience. It looks at the value of resilience in overcoming obstacles and gives techniques for enhancing resilience in problem-solving processes. The study of Allan *et al.* [6] supports the implementation of sufficiently challenging pedagogical strategies in higher education. This shows that the needs of students and the dynamics of outdoor adventure programming are compatible because these techniques did not make new members perceived vulnerability worse. This shows that including difficult experiences in higher education settings might aid in developing resilience in problem-solving.

The distinction between mathematical resilience and academic resilience, helps understand that mathematical resilience is a specific construct that equips learners to engage with and master mathematics, while academic resilience pertains to overcoming challenges in broader academic contexts. These strands come together to create a literature of resilience in education, highlighting its varied importance in influencing the process of learning [7]. Additionally, an individual's capacity to overcome obstacles is influenced by a multifaceted interaction of social support networks, environmental elements, and personality qualities. These elements are shown through resilience and problem-solving abilities. More specifically, resilience is more prevalent in gifted people with excellent problem-solving skills, but it may also be impacted by outside influences. Hence, the idea of "learning to learn" is also a potent tool that improves problem-solving skills and gives people the ability to actively govern their learning experiences. This body of knowledge collectively provides valuable insights into the development of resilience in problem-solving, particularly in educational settings.

While there are quite a number of theories and models on resilience (resilience theory, Richardson's meta-theory resilience and resiliency, individual differences model of resilience, Bronfenbrenner's ecological systems theory, compensatory model, protective factor model, challenge model of resiliency), mathematics achievement of students has still not improved, particularly the twin goals of mathematics (critical thinking and problem solving). It is in this premise that the researcher aims to develop a theory that is specific to problem solving skills of the students. Furthermore, the implications of this study lie on research and practice. In identifying the key components of mathematical resilience and understanding how it develops, the study will help mathematics educators to develop more effective interventions for supporting students in developing this trait, which in turn will lead to improved mathematical achievement for all students.

2. METHOD

This theory development study employed the deductive method of theory generating in its initial phase. The researcher brainstormed with his mentor and research experts for initial ideas and studied the literature available on the development of mathematics resilience in problem solving. Axioms relevant to mathematics resilience were generated. Grouping these axioms together, propositions were crafted. Based from these, the theory regarding the development of mathematics resilience was formulated.

The second phase involved the validation of propositions. Two studies were conducted to validate the three propositions on the theory developed. The first study is qualitative research utilizing multiple case method to validate the proposition stating that students with higher levels of mathematics resilience will demonstrate greater persistence and effort when faced with challenging problems. The second study is a mixed method study particularly explanatory sequential design to validate proposition 2 and 3 of the developed theory.

This study utilized the deductive theory development approach. A few axioms simple, true statements about how the world functions are the foundation of the deductive method. From the nature of the axioms, one can infer an explanation of the phenomenon [8]. To produce the theory on students' mathematical resilience in a problem-solving setting, the deduction process was specifically carried out using the deductive axiomatic technique.

The underlying presumptions are referred to as axioms, and the propositions are the results of these axioms. These hypotheses are tested with particular data and the proper methods. The created theory must be accepted when these premises are accepted [9]. Figure 1 illustrates the processes that the study took to generate the theory, which are representative of Padua's deductive axiomatic approach [10].

Choosing the relevant phenomenon was the first stage in developing a theory utilizing the deductive axiomatic technique. The development of the theory will center around this stage, which is critical because it could encompass a range of underlying concepts [11]. The phenomena could have its roots in the real world of affairs, in a theoretical field, or in a person's experience or intuition [12]. In this study, the researcher decided to explore on the phenomenal processes employed by students in dealing with challenging math problems.

Following the selection of the relevant phenomena, the next step is to read the numerous resources that have been reviewed. This step gives the phenomena more emphasis and clarity. It also describes how each study relates to the others being considered, puts each work in the perspective of how it helps comprehend the research problem being researched, and suggests new ways to interpret previous research [13]. Expanding knowledge base is the most important factor in the creation of theories since it helps to solidify the axioms and propositions that describe reality. In this step, comprehensive literature was conducted to gather all the related studies about the processes being utilized by students in dealing with mathematics problems.

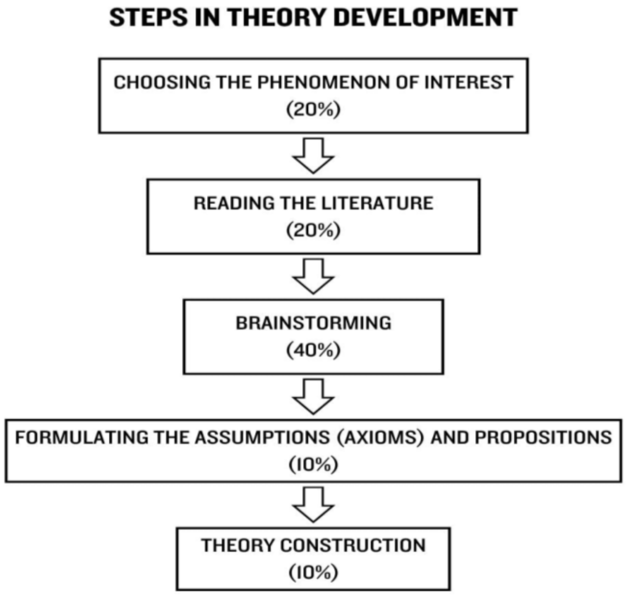

Figure 1. Deductive axiomatic approach in theory development

After reviewing the literature, the researcher gathered and examined the data to obtain different perspectives on the phenomenon and investigate its features. These helped the researcher formulate pertinent axioms for the phenomenon and make claims that made sense in light of the axioms. This stage facilitates the consistency and cohesion of the data that will be used in the theory building process [14]. In this particular step, the researcher together with his adviser exchanges ideas and brainstormed about the possible axioms based on the gathered literature.

To develop axioms and propositions, the outcomes of the brainstorming sessions were gathered, assessed, and blended together. The specification of axioms and propositions is an important step in the creation of a theory. This paper, Amgoud and Ben-Naim [15] defines axioms as the basic theorems and assumptions that underpin propositions, which are claims that follow from them. Some axioms and propositions must be followed in order for theory to be formed. After careful examination, the researcher came up with seven axioms and formulated three propositions.

The alignment of all premises to identify and conclude a theory is the last step in the deductive axiomatic approach to theory development [16]. The theory must be articulated in terms of constructions, propositions connecting those constructs, logical justifications for the statements, and presumptions defining the theory's parameters. Considering the generated axioms and propositions, the researcher formulated a theory on the phenomenon about the processes on how do students deal with challenging problem solving in mathematics.

3. RESULTS AND DISCUSSION

Mathematics is the discipline that explores the logic governing shape, quantity, and arrangement. It involves the pursuit of meaningful patterns and structures applicable to modeling and solving problems in various areas of human inquiry. While its foundational knowledge originated from basic counting, measurement, and calculation, the comprehensive understanding of mathematics encompasses disciplinary knowledge, including inquiry skills, conjecture, and proof, playing a vital role in the study and practical application of the subject [17]. In addition, it also involves several other processes such as communicating, connecting, reflecting, problem solving, representing, reasoning and proving, as well as selecting tools and strategies. Thus, learners are able to develop the aforementioned processes through academic involvement together with social-emotional learning skills, which will eventually develop their understanding of the content.

However, there are still many students who have not mastered the skill in mathematical problem-solving despite numerous theories and models on resilience such as resilience theory, Richardson's meta-theory resilience and resiliency, the individual differences model of resilience, Bronfenbrenner's ecological systems theory, the compensatory model, the protective factor model, and the challenge model of resiliency. This indicates that most students still struggle in connecting mathematics ideas while addressing problems. This ongoing challenge highlights the need for a more focused approach. In response, this study aims to develop a theory specifically tailored to enhance students' problem-solving skills in mathematics.

In spite of this, students who have been able to make good mathematical connections show that they have a good understanding of using various mathematical concepts and procedures and their relationships to solve problems [18]. Hence, it was found out that, *Math is a complex subject, learned hierarchically (Axiom 1)*. On a deeper sense, Ledesma and Linaugo [4] research in 2023 highlights the profound impact of resilience not only on academic success but also on various facets of life. Resilient students not only have a better shot at realizing their full potential academically but also tend to progress socially. This underscores the importance of nurturing intellectual resilience as a strategy to promote equity within educational systems.

As a matter of fact, during the COVID-19 pandemic, educational dynamics shifted dramatically. Murni and Juandi [19] stated that learning in tertiary schools is constrained and affects the competence of a teacher and the blended learning model was one of the right solutions in the implementation of it. It was found that the ability to use blended learning to improve literacy and mathematics resilience was shown to be 31% and 59% higher, respectively. Furthermore, a study conducted among junior high school students indicates that students' mathematical resilience is directly proportional to their expression of mathematical ideas through writing and orally. They are able to demonstrate, describe, and understand mathematical ideas [20].

In a study conducted by Zanthy *et al*. [21], they highlight the transformative power of mathematical resilience. It is a big deal in education because lots of students struggle with math. When a student has mathematical resilience, it means they can boost their confidence. They believe that math is not something they cannot conquer, even if it is tough at times. They stay confident, even when they face challenges, and keep going until they succeed. They are also willing to help their friends or groups with what they know, and they are open to receiving help and support if they need it.

Furthermore, those learners with higher level of thinking are also expected to be more hard working, more persevere, and should have more self-control than others [22]. As a matter of fact, fear and anxiety are typically avoided by students who exhibit self-control. Therefore, students are required to put forth a lot of effort in learning mathematics in order for them to have mathematical resilience. In their study "Developing mathematical resilience," they have defined a construct mathematical resilience which they use to refer to a constructive method of approaching mathematics that enables individuals to get past any emotional obstacles that arise when learning the subject, including solving mathematical problems. This study confirms that, *Unmastered previous Math lessons hinders succeeding lessons and fuels anxiety (Axiom 2).*

Moreover, empirical evidence indicates that while basic logical skills tend to develop spontaneously in individuals, more intricate logical processes, which are inherently complex, do not naturally evolve and necessitate deliberate and purposeful methodological intervention for their cultivation. This observation has only recently begun to capture the attention of methodologists, predominantly among mathematics educators at the secondary level. Simultaneously, numerous methodologists acknowledge that poor logical reasoning exhibited by secondary students stems from the absence of systematic efforts directed towards nurturing logical thinking during the formative years of primary education. Nonetheless, a comprehensive and well-elaborated methodological framework, upon which primary school educators could rely for guidance, is currently lacking [23]. Additionally, it appears that one-on-one settings are the most effective means of assisting struggling students in their mathematical development [24]. Many effective learning hours are spent employing non-curriculum-based teaching strategies that center on each student's current achievement level rather than the competencies that the curriculum expects them to have already attained.

Consequently, motivational factors play a significant role in shaping learning processes and can either enhance or impede students' academic performance. Particularly in the realm of mathematics, many students exhibit feelings of insecurity when facing math exams or coursework in their everyday school experiences [25]. When students encounter failure, their motivation to fully engage with learning tends to diminish, whereas success tends to boost their motivation to delve deeper into the subject matter [26]. Therefore, for students grappling with failure in mathematics, additional motivational factors could potentially counteract the natural decline in motivation.

In context, teaching that is, accessible, linked, inclusive, valuable, and engaging (ALIVE) means that everyone is included, engaged and making links and connections [27]. Classrooms that allow students to express their struggle and examine "wrong" answers are seen as opportunities to explore and serve to better support and motivate students to persist [28]. This is mathematical resilience which means that students have a positive mindset when they encounter challenges while learning math. When students have this positive attitude, it motivates them to believe that they can learn math, even when it is tough. This belief leads to them feeling confident in their ability to learn, even when math seems difficult. So, students with strong mathematical resilience tend to enjoy learning math and feel comfortable with it. This positive attitude also has a good impact on their thinking and learning processes [29].

Indeed, *growth mindset fosters mathematical resilience in problem-solving (axiom 3)*. As a matter of fact, having a growth mindset can assist students in maintaining a consistent level of resilience when encountering challenges in learning. In supportive environments with teachers and peers, students become more engaged, form stronger connections, are less afraid of making mistakes, and exert greater effort [30]. For instance, a large number of Manchester students in 2020 responded differently when faced with a difficult math problem. Some disengaged from the learning process, while others saw it as a chance to improve. There are various forms of disengagement, such as students putting their heads down or fidgeting with their supplies, and some even become frustrated to the point of tears. These behaviors all lead to avoiding the work. These patterns have been consistently observed over the past seven years and find them alarming. Students who avoid challenges have difficulty mastering learning goals, likely due to low effort, lack of strategies, and motivation, which hinders their progress. Additionally, students' prior experiences with math shape their attitudes toward the subject, influencing how much effort they put into solving challenging math problems [30].

This axiom underscores the fundamental role of one's mindset in the realm of mathematical problem-solving activities. Thus, it is a well-established fact that the mathematical resilience and a growth mindset are related. As described by Dweck [31], growth mindset, is the conviction that one's skills and intellect can be enhanced by commitment, perseverance, and learning from mistakes. Conversely, mathematical resilience is the capacity to persevere and adjust when faced with mathematical obstacles, exhibiting a proactive and optimistic reaction to hurdles in problem-solving.

Based on these ideas, it can be concluded that there is a connection between having a growth mindset and mathematical resilience. Dweck [31] has shown through various research that individuals with a growth mindset are more likely to embrace challenges, persist in the midst of failure, and view effort as a path to mastery. Consequently, in the field of mathematics, this way of thinking turns into a potent motivator for fostering mathematical resilience. Pupils who think they can improve their mathematics skills are more likely to approach challenging assignments with excitement because they view setbacks as chances to learn and advance.

In the educational setting, teachers need to help learners develop a growth mentality. They have a significant impact on how pupils view obstacles and failures. Strategies such as praising effort, providing constructive feedback, and highlighting the process of problem-solving over mere outcomes contribute to the cultivation of a growth mindset [32]. Outside the confines of traditional education, individuals with a growth mindset are more adept at navigating the complex problem-solving environments characteristic of fields such as mathematics, engineering, and technology. They can deal with adversities with a resilience. Thus, a *supportive learning environment nurtures mathematical resilience (axiom 4)*. This axiom encapsulates a profound truth about the relationship between mindset and the ability to overcome mathematical challenges. Hence, it can be established that there is essential connection between the classroom atmosphere and students' ability to persevere through mathematical challenges.

When it comes to mathematics, a positive and encouraging atmosphere plays a crucial role in nurturing mathematical resilience. In such an environment, students feel empowered to take risks, ask questions, and explore mathematical concepts without fear of judgment. In view of this, a harmonious relationship between teacher and students is also essential in developing mathematical resilience among students. It is when a trust and positive connection between teacher and students is created that students will become more motivated and will persevere through the challenges that come their way [33]. Indeed, a supportive learning environment also encourages collaboration among students. Peer interactions foster a sense of community, allowing students to share diverse perspectives, discuss problem-solving strategies, and learn from each other.

Furthermore, *mathematical resilience plays a crucial role in problem solving process (axiom 5)*. Assisting students in conquering challenges in solving math problems is what mathematical resilience is about. In fact, students who have strong mathematical resilience skills not only understand the theory well but can also adjust to any problems they encounter and interact with others while staying true to themselves [5]. For example, the findings of a study conducted by Nelson and Powell [34] suggest that students facing challenges in mathematics show improvement on mathematical assessments. However, despite this progress, their performance remains below that of students who do not encounter math difficulties. The identification of math difficulty is closely linked to subsequent math performance, and this diagnosis tends to persist over time. In summary, the literature highlights that students experiencing math difficulty tend to face ongoing challenges in mathematics as they progress to later grades.

The term mathematical resilience is strongly connected to self-determination theory and appear to provide a method to assist young individuals in learning mathematics. Mathematical resilience is described as "*Sustaining belief in one's ability despite personal or social challenges to mathematical well-being*" [22] and was created as a practical concept to illustrate approaches that would foster a positive attitude of determination and self-protection when students tackle mathematical concepts. True indeed that, *fostering mathematical problem-solving resilience encourage lifelong engagement with mathematics (axiom 6).*

Although research by Oszwa [35] indicates that many children with math anxiety experience declining math performance, there has been an overall increase in resilience among children and adolescents over the past few decades. In the same way, it can be clearly stated that high math anxiety negatively impacts the mathematical performance of individuals, particularly those with math learning difficulties. As a matter of fact, high levels of math anxiety are associated with detrimental effects across various dimensions, notably impairing working memory [36]. Furthermore, it was reported that the primary challenges in establishing mathematical connections were a lack of comprehension and struggles in working with algebraic manipulations [37].

Lastly, *effective teacher scaffolding can promote mathematical resilience, especially in problem-solving (axiom 7).* Teachers can provide support to help students overcome difficulties, foster a positive culture of learning and collaboration in the classroom to help students develop a favorable attitude towards learning math. Hence, it is crucial to examine the challenges students encounter when making connections in math problem solving. When offering choices, teachers must carefully balance providing enough challenge to energize students without causing fear or anxiety. Additionally, collaboration can help students meet challenges more effectively [22].

It is important to note that autonomy can be hindered in many learning situations when instructors emphasize control, push information onto disengaged students, dismiss student perspectives, or try to dictate student thoughts and behaviors. Controlling teaching can lead to frustration of needs [38]. According to Cousins *et al*. [39] students may experience autonomy-suppressing conditions when faced with pressure tactics like punishment, shouting, or phrases such as "you have to." These tactics also work against the needs for relatedness and competence. In a controlling environment, students seldom have the chance to independently solve problems or develop their own solutions, which is regarded as essential by Ryan and Deci [40] for the development of students' competence needs.

The succeeding paragraphs are generation of propositions from axioms which signifies a process of logical deduction and theoretical development within the study. It reflects the construction of knowledge, the formalization of assumptions, and the establishment of testable claims that contribute to the overall understanding of the research area. This process is crucial for theoretical development within a study. It allows researchers to build a coherent theoretical structure where each proposition is a piece of the larger theoretical puzzle.

3.1. Proposition 1: students with higher levels of mathematics resilience will demonstrate greater persistence and effort when faced with challenging mathematical problems

Proposition 1 is anchored on the following axioms: mathematical resilience plays a crucial role in problem solving process (axiom 5); and *fostering mathematical problem-solving resilience encourage lifelong engagement with mathematics (axiom 6)*. This is supported by Ishak *et al.* [41] which claims that resilience entails more than simply recovering from setbacks; it involves actively embracing challenges. As a result, resilient students are more inclined to persist through difficult problems. In developing mathematical resilience among students, it can lead to a lifelong interest in mathematics, making it an internal factor in students that plays a crucial role in dealing with learning mathematics.

In addition, according to Cheung [42], students with strong mathematical resilience are more likely to support the success of the mathematics learning process, even in challenging situations. This resilience helps them overcome difficulties in solving mathematical problems and adapt to various challenges while maintaining their identity. Windle [43] noted that mathematical resilience shares characteristics with constructs like self-efficacy, optimism, motivation, and confidence. Additionally, Agustin *et al*. [44] added that fostering intrinsic motivation in students, closely linked to mathematical resilience, can lead to a lifelong interest in mathematics.

Resilience, as it appears, thrives in those who possess self-confidence, tenacity, curiosity, and problem-solving skills. These traits empower individuals to navigate difficult situations successfully. Gifted individuals with advanced problem-solving abilities, logical and critical thinking, and a sensitivity to ethical issues are particularly resilient. However, it's essential to recognize that not all gifted students possess strong problem-solving skills, and the growth of resilience in this group can be limited by factors like parental autonomy or a lack of supportive conditions.

Further evidence of the connection between resilience and problem-solving abilities is provided, especially when it comes to learners' use of mathematics to solve problems [45]. Their results emphasize the value of resilience in educational environments by showing that people with high resilience are better able to handle obstacles and unfavorable situations related to problem-solving.

3.2. Proposition 2: psychological, cognitive and social factors are influential to a student's resilience in solving mathematical problems

Based on these axioms, the second proposition is made: *math is a complicated topic that is learnt hierarchically (axiom 1); math lessons that are not mastered prevent students from learning subsequent lessons and increase anxiety (axiom 2);* and *mathematical resilience is fostered by a supportive learning environment (axiom 4)*. This proposition is supported by Attami *et al*. [45] who found out that individuals who previously avoided mathematics can transform into individuals who are inquisitive and more attuned to their emotions; they cultivate an inner sense of control and establish a supportive social circle by learning to ask for and provide assistance. This is supported by Simacon and Veloria [46] who concluded that higher mathematical resilience is associated with a more positive attitude towards problem-solving. Szabo *et al*. [47] also clarified that fundamental logical-mathematical intelligence emerges as a person concentrates on the mathematical patterns, symmetry, logic, and beauty to resolve, create, and simulate everyday issues and activities. Additionally, they noted that instructing mathematical issue solving fosters skills required in the 21st century and, consequently, the ability to solve real-life problems.

Furthermore, students who are strong in mathematics study the subject well. Specifically, they will anticipate that doing math in a new scenario will be challenging at first, but they will have techniques or ways to get past the initial "cannot do it" reaction [48]. Conversely, socio-emotional factors encompass a wide variety of aspects, such as relationships with peers, high parental expectations, teacher attention, and kindness. Permatasari *et al*. [49] conducted a study examining the impact of perceived social support from peers, family, and educators on the development of academic resilience in the context of online learning during the COVID-19 pandemic. The research included 291 participants from Politeknik Ilmu Pelayaran in Makassar city, chosen through accidental sampling. The results show that perceived social support significantly contributes to enhancing academic resilience, explaining 71.8% of the variance. Family support was found to be the most influential element at 71.8%, followed by teacher support at 16.6%, and peer support at 12.8%. The study highlights how individuals' perceptions of support from peers, family, and teachers are crucial in providing assistance and care during academic challenges, thus promoting greater academic resilience.

The study by Sarrionandia *et al*. [50] suggests that having high resilience is linked to showing fewer signs of maladjustment, while low resilience is linked to impaired functioning. Resilience among young adults and adolescents is inversely related to family-related stress. However, more research is necessary to comprehend the protective influence of resilience on perceived stress in college students.

Building on these bases, Ahmed *et al*. [51] sought to investigate how individual psychological capital resources, such as academic efficacy and resilience, influence the involvement of master's students in the Kingdom of Bahrain. The results, framed by conservation of resource theory, revealed a favorable association between academic efficacy and resilience, as well as a positive link between teachers' support and student engagement. Furthermore, the research demonstrated a notable influence of teachers' support in the correlation between academic efficacy, resilience, and student engagement.

Moreover, Li *et al*. [52] found that resilience in learners is influenced by socio-affective, socio-economic, and affective factors. Parents high expectations, peer relations, and teacher's attention and kindness are all defined by socio-economic factors. Socio-economic factors encompass elements such as the financial support derived from parents' educational background, economic status, and social class. Affective factors include aspects like anxiety, self-belief, and motivation, among others. It's important to note that these factors can significantly impact students' academic performance and guide policymakers in creating suitable learning environments.

3.3. Proposition 3: developing a growth attitude, fostering a supportive learning environment, and providing appropriate teacher scaffolding can help to build mathematical resilience and problem-solving process

Proposition 3 is generated from the axioms: a growth mindset fosters mathematical resilience in problem-solving (axiom 3); and *effective teacher scaffolding can promote mathematical resilience, especially in problem-solving (axiom 7)*. Indeed, students with strong mathematical resilience are more likely to put in the necessary effort to solve problems in the field of mathematics. Mathematical resilience is an internal factor in students that plays a crucial role in dealing with learning mathematics [44]. In relation to this, Kooken *et al*. [53] posited that mathematical resilience is closely related to attitudes toward studying mathematics and involves three correlated factors, namely: value, struggle, and confidence.

Also, it enables students to face challenges and uncertainties in mathematics with a positive attitude and adaptive strategies [45]. In fact, Rohmah *et al*. [54] have found a positive significant and relationship between mathematical resilience and students' mathematical problem-solving abilities. It was mentioned that mathematical resilience is a non-intellectual attribute that students need in order to face anxiety, have determination, perseverance, and confidence when tackling mathematical problems.

Clearly, different students have varying characteristics and attitudes towards overcoming challenges in the mathematics learning process, known as mathematical resilience. This factor plays a role in supporting student achievement and can be nurtured through different teaching approaches. Students with strong mathematical resilience demonstrate adaptive attitudes, deal with uncertainty and challenging problems, and solve problems with logical and flexible approaches.

A holistic view of mathematical resilience, as advocated by Ishak *et al*. [41], portrays it as a comprehensive approach that seeks to gather all the necessary support for effectively tackling mathematical challenges. Although many people have to deal with mathematics till the completion of their education, many people decide to put it off as soon as classes are over. Mathematical resilience encompasses elements such as possessing a growth mindset, recognizing the personal significance of mathematics, understanding that mathematics often involves grappling with difficulties, and being adept at seeking assistance when engaged in mathematical learning.

Aside from that, teachers can play a crucial role in developing mathematical resilience in students, particularly in problem-solving. Scaffolding refers to the support provided by teachers to help students learn and solve problems. Educators use dynamic, individual support to help students with their current performance. This type of support can aid students in overcoming math problems and in developing a positive outlook on learning math. Additionally, teachers can foster a positive learning environment and encourage collaboration, while also valuing the challenges of math., and encourages discussion between students [44]. In this way, teachers can use formative assessments and observations to understand students' learning needs and spend quality time with individual students to provide support [55].

Furthermore, when it comes to tackling academic tasks, academically resilient students believe in a unique approach. They view the expression of their emotions not as a problem but as a potential part of the solution. Fundamentally, they aim to perform at their highest level and participate actively in the school environment. They make use of both contextual and emotional resources, including the support from their teachers [56].

Thus, developing mathematical resilience can rapidly raise student achievement in mathematics, and it is essential for teachers to instill this resilience in students to enhance their self-confidence to solve problems in mathematics. Mathematical resilience is a vital aspect of the problem-solving process, as it enables students to overcome challenges and uncertainties in mathematics with a positive attitude and adaptive strategies. Developing mathematical resilience through various teaching practices can significantly improve students' mathematical problem-solving abilities and overall achievement in the subject.

Further research from frontier shows that while underprivileged adolescents frequently perform poorly academically, others, referred to as "resilient students," are able to overcome familial issues and attain exceptional outcomes. In order to assist researchers and educators in guiding underprivileged pupils, this study attempts to discover elements that can lessen the influence of family socioeconomic position on academic attainment. Also, results of the study conducted by Bettinger *et al*. [57], present proof that students' confidence in their capacity to learn can anticipate their future determination. Moreover, it has been seen that these beliefs are flexible, and that they have an impact on students who were previously poor achievers or had a fixed attitude before the intervention.

The pupils' subsequent performance on a real effort assignment that involved answering challenging algebraic problems was significantly impacted by the treatment, on average. A growth attitude, according to van Aalderen-Smeets *et al*. [58], may enable students to keep their resilience levels relatively steady in the face of setbacks and learning challenges. Current research on interventions has indicated that using a growth mindset intervention may enhance students' self-efficacy [59], [60]. One college statistics course, for instance, implemented a two-semester growth mindset-based intervention. After the intervention, students in that group demonstrated higher confidence in math abilities compared to students in the control group [60].

Additionally, teacher scaffolding is essential for creating a supportive learning environment as well as for guiding students, dissecting difficult problems into manageable steps, and providing constructive criticism so that they can gain the confidence and skills needed to handle mathematical challenges on their own. In fact, according to El-Adl and Alkharusi [61] learning to learn is defined as having the ability to plan one's own learning experience, manage time and information efficiently, and actively participate in and endure the learning process. This idea has a strong relationship to the self-regulated learning paradigm that emerged in the 1980s. Regarding self-regulated learning, students take on the responsibility of monitoring and fine-tuning their learning strategies. These monitoring activities encompass reviewing study content, assessing learning challenges, gauging progress, and forecasting learning results.

When teachers are knowledgeable about safeguarding in the context of learning math, and students are able to recognize and communicate feelings of threat effectively, math teachers can promote risk-taking and the development of new skills to handle challenges safely [62]. Hence, with the ability to face obstacles, manage stress, and eventually succeed academically, children can be empowered by the idea of academic resilience in this ever-changing educational environment. As numerous studies and viewpoints have demonstrated, it goes well beyond scholastic success to encompass kids' complete life development and their ability to overcome extraordinary circumstances like the COVID-19 pandemic. The combination of techniques, support networks, and academically resilient students' distinct mindsets demonstrates a comprehensive approach that not only promotes academic success but also develops resilient, well-rounded people who can succeed in a variety of contexts.

3.4. Three-dimensional resilience theory in mathematical problem solving

The term mathematical resilience describes the capacity to persevere, adjust, and achieve in mathematical endeavors despite obstacles and disappointments. According to the three-dimensional resilience theory in mathematical problem solving, the development of cognitive, psychological, and social aspects is necessary for resilience in problem resolution. More specifically, problem-solving and critical thinking abilities are part of the cognitive component. This implies that a crucial component of resilience is the efficient management of emotional reactions, which is facilitated by cognitive capacity. As it allows people to control critical thinking and problem-solving abilities even in the face of risk factors, cognitive aspects are, in fact, essential to the development of mathematical resilience.

As part of the cognitive aspect, critical thinking enhances innovation and adaptability by helping individuals manage risks, develop fresh perspectives, and create effective solutions to complex problems. This fosters resilience by promoting a growth mindset and comfort with change, both crucial for developing resilience [63]. On the other hand, the psychological dimension includes lifelong involvement and a growth mindset, which help individuals overcome emotional barriers in learning math. Math anxiety, a feeling of stress and worry related to math, differs from cognitive deficits like dyscalculia and can negatively impact performance [64], [65]. A growth mindset, associated with embracing challenges and persistence, is crucial for developing resilience in mathematics [31]. Furthermore, encouraging a positive attitude toward math and reducing severe math anxiety can improve academic performance by alleviating its detrimental effects on working memory, particularly in students who struggle with math [66], [67].

Developing and maintaining mathematical resilience requires lifelong engagement with mathematics. Fostering a growth mindset and positive attitude toward learning math from an early age can significantly enhance resilience, leading to better learning outcomes. Sustaining this resilience involves a commitment to engaging in mathematical activities throughout one's academic and professional life [68]. Teachers play a key role by providing regular opportunities for students to practice math, develop problem-solving skills, and maintain a positive, flexible mindset. Addressing math anxiety through effective instruction such as cumulative review, clear teaching, and strong conceptual foundations is crucial for improving performance.

Social factors, on the other hand, including a supportive learning environment and effective teacher scaffolding, are also essential for building mathematical resilience [69]. A positive learning atmosphere, opportunities for collaboration, and access to educational resources help students persist through challenges. Teacher scaffolding, such as breaking down complex problems and providing feedback, supports students' learning [70]. Additionally, social elements like peer support and parental involvement contribute to resilience by encouraging a positive attitude and boosting self-confidence. Together, teachers and parents can create a supportive social environment that fosters the resilience needed for success in mathematics [63].

In summary, social elements like peer support, parental participation, an encouraging learning environment, and efficient teacher scaffolding all have a big impact on how mathematical resilience develops. While good teacher scaffolding helps students develop problem-solving abilities and boost their confidence in their capacity to achieve, a supportive learning environment gives them the tools and support they need to conquer challenges and persist in the presence of difficulties. Positive attitudes toward learning mathematics and the formation of a growth mindset can also be facilitated by parental participation and peer support. Teachers and parents may help children build the resilience necessary to overcome obstacles and succeed in mathematics by creating a supportive social environment. It is clear then that the development of students' mathematical resilience is not the result of a single component or dimension but rather the interaction and interdependence of the cognitive, psychological, and social dimensions. Therefore, the more these aspects are maintained, nurtured, or even improved, the more likely it is that a student will be resilient in mathematics.

While the study on the "development of three-dimensional resiliency theory in solving mathematical problems" provides valuable insights into the factors that contribute to student resilience in mathematics, it is important to recognize the limitations that may affect the scope and applicability of its findings. Understanding these limitations helps in interpreting the results with caution and highlights areas for further research and refinement. The limitations include but not limited to: i) the strategies and interventions derived from the theory may not be easily implemented in all educational environments due to constraints such as resource availability, teacher training, or institutional support; ii) the effectiveness of applying the theory in practice might be influenced by the readiness and willingness of both teachers and students to engage with new approaches to resilience-building, which can vary widely; iii) the focus on cognitive, emotional, and social dimensions may exclude other relevant factors that influence resilience, such as environmental or motivational aspects, potentially limiting the comprehensiveness of the theory; and iv) the theory is specifically tailored to mathematical problem-solving, which may limit its applicability to other academic subjects or types of learning challenges.

Future research could focus on testing the three-dimensional resiliency theory in various educational settings, such as different grade levels, cultural contexts, or educational systems, to assess its generalizability and robustness. Moreover, researchers may explore the application of the theory in other disciplines beyond mathematics, such as science, engineering, or language arts, to understand its broader applicability. Not only that, the theory could also inform the development of curricula that integrate resilience-building activities across cognitive, emotional, and social dimensions. This might include problem-based learning, collaborative projects, and reflective exercises that encourage persistence and adaptability.

The findings of this study provide conclusive evidence that, the three-dimensional resilience theory in mathematical problem-solving includes three primary elements that impact a person's ability to overcome obstacles when solving mathematical problems. These are cognitive, psychological, and social dimensions. Critical thinking skills, growth mindsets, and a lifetime love of learning are crucial for resilience. Social factors like supportive parents, competent educators, and secure learning settings also contribute to resilience. Math anxiety, which can be multidimensional, can be addressed by understanding these interrelated factors. By fostering cognitive skills, positive mindsets, and a supportive social environment, teachers can empower students to succeed in mathematics.

Figure 2 illustrates the process of developing mathematical resilience in problem-solving, encompassing three key dimensions: cognitive skills, psychological attitudes, and social interactions. Cognitive skills involve a methodical approach to problem-solving, flexible thinking, and a strong grasp of fundamental concepts, enabling individuals to navigate challenges. Psychological resilience is equally crucial, combining self-confidence, a growth mindset, and self-awareness. Resilient problem solvers view challenges as opportunities for growth and see mistakes as learning experiences, driven by perseverance and curiosity. Finally, social interactions play a vital role in nurturing resilience, where collaboration, mentorship, and a supportive learning environment foster growth and understanding through constructive feedback and shared learning experiences.

The three dimensions (cognitive, psychological, and social) are represented by gears in different colors. These gears, with the movement of the arrow, transfer motion or power from one dimension to the other. For example, the cognitive dimension is geared toward social factors and vice versa. Their movement will generate motion to the psychological factor as well showing their interconnectedness.

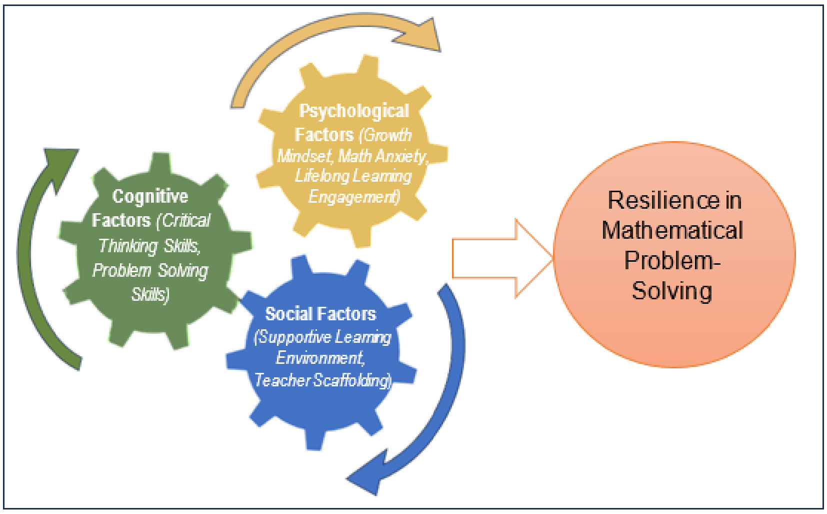

Figure 2. Framework of three-dimensional resilience theory in mathematical problem-solving

4. CONCLUSION

Mathematical resilience is not just having the courage to solve mathematical problems when presented with them. It also involves developing the cognitive skills, cultivating psychological factors, and creating solid social networks to meet the difficulties of mathematical problem-solving head-on. Through the cultivation of these three aspects, mathematics may be transformed from a challenging obstacle into a place of discovery, with resilience serving as the key to unlocking its infinite possibilities.

ACKNOWLEDGEMENTS

The authors would like to thank the University of Southeastern Philippines for the dissertation grant incentive.

FUNDING INFORMATION

This research received an incentive from the University of Southeastern Philippines to aid the necessary expenses towards the completion of the study.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Roar Callaman	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓
Daisy Palompon	✓	✓			✓			✓		✓		✓		

C : **C**onceptualization	I : **I**nvestigation	Vi : **Vi**sualization
M : **M**ethodology	R : **R**esources	Su : **Su**pervision
So : **So**ftware	D : **D**ata Curation	P : **P**roject administration
Va : **Va**lidation	O : Writing - **O**riginal Draft	Fu : **Fu**nding acquisition
Fo : **Fo**rmal analysis	E : Writing - Review & **E**diting	

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ETHICAL APPROVAL

This study underwent ethical review and clearance from Cebu Normal University with CNU ERC Code -896/2024-02.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article.

REFERENCES

[1] D. Kalaivani, "Academic resilience among students: a review of literature," *International Journal of Research and Review*, vol. 8, no. 6, pp. 360–369, 2021, doi: 10.52403/ijrr.20210646.

[2] A. Amzil, "Academic resilience and its relation to academic achievement for Moroccan university students during the COVID19 pandemic," *International Education Studies*, vol. 16, no. 1, p. 1, 2022, doi: 10.5539/ies.v16n1p1.

[3] Organisation for Economic Co-operation and Development, *PISA 2018 results (volume i): what students know and can do*. Paris, France: OECD Publishing, 2019, doi: 10.1787/5f07c754-en.

[4] J. Ledesma and J. Linaugo, "Mathematics anxiety, resiliency, and chemistry performance of grade 9 students," *Technium Social Sciences Journal*, vol. 42, pp. 49–62, 2023, doi: 10.47577/tssj.v42i1.8712.

[5] C. Lee and S. Johnston-Wilder, "The construct of mathematical resilience," in *Understanding Emotions in Mathematical Thinking and Learning*, U. X. Eligio, Ed. United Kingdom: Elsevier, 2017, pp. 269–291, doi: 10.1016/B978-0-12-802218-4.00010-8.

[6] J. F. Allan, J. McKenna, and K. Hind, "Brain resilience: shedding light into the black box of adventure procesess," *Journal of Outdoor and Environmental Education*, vol. 16, no. 1, pp. 3–14, 2012, doi: 10.1007/bf03400934.

[7] E. E. Rohaeti and D. Koswara, "Mathematical critical thinking and resiliency: experiment of grade-7 students using scientific approah," *Jurnal Riset Pendidikan Matematika*, vol. 5, no. 2, pp. 223–232, 2018, doi: 10.21831/jrpm.v5i2.17322.

[8] M. Ferrante, N. Ferro, and S. Pontarollo, "A general theory of IR evaluation measures," *IEEE Transactions on Knowledge and Data Engineering*, vol. 31, no. 3, pp. 409–422, Mar. 2019, doi: 10.1109/TKDE.2018.2840708.

[9] H. Zalaghi and M. Khazaei, "The role of deductive and inductive reasoning in accounting research and standard setting," *Asian Journal of Finance & Accounting*, vol. 8, no. 1, p. 23, Feb. 2016, doi: 10.5296/ajfa.v8i1.8148.

[10] R. N. Padua, M. M. Lerin, T. T. Tumapon, and Z. A. Pañares, "Patterns and dynamics of an arrogance- competence theory in organizations," *Liceo Journal of Higher Education Research*, vol. 6, no. 2, Dec. 2010, doi: 10.7828/ljher.v6i2.66.

[11] A. L. George, "Case Studies and Theory Development: The Method of Structured, Focused Comparison," in *A Pioneer in Political and Social Sciences*, A. L. George, Ed. 2019, pp. 191–214, doi: 10.1007/978-3-319-90772-7_10.

[12] A. H. Van de Ven, "Grounding the research phenomenon," *Journal of Change Management*, vol. 16, no. 4, pp. 265–270, 2016, doi: 10.1080/14697017.2016.1230336.

[13] H. Snyder, "Literature review as a research methodology: an overview and guidelines," *Journal of Business Research*, vol. 104, pp. 333–339, Nov. 2019, doi: 10.1016/j.jbusres.2019.07.039.

[14] D. D. Henningsen and M. L. Henningsen, "Considering the rules of brainstorming in untrained idea generating groups," *Groupwork*, vol. 30, no. 2, pp. 77–92, 2023, doi: 10.1921/gpwk.v30i2.1850.

[15] L. Amgoud and J. Ben-Naim, "Axiomatic foundations of explainability," in *Proceedings of the Thirty-First International Joint Conference on Artificial Intelligence*, Jul. 2022, pp. 636–642, doi: 10.24963/ijcai.2022/90.

[16] D. P. Stergiou and D. Airey, "Understandings of tourism theory," *Tourism Review*, vol. 73, no. 2, pp. 156–168, May 2018, doi: 10.1108/TR-07-2017-0120.

[17] R. Winter, "I am a mathematician." Cabot Learning Federation, 2022. Accessed: Mar. 24, 2024. [Online]. Available: https://haywoodvillageacademy.clf.uk/wp-content/uploads/CLF-Primary-Maths-Curriculum-July-2022-1.pdf

[18] J. Jailani, H. R. Heri Retnawati, N. F. Wulandari, and H. Djidu, "Mathematical literacy proficiency development based on content, context, and process," *Problems of Education in the 21st Century*, vol. 78, no. 1, pp. 80–101, 2020, doi: 10.33225/pec/20.78.80.

[19] S. Murni and D. Juandi, "Mathematical resilience and literacy ability through blended learning in mathematics learning," *Journal of Educational Experts (JEE)*, vol. 6, no. 1, p. 49, 2023, doi: 10.30740/jee.v6i1.179.

[20] A. Juniasani, S. Sutrisno, and A. S. Pramasdyahsari, "Mathematical communication skills of junior high school students with high mathematical resilience on opportunity materials," *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang*, vol. 6, no. 1, p. 11, 2022, doi: 10.31331/medivesveteran.v6i1.1796.

[21] L. S. Zanthy, Y. S. Kusuma, and U. Soemarmo, "Mathematical resilience analysis of senior high school students," *Journal of Physics: Conference Series*, vol. 1315, no. 1, p. 012074, Oct. 2019, doi: 10.1088/1742-6596/1315/1/012074.

[22] S. Johnston-Wilder and C. Lee, "How can we address mathematics anxiety more efficiently as a community?" in *15th International Conference of The Mathematics Education for the Future Project Theory and Practice*, 2019.

[23] O. F. O`ljayevna and S. R. Shavkatovna, "The development of logical thinking of primary school students in mathematics," *European Journal of Research and Reflection in Educational Sciences*, vol. 8, no. 2, 2020.

[24] E. A. Stevens, M. A. Rodgers, and S. R. Powell, "Mathematics Interventions for upper elementary and secondary students: a meta-analysis of research," *Remedial and Special Education*, vol. 39, no. 6, pp. 327–340, 2018, doi: 10.1177/0741932517731887.

[25] A. Devine, F. Hill, E. Carey, and D. Szucs, "Cognitive and emotional math problems largely dissociate: prevalence of developmental dyscalculia and mathematics anxiety," *Journal of Educational Psychology*, vol. 110, no. 3, pp. 431–444, 2018, doi: 10.1037/edu0000222.

[26] E. Jaffe, "Mindset in the classroom: changing the way students see themselves in mathematics and beyond," *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, vol. 93, no. 5, pp. 255–263, 2020, doi: 10.1080/00098655.2020.1802215.

[27] E. De Geest and C. Lee, *Promoting a positive learning environment*. 2nd ed. Abingdon: Routledge, 2019, doi: 10.4324/9781351060714-11.

[28] E. Gray, "Productive struggle: how struggle in mathematics can impact teaching and learning," thesis, The Ohio State University, 2019.

[29] K. N. Rokhmah, H. Retnawati, and P. Solekhah, "Mathematical resilience: is that affecting the students' mathematics achievement?" *Journal of Physics: Conference Series*, vol. 1320, no. 1, 2019, doi: 10.1088/1742-6596/1320/1/012036.

[30] R. Lazarides, H. Gaspard, and A. L. Dicke, "Dynamics of classroom motivation: teacher enthusiasm and the development of math interest and teacher support," *Learning and Instruction*, vol. 60, pp. 126–137, 2019, doi: 10.1016/j.learninstruc.2018.01.012.

[31] C. S. Dweck, *The new psychology of success*. New York: Random House, 2006.

[32] L. S. Blackwell, K. H. Trzesniewski, and C. S. Dweck, "Implicit theories of intelligence predict achievement across an adolescent transition: a longitudinal study and an intervention," *Child Development*, vol. 78, no. 1, pp. 246–263, Jan. 2007, doi: 10.1111/j.1467-8624.2007.00995.x.

[33] B. Hamre and R. C. Pianta, "Early teacher-child relationships and the trajectory of children's school outcomes through eighth grade," *Child Development*, vol. 72, no. 2, 2001.

[34] G. Nelson and S. R. Powell, "A systematic review of longitudinal studies of mathematics difficulty," *Journal of Learning Disabilities*, vol. 51, no. 6, pp. 523–539, 2018, doi: 10.1177/0022219417714773.

[35] U. Oszwa, "Mathematical resilience as a conceptual framework for school practice," *Multidisciplinary Journal of School Education*, vol. 11, no. 1 (21), pp. 99–114, 2022, doi: 10.35765/mjse.2022.1121.05.

[36] Y. Mutlu, "Math anxiety in students with and without math learning difficulties," *International Electronic Journal of Elementary Education*, vol. 11, no. 5, pp. 471–475, 2019, doi: 10.26822/iejee.2019553343.

[37] C. Dolores-Flores, M. I. Rivera-López, and J. García-García, "Exploring mathematical connections of pre-university students through tasks involving rates of change," *International Journal of Mathematical Education in Science and Technology*, vol. 50, no. 3, pp. 369–389, 2019, doi: 10.1080/0020739X.2018.1507050.

[38] E. M. Bonem, H. N. Fedesco, and A. N. Zissimopoulos, "What you do is less important than how you do it: the effects of learning environment on student outcomes," *Learning Environments Research*, vol. 23, no. 1, pp. 27–44, 2020, doi: 10.1007/s10984-019-09289-8.

[39] S. Cousins, J. Brindley, J. Baker, and S. Johnston-Wilder, "Stories of mathematical resilience: how some adult learners overcame affective barriers," *Widening Participation and Lifelong Learning*, vol. 21, no. 1, pp. 46–70, 2019, doi: 10.5456/wpll.21.1.46.

[40] R. M. Ryan and E. L. Deci, *Self-determination theory: basic psychological needs in motivation, development, and wellness*. New York: Guilford Press, 2017, doi: 10.1521/978.14625/28806.

[41] N. H. F. Binti Ishak, N. F. B. M. Yusoff, and A. Madihie, "Resilience in mathematics, academic resilience, or mathematical resilience?: an overview," *Universal Journal of Educational Research*, vol. 8, no. 5A, pp. 34–39, May 2020, doi: 10.13189/ujer.2020.081905.

[42] K. Cheung, "The effects of resilience in learning variables on mathematical literacy performance: a study of learning characteristics of the academic resilient and advantaged low achievers in Shanghai, Singapore, Hong Kong, Taiwan and Korea," *Educational Psychology*, vol. 37, no. 8, pp. 965–982, Sep. 2017, doi: 10.1080/01443410.2016.1194372.
[43] G. Windle, "What is resilience? a review and concept analysis," *Reviews in Clinical Gerontology*, vol. 21, no. 2, 2011, doi: 10.1017/S0959259810000420.
[44] N. Agustin, M. S. Noto, and I. L. K. Dewi, "Construction of student mathematics resilience through the development of sainsmatika-based teaching materials," *International Electronic Journal of Mathematics Education*, vol. 17, no. 2, p. em0683, 2022, doi: 10.29333/iejme/11835.
[45] D. Attami, Budiyono, and D. Indriati, "Mathematical resilience and mathematical problem-solving ability in Junior High School," *Journal of Physics: Conference Series*, vol. 1613, no. 1, p. 012028, 2020, doi: 10.1088/1742-6596/1613/1/012028.
[46] P. D. P. Simacon and E. V. Veloria, "Reflective thinking skills and attitude towards problem-solving as mediated by mathematical resilience of the students," *Asian Journal of Education and Social Studies*, pp. 39–51, 2022, doi: 10.9734/ajess/2022/v35i4765.
[47] Z. K. Szabo, P. Körtesi, J. Guncaga, D. Szabo, and R. Neag, "Examples of problem-solving strategies in mathematics education supporting the sustainability of 21st-century skills," *Sustainability (Switzerland)*, vol. 12, no. 23, pp. 1–28, 2020, doi: 10.3390/su122310113.
[48] J. Lobo, "Emotional support, academic resiliency, and school engagement in an online learning setting during Covid-19 pandemic," *Journal of Learning for Development*, vol. 10, no. 2, pp. 252–266, 2023, doi: 10.56059/jl4d.v10i2.826.
[49] N. Permatasari, F. Rahmatillah Ashari, and N. Ismail, "Contribution of perceived social support (peer, family, and teacher) to academic resilience during COVID-19," *Golden Ratio of Social Science and Education*, vol. 1, no. 1, pp. 01–12, 2021, doi: 10.52970/grsse.v1i1.94.
[50] A. Sarrionandia, E. Ramos-Díaz, and O. Fernández-Lasarte, "Resilience as a mediator of emotional intelligence and perceived stress: A cross-country study," *Frontiers in Psychology*, vol. 9, no. DEC, 2018, doi: 10.3389/fpsyg.2018.02653.
[51] U. Ahmed, W. A. Umrani, M. A. Qureshi, and A. Samad, "Examining the links between teachers support, academic efficacy, academic resilience, and student engagement in Bahrain," *International Journal of Advanced and Applied Sciences*, vol. 5, no. 9, pp. 39–46, 2018, doi: 10.21833/ijaas.2018.09.008.
[52] Z. Li, W. Shang, C. Wang, K. Yang, and J. Guo, "Characteristics and trends in acceptance and commitment therapy research: a bibliometric analysis," *Frontiers in Psychology*, vol. 13, 2022, doi: 10.3389/fpsyg.2022.980848.
[53] J. Kooken, M. E. Welsh, D. B. McCoach, S. Johnston-Wilder, and C. Lee, "Development and validation of the mathematical resilience scale," *Measurement and Evaluation in Counseling and Development*, vol. 49, no. 3, pp. 217–242, Jul. 2015, doi: 10.1177/0748175615596782.
[54] S. Rohmah, T. A. Kusmayadi, and L. Fitriana, "Problem solving ability of junior high school students viewed by mathematical resilience," *Universal Journal of Educational Research*, vol. 8, no. 7, pp. 3026–3033, 2020, doi: 10.13189/ujer.2020.080731.
[55] B. R. Belland, C. M. Kim, and M. J. Hannafin, "A framework for designing scaffolds that improve motivation and cognition," *Educational Psychologist*, vol. 48, no. 4, pp. 243–270, Oct. 2013, doi: 10.1080/00461520.2013.838920.
[56] L. Romano, G. Angelini, P. Consiglio, and C. Fiorilli, "Academic resilience and engagement in high school students: the mediating role of perceived teacher emotional support," *European Journal of Investigation in Health, Psychology and Education*, vol. 11, no. 2, pp. 334–344, 2021, doi: 10.3390/ejihpe11020025.
[57] E. Bettinger, S. Ludvigsen, M. Rege, I. F. Solli, and D. Yeager, "Increasing perseverance in math: evidence from a field experiment in Norway," *Journal of Economic Behavior and Organization*, vol. 146, pp. 1–15, 2018, doi: 10.1016/j.jebo.2017.11.032.
[58] S. I. van Aalderen-Smeets, J. H. W. van der Molen, and I. Xenidou-Dervou, "Implicit STEM ability beliefs predict secondary school students' STEM self-efficacy beliefs and their intention to opt for a STEM field career," *Journal of Research in Science Teaching*, vol. 56, no. 4, pp. 465–485, 2019, doi: 10.1002/tea.21506.
[59] Y. Zhang, S. Liu, L. Yang, T. Feng, and X. Yang, "Coparenting matters: the mediating effect of implicit theories of intelligence and depression on the relation between coparental conflict and STEM self-efficacy among Chinese adolescents," *Current Psychology*, vol. 41, no. 10, pp. 6687–6699, 2022, doi: 10.1007/s12144-022-03118-7.
[60] T. S. Samuel and J. Warner, "'I can math!': reducing math anxiety and increasing math self-efficacy using a mindfulness and growth mindset-based intervention in first-year students," *Community College Journal of Research and Practice*, vol. 45, no. 3, pp. 205–222, 2021, doi: 10.1080/10668926.2019.1666063.
[61] A. El-Adl and H. Alkharusi, "Relationships between self-regulated learning strategies, learning motivation and mathematics achievement," *Cypriot Journal of Educational Sciences*, vol. 15, no. 1, pp. 104–111, Feb. 2020, doi: 10.18844/cjes.v15i1.4461.
[62] S. Johnston-Wilder and J. Moreton, "Developing mathematical-resilience-promoting practices in teachers," in *11th annual International Conference of Education, Research and Innovation*, Nov. 2018, vol. 1, pp. 8228–8237, doi: 10.21125/iceri.2018.0049.
[63] B. N. Macnamara and A. P. Burgoyne, "Do growth mindset interventions impact students' academic achievement? a systematic review and meta-analysis with recommendations for best practices," *Psychological Bulletin*, vol. 149, no. 3–4, pp. 133–173, 2022, doi: 10.1037/bul0000352.
[64] M. H. Ashcraft, "Math anxiety: personal, educational, and cognitive consequences," *Current Directions in Psychological Science*, vol. 11, no. 5, pp. 181–185, 2002, doi: 10.1111/1467-8721.00196.
[65] M. Olango, "Mathematics anxiety factors as predictors of mathematics self-efficacy and achievement among freshmen science and engineering students," *African Educational Research Journal*, vol. 4, no. 3, pp. 109–123, 2016.
[66] S. Luttenberger, S. Wimmer, and M. Paechter, "Spotlight on math anxiety," *Psychology Research and Behavior Management*, vol. 11, pp. 311–322, Aug. 2018, doi: 10.2147/PRBM.S141421.
[67] N. Suren and M. Ali Kandemir, "The effects of mathematics anxiety and motivation on students' mathematics achievement," *International Journal of Education in Mathematics, Science and Technology*, vol. 8, no. 3, pp. 190–218, 2020, doi: 10.46328/IJEMST.V8I3.926.
[68] E. Khasawneh, C. Gosling, and B. Williams, "What impact does maths anxiety have on university students?" *BMC Psychology*, vol. 9, no. 1, 2021, doi: 10.1186/s40359-021-00537-2.
[69] T. Agasisti, F. Avvisati, F. Borgonovi, and S. Longobardi, "Academic resilience: what schools and countries do to academic resilience: what schools and countries do to help disadvantaged students succeed in PISA," *OECD Publishing*. pp. 1–40, 2018.
[70] J. DiNapoli and E. K. Miller, "Recognizing, supporting, and improving student perseverance in mathematical problem-solving: The role of conceptual thinking scaffolds," *Journal of Mathematical Behavior*, vol. 66, 2022, doi: 10.1016/j.jmathb.2022.100965.

BIOGRAPHIES OF AUTHORS

Roar Callaman is an associate professor of the College of Education in the University of Southeastern Philippines. He received his bachelor and master degree in teaching mathematics from the University of Southeastern Philippines. He finished his PhD in science education major in mathematics (PhD in SciEd-mathematics) at Bukidnon State University in 2018 and PhD in education major in research and evaluation (PhD-RE) at Cebu Normal University in 2024. Currently, he serves as the program head of the masters of arts in mathematics education in USeP. Moreover, he is one of the DOST-SEI Project STAR trainers in STEM education. He is an associate member of the National Research Council of the Philippines (NRCP). His research has been published in reputable indexed journals, further solidifying his commitment to advancing the field. His research interests also include assessment, mathematics education, STEAM education, research, and evaluation. He can be contacted at email: racallaman@usep.edu.ph.

Daisy Palompon is a professor of Cebu Normal University in Cebu City, Philippines. She is a licensed nurse and teacher. She finished the degrees bachelor of science in nursing, master of arts in nursing, doctor of science in nursing in gerontology nursing and PhD in research. She served as former vice-president for academic affairs, vice-president for research and publication and dean of the College of Nursing of Cebu Normal University. She was recently awarded as National Winner in the Best Mentor in Health Research Award for the Early Career or Junior Researchers 2023 with DOST PCHRD and Distinguished Educator in Gerontology National Hartford Center of Gerontological Nursing Excellence. She is one of the first Filipino to be recognized as fellow in the American Academy of Nursing. As a tenured professor, she is privileged to practice her advocacy towards advancement of nursing education and practice in the Philippines specifically on the field of gerontology and adult health nursing. Her passion for research led to many publications on health and gerontology nursing and founded the International Conference of Nursing (ICONS) since 2011. She is currently a member of the Commission on Higher Education Technical Evaluation Committee for Nursing program. She can be contacted at email: palompond@cnu.edu.ph.