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Beyond the score: a sequential study on the predictors of student resilience in mathematics problem-solving

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ABSTRACT

This sequential explanatory study aims to probe on the influences of cognitive, psychological, and social factors on mathematics resilience in problem solving. Anchored on three-dimensional resilience theory in problem solving, stratified sampling and purposive sampling were used to determine the respondents of the study coming from the six large-categorized senior high schools in Davao City (Philippines), school year 2023-2024. Data gathering was administered using the researcher-made questionnaire and interview guide, and content validated by experts. The quantitative findings, through the multiple regression test, revealed that problem-solving skills (PSS), growth mindset (GM), and teacher scaffoldings (TS) significantly predict students' resiliency in mathematics. For the qualitative data, following Colaizzi's data analysis, the following themes surfaced: i) GM and positive learning attitudes; ii) active problem-solving strategies; and iii) supportive learning environment (SLE) and TS. The results confirmed that cognitive, psychological, and social factors are significantly related to students' resiliency in solving mathematics problems and that developing a growth attitude, fostering a SLE, and providing appropriate TS, can help build students' mathematical resilience and PSS.

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1. INTRODUCTION

Problem solving is considered an important 21st-century skill. As a matter of fact, one of the fundamental abilities required by all people to handle the ever-more complicated demands of life is the capacity for problem-solving [1]. Hence, the need for students to be taught with problem-solving techniques since they help them become more independent and develop higher-order thinking skills [2]. Specifically, it assesses pertinent data, the problem's link to it, and the problem itself using problem-solving techniques. However, the fact is that there are still many students who have difficulty in improving their problem-solving skills (PSS) [3] and although problem solving skill is not new, until now several factors pose a higher risk of decreasing mathematics learning achievement which becomes a challenge as well as creates various anxiety for students. Despite this, the learning process can still be controlled if students have the ability to survive through a positive attitude as a form of adaptation from abnormal situations.

Seen from a point of view centered on human psychology, there are many definitions of resilience that look at subject specifics as well as various conceptual trends due to the widely accepted need to clarify and define its construct. In the context of this study, mathematical resilience is shown from a positive attitude to overcome anxiety, fear in facing challenges and difficulties in learning mathematics. These positive attitudes include hard work and good language skills, self-confidence, as well as being diligent and tough in dealing with difficulties, being able to work or study collaboratively with peers, have language skills to express mathematical understanding, and master mathematics learning theory [4].

Furthermore, mathematical resilience acknowledges social and emotional responses to the subject that need to be anticipated and managed to support enjoyment and success. There are four key aspects in building mathematical resilience: i) having a growth mindset (GM); ii) believing that mathematical capability can improve through effort with effective strategies; iii) knowing that math can have personal value, is of value in the world and that the learner is valued as a mathematician (e.g. in their class), knowing that learning math can involve struggle and ‘getting stuck’ and that this is to be expected rather than avoided; and iv) knowing how to find and enlist support to stay in the ‘growth zone’ [5].

Given the different definitions of mathematics resiliency, it is quite interesting on the part of the researcher to study the intricate interplay of cognitive, psychological, and social factors that significantly shapes an individual’s mathematics resiliency in problem-solving. Moreover, the researcher believes that understanding and addressing these multifaceted influences can foster a resilient and adaptive approach to mathematical problem-solving that ultimately enhances the individuals’ capacity to navigate and conquer the complexities of mathematical tasks.

Unlike traditional resilience theories that focus primarily on individual grit, the three-dimensional resiliency theory [6] posits that mathematical success stems from the synergy of cognitive, psychological, and social factors. This study validates the second proposition of the theory which states that the cognitive, psychological and social factors are influential to a students’ resiliency in solving mathematical problems. It also determines the validity of the third proposition stating that developing a growth attitude, fostering a supportive learning environment (SLE), and providing appropriate teacher scaffolding (TS) can help build mathematical resilience and problem-solving process. Furthermore, this research seeks to determine the cognitive, psychological, and social factors that influenced students’ mathematics resilience; and gain deeper insights into the lived experiences and perspectives of students with varying levels of resilience, focusing on their cognitive processes, emotional responses, and social interactions during problem-solving activities.

2. METHOD

This study utilized an explanatory sequential mixed-methods design. In this design, researchers typically connect the two phases by selecting qualitative participants based on the quantitative results from the first phase [7]. Specifically, the study applied the follow-up explanation model, wherein the researcher sought to clarify and enrich the quantitative findings through qualitative data. The qualitative data were used to interpret and explain the results obtained from the quantitative analysis. The quantitative component employed a descriptive-correlational approach, while the qualitative part used a descriptive phenomenological approach. This design was appropriate because the study aimed to determine the significant cognitive, psychological, and social factors influencing students’ mathematics resiliency by administering a survey questionnaire to the respondents, followed by an in-depth interview to support and contextualize the quantitative results.

The study was conducted in six large public senior high schools (SHS) in Davao City during school year (SY) 2023–2024. These schools have the highest number of enrollees in the division and are located across the city’s three congressional districts, ensuring geographical diversity in the sample. For the quantitative data, the respondents were 579 non-science, technology, engineering, and mathematics (STEM) SHS students enrolled in the second semester. The sample consisted of 244 males (42.14%) and 335 females (57.86%). According to Comrey and Lee [8], a minimum of 500 observations is ideal in factor analysis to establish validity, reliability, and to support multiple linear regression. Stratified sampling was used to determine the number of respondents, as recommended by Creswell [9], which involves dividing the population into homogeneous strata based on certain characteristics. Two non-STEM classes per school were randomly selected, resulting in a total of 12 classes and 579 student respondents.

For the qualitative phase, 10 participants were selected from the survey to take part in follow-up interviews: six who demonstrated high levels of resilience and four who scored low. All participants volunteered to share their personal experiences and perspectives. They were identified through purposive sampling, which is appropriate when the researcher determines what information is needed and selects individuals capable and willing to provide it [10], [11].

A researcher-made questionnaire was used for the quantitative phase. The 4-point Likert scale questionnaire was validated by a psychometrician or psychologist, a language expert, and a mathematics education expert. A confirmatory factor analysis (CFA) was conducted to examine whether the questionnaire items aligned with the latent construct of mathematics resilience [12]. Results revealed seven constructs with their corresponding composite reliability (CR): 7 items for PSS (CR=0.772); 4 items for GM (CR=0.760); 9 items for lifelong learning engagement (LLE) (0.821); 9 items for critical thinking skills (CTS)

(CR=0.799); 10 items for math anxiety (MA) (CR=0.858); 10 items for SLE (0.896); and 9 items for teaching scaffolding (0.891). Meanwhile, the interview guide for the qualitative phase was crafted after the quantitative analysis and validated by two qualitative research experts. It consisted of 10 open-ended questions designed to elicit students' experiences in mathematical problem solving.

To gather data, the researcher first sought permission from the schools division superintendent and school principals, as well as approval from the ethics research committee. The 579 SHS respondents were identified through stratified random sampling, with two sections per school randomly chosen. The questionnaire and interview guide were validated by five experts whose feedback informed the final version of the instruments. The questionnaire was administered via Google Forms, and students were given 15–30 minutes to respond. Interviews were conducted after analyzing the quantitative results. The collected data were then sorted, tabulated, and subjected to statistical analysis, while the recorded interviews were transcribed and analyzed thematically. Hypotheses were tested at the 0.05 level of significance.

Multiple regression analysis was employed to determine the influence of the independent variables—CTS, PSS, GM, MA, LLE, SLE, and TS —on the dependent variable, mathematics resiliency in problem solving. A two-tailed test at the 0.05 level of significance was applied. For the qualitative data, Colaizzi's seven-step thematic analysis was used. This involved repeatedly reading the interview responses, extracting significant statements, formulating meanings, clustering similar meanings into themes, producing an exhaustive description of the phenomenon, identifying its fundamental structure, and returning the synthesized findings to the participants for validation.

Prior to data collection, the researchers obtained ethics clearance from the Cebu Normal University's Research Ethics Committee-CNU ERC Code-896/2024-02. The main researcher briefed the student-respondents on the study's purpose and benefits. Those who consented were provided with informed consent or assent forms and were asked to sign and date them to confirm their voluntary participation.

3. RESULTS AND DISCUSSION

Quantitative findings are first reported to identify the significant cognitive, psychological, and social factors that influence students' mathematics resiliency. These results then guided the qualitative phase, where students' experiences were explored to clarify and deepen the understanding of the patterns revealed in the statistical analysis. Together, the integrated findings provide a coherent explanation of how various predictors shape students' resilience in mathematical problem-solving tasks.

3.1. Quantitative findings

In a multiple regression analysis study, it is vital to ensure that the assumptions of no multicollinearity have been satisfied. In statistics, multicollinearity exist when two or more predictor variables are highly correlated [13]. As reflected in Table 1, the Pearson correlations among the seven predictive variables were calculated. It can be noted that none of the variables had a threshold of 0.80. This result shows that no two variables are closely related to each other. Thus, the assumption of no multicollinearity has been satisfied.

Table 1. Correlation among the predictor variables

Variables	CTS	PSS	GM	MA	LLE	SLE	TS
CTS		0.743	0.414	-0.093	0.595	0.549	0.528
PSS	0.743		0.471	-0.069	0.545	0.575	0.526
GM	0.471	0.414		0.021	0.560	0.521	0.535
MA	-0.093	-0.069	0.021		0.111	0.098	0.134
LLE	0.595	0.545	0.560	0.111		0.598	0.540
SLE	0.549	0.575	0.521	0.098	0.598		0.770
TS	0.528	0.526	0.535	0.134	0.540	0.770	

In Table 2, the estimate for each predictor variable represents the expected change in mathematics resiliency associated with a one-unit increase in that variable, while holding all other variables constant. This value quantifies the direction and strength of the relationship. A positive estimate signifies that higher values of the predictor variable are associated with greater mathematics resiliency, and vice versa for a negative estimate. Meanwhile, the standard error (SE) reflects the precision of the estimated coefficient. Smaller SE values indicate more precise estimates, while larger SEs suggest greater uncertainty. It helps us gauge the confidence interval around the estimated effect size.

The t-statistic indicates how many SE the coefficient estimate is away from zero. It is used to assess the statistical significance of the relationship between the predictor and the outcome variable. A statistically significant coefficient (based on a chosen alpha level, often 0.05) suggests that the observed association is unlikely due to chance. The corresponding p-value represents the probability of observing a t-statistic as extreme as the one calculated, assuming no real relationship exists (null hypothesis). Smaller p-values provide stronger evidence against the null hypothesis, indicating a statistically significant association.

Table 2. Multiple regression of mathematics resiliency

Predictor	Estimate	SE	T	p
Intercept	2.107	0.144	14.614	0.000
PSS	0.141	0.050	2.798	0.005
CTS	-0.025	0.055	-0.45	0.653
GM	0.077	0.036	2.141	0.033
LLE	0.048	0.049	0.981	0.327
MA	0.052	0.026	1.96	0.050
SLE	-0.036	0.051	-0.704	0.482
TS	0.107	0.051	2.116	0.035

The regression results show that four of the seven independent variables which are, CTS, LLE, MA, and SLE, do not significantly predict students' mathematics resiliency in problem solving, as indicated by their p-values being above 0.05. This means there is insufficient evidence to conclude that these factors are related to resiliency. In contrast, three variables which are PSS, GM, and TS are statistically significant predictors. Specifically, PSS strongly influence students' mathematics resilience, with a regression coefficient of 0.141 and a p-value of 0.005, indicating that higher PSS are associated with greater resiliency. Overall, the findings highlight that cognitive, psychological, and social factors play a crucial role in shaping students' resilience in mathematics.

The result is in conformance in the study of Harsela and Asih [14] who viewed that the achievement of students' ability to solve mathematical problems affects their resiliency in mathematics. Students are quite capable of overcoming the difficulties they face when learning mathematics. Additionally, the research indicates that there is a positive and significant relationship between mathematical resilience and student problem-solving ability, with mathematical resilience being used to predict the level of academic ability. This suggests that students' achievement of mathematical problem-solving abilities at a moderate level may also be influenced by their level of mathematical resilience.

The same is true with the study conducted by Harsela *et al.* [15] which shows that, while the effect varies depending on the learner type, mathematical resilience affects students' capacity to solve mathematical application and word problems. While independent learners with only moderate resilience did not significantly improve in their ability to solve word problems, those with excellent resilience were better able to overcome obstacles. In addition, the achievement of mathematical resilience, both overall and based on mathematical prior knowledge, is not significantly affected by the type of learning model that is used. Also, students who receive instruction using problem-based learning models do not significantly outperform students who receive conventional instruction either overall or based on prior knowledge in mathematics [16].

GM is also found to be statistically significant in predicting students' mathematics resiliency based on the results of the multiple regression analysis. The factor has an estimated regression coefficient of 0.077 and an estimated SE 0.036. These values indicate the precision of the regression estimate, which suggests that if the students possess a high level of GM, their mathematics resiliency in problem solving will increase and that the estimated value is precisely the true value because it is closer to 0. On the other hand, there is compelling evidence that the variable GM is very important in math resiliency, as indicated by the computed t-statistic value of 2.141 and the p-value of 0.033.

Indeed, GM interventions have demonstrated encouraging benefits in raising students' motivation [17]. According to previous research, students who had GM interventions showed greater levels of intrinsic drive and a greater sense of confidence in their capacity to overcome challenges and advance academically. Likewise, Johnston-Wilder and Lee [18] discovered that GM interventions had a favorable impact on students' self-efficacy beliefs, hence augmenting their will to persevere through difficult activities. As a matter of fact, it can help protect students from academic stress by encouraging them to view failure as an opportunity to learn and improve [19]. Furthermore, Harbert [20] learned that students who believe they are "bad at math" approach every work with this mindset, fearing they will be mistaken. Hence, students start to withdraw and stop participating in group activities. Consequently, learners often give up before they even try because of the well-known math stereotypes and their fear of humiliation or shame in the classroom.

Using structural equation modeling, Chen *et al.* [21] discovered that middle school students who have a GM are substantially more likely to achieve academic success. Cognitive-behavioral adaptability, which is the capacity of students to modify their learning strategies and persevere in the face of academic difficulties, influences this relationship. Mathematical resilience is a positive attitude that arises when learners find mathematics difficult and they come up with innovative ways to solve the problem. It is an attribute, behavior, or deed that results from adjusting to difficult circumstances [22]. Additionally, building mathematical resilience promotes students' confidence and willingness to engage in mathematical learning while safeguarding their wellbeing during the study process [23].

Furthermore, research shows that although students often carry negative emotions from past mathematics experiences, these feelings can be overcome with appropriate support. According to study by Cousins *et al.* [24], learners were able to move beyond fear and discomfort in mathematics when they received sensitive encouragement, effective instructional strategies, and opportunities to build their mathematical resilience. GM interventions have also demonstrated positive effects on academic performance. A study by Burnette *et al.* [25] reported significant improvements in students' achievement when they engaged in activities such as goal-setting, effort-focused feedback, and explicit GM instruction. Similarly, Mohamoud [17] found that students who participated in GM programs attained higher mathematics grades than those who did not. In the present study, TS emerged as a meaningful predictor of students' mathematics resiliency in problem solving, supported by a statistically significant p-value of 0.035. This indicates strong evidence that effective guidance from teachers contributes to students' ability to persist and adapt when faced with mathematical challenges.

The analysis reveals that TS plays a meaningful role in enhancing students' mathematics resiliency. The regression coefficient of 0.107 indicates that for every one-unit increase in TS, student resiliency is expected to improve by 0.107 units, assuming all other variables remain constant. This positive coefficient signifies that increased support from teachers is associated with stronger student resilience in mathematics. The precision of this estimate is supported by a SE of 0.051, and the t-value of 2.116 provides further evidence that the coefficient significantly differs from zero, reinforcing the variable's predictive power. Literature also supports this finding. As noted by van de Pol *et al.* [26], scaffolding involves timely, contingent assistance that gradually fades as learners gain competence, and this process is highly correlated with how effectively students apply teacher support. Students are more likely to benefit from scaffolding when teachers provide timely, responsive guidance tailored to learners' needs.

Indeed, the attitudes and experiences that students have with mathematics are also greatly influenced by their teachers. Intentionally or unintentionally, MA can cause teachers to transmit their discomfort to students, which can exacerbate negative attitudes toward the subject and lower the level of support in the classroom. Because it may reinforce broader societal stereotypes about mathematical aptitude, this anxiety may have an impact outside of the classroom. This underscores the importance of training teachers to ask probing questions, assess student comprehension, and adjust support accordingly until students can independently apply their learning [27]. As a matter of fact, Calor *et al.* [28] states that, by providing social and analytical support that is adapted to students' zones of proximal development, math teachers can increase student engagement and deepen their conceptual understanding. Overall, the model identifies PSS, GM, and TS as significant predictors of mathematics resiliency, affirming the study's proposition that cognitive, psychological, and social factors collectively influence students' ability to persist and succeed in mathematical problem-solving.

3.2. Qualitative findings

The researchers conducted interviews with students, who agreed to be interviewed, reaching the saturation point at the 10th participant. A total of 49 significant statements were extracted. There were 33 formulated meanings and three themes emerged from the analysis, which are as: i) GM and positive learning attitude; ii) active problem-solving strategies; and iii) SLE and TS.

3.2.1. Growth mindset and positive learning attitudes

One of the aspects that is essential to successfully deal with mathematics problem is to foster GM and positive learning attitudes. This theme empowers students to tackle math with confidence and willingness to learn from their experience. GM enables students to see mistakes and setbacks not as failure but as an opportunity to learning. Positive learning attitudes allows students to approach difficulties with willingness and enthusiasm.

Importance of GM. This emphasize that mathematics confidence is not a fixed trait, but rather a skill that can be developed. Confidence in math is a skill that can be learned and improved over time. The more you practice and learn from mistakes, the more confident you will become in math. This concept was articulated by the participants during the interview. They mentioned:

> "*Sometimes I feel confident, but other times I don't. It depends on whether I can understand the questions easily and if they make sense to me.*" (I1)

"*It depends. I feel confident if I can solve a problem in a short amount of time and also get the correct answer. But there are times when you get the answer wrong, so it really depends on the situation on whether I'm confident or unsure about my answer.*" (I2)
"*Actually, sometimes I get excited and confident solving these problems. Like right now, with what Sir Sean taught us about probability, we already learned some of it in Grade 10 so we feel more confident solving it even though it's more difficult now.*" (I3)

Moreover, the importance of a GM is being highlighted where challenges are seen as avenue to learn and improve. Classrooms that allow students to express their struggle and examine "wrong" answers are seen as opportunities to explore serve to better support and motivate students to persist [29]. This insight allows students to view mistakes as stepping stones to mastery, fostering confidence in their ability to learn from errors and ultimately succeed in mathematics. The participants pointed out:

"*Sometimes I'm confident, sir, and other times I'm not because I feel like my answer might be wrong, but then when I answer, it turns out to be right, so I don't know what to think about myself.*" (I4)
"*Yes, sir. Because you can learn from doing it. So, by just trying, I think I can figure it out. So, it's not a problem for me to face new problems.*" (I5)

This finding is supported by the study of Aalderen-Smeets *et al.* [30] which believes that the adoption of a GM could help students to maintain a relatively stable level of resilience when facing failure and difficulties in learning. Also, Dweck [31] added that there has been a plethora of research showing that individuals with a GM are more likely to embrace challenges, persist in the face of setbacks, and view effort as a path to mastery. Furthermore, the study conducted by Xiao *et al.* [32] implies that encouraging students to have a GM and improving their general well-being through constructive teaching methods can increase their motivation to learn, promote their general wellbeing, and eventually result in better academic achievement.

Developing positive attitudes towards challenges. Cultivating a positive attitude towards challenges is key to unlocking success in math. This means viewing difficulties as opportunities to learn and grow, rather than an obstacle. Students who embrace challenges can develop a sense of excitement about tackling new problems. They see mistakes as natural part of the learning process, not a reflection of their intelligence. As a matter of fact, this subtheme was brought up by the participants during the interview. Participants said:

"*A chance to learn and grow because I know that we are not perfect and it is normal for us to make mistakes as long as we are supposed to do it because we will still improve.*" (I3)
"*At first, I'll of course be disappointed at myself and I'll start doubting myself, but that doesn't mean that I can't grow and learn a lot from it.*" (I10)

These claims were supported by the other participant who sees setbacks as an opportunity to correct mistakes, and to learn lessons. They stated:

"*For me, it is a chance to learn and grow because of course, as the saying goes, lessons can be learned from mistakes.*" (I2)
"*I see it as an opportunity to grow, sir. It is because it helped me to correct my wrongs and it's also a challenge for me to be more determined in solving more math problems.*" (I5)
"*I take it as a learn because every day there is a new way to learn.*" (I6)

The study of Hwang and Son [33] supports this claim stating that students with positive attitudes are more likely to succeed in mathematics. They emphasized that attitude towards mathematics has a significant relationship with mathematics achievement. In addition, a student's positive attitude towards mathematics might increase their mathematics-related hippocampal activity and memory-retrieval activity in the brain, which could help them to achieve high mathematics performance [34].

3.2.2. Active problem-solving strategies

One of the themes that emerged when students are ask on the factors that help them build their resiliency in solving mathematics problems is active problem-solving. The theme highlights the importance of developing and utilizing effective problem-solving strategies in mathematics. Importance of understanding the problem. Understanding the problem itself is the foundation to successfully solve the problem. The subthemes emphasize that students need to grasp core concepts, decipher the wording and visualizing the problem. This was emphasis when one participant mentioned:

"*If the problem is a word problem, I always try to understand the problem first to make it easier to solve and get the answer. If the questions already have numbers given, then I ask for help and check my notes to see what the solution is for that specific question. I usually identify the given information and what is being asked in the problem.*" (I1)

By taking time to truly understand the problem, students can approach strategically and choose the most appropriate solution method. This is supported by the study of Sinaga *et al.* [35] which posited that students' problem-solving understanding has a significant influence on mathematics learning. Hence, when students have a more positive perception of the mindset environment, they are more likely to achieve better results [36].

Developing PSS, this subtheme goes beyond simply knowing how to solve problems. It focuses on the various strategies and skills students develop to solve problems in mathematics effectively. It emphasizes the importance of moving beyond rote memorization and towards a more flexible and adaptable approached. These includes practice and effort, strategic use of resources, connecting new problems to prior knowledge, analyzing mistakes and developing self-learning habits. In essence, regularly engaging with diverse problems allows students to solidify their understanding of mathematical concepts and their applications. Students' effort and practice in solving problems lead to knowledge gain. This was highlighted when one of the participants stated:

"*Yes, if you don't put in effort, you don't try to solve problems, and you don't practice how to solve them, how can you gain the knowledge to solve other questions?*" (I3)

Apart from this, participants also exclaimed that strategic use of resources leads students to confront challenges. This includes textbook and notes references, online tools and peer and teacher guidance. They said:

"*My strategy is to take notes on our lessons, and then when we have activities, I refer back to my notes to see how to answer them.*" (I4)
"*I would ask the teacher to help me with that because it's the teacher's duty to help me with my difficulties, especially in math. So, if the teacher is available to teach and guide me, then I'm up for it.*" (I5*)*
"*When I go home and I still can't understand the equation itself, I'll find tutorials from YouTube.*" (10)

The result of the study is contrary to the findings of Dixit *et al.* [37]. It revealed that students who use the conventional self-regulated learning approach only pay attention to the results of tests and feedback provided by their teacher. They seldom have behaviors of looking at the supplementary materials, adding or deleting notes. Moreover, taking initiatives to learn independently strengthens problem-solving abilities. This comprises actively seeking out additional practice problems, exploring alternative solution methods and researching relevant concepts and formulas to deepen understanding. Participants responded:

"*First, I recall what Sir Sean taught us, different topics, and then I create my own questions that are more difficult to see if I can answer them or not.*" (I3)
"*I just do self-learning now because math class isn't that good anymore, sir.*" (I7)

Learning a single technique by itself is not the goal of improving problem-solving abilities as a whole. It involves developing an approach that blends these many components in a flexible and adaptive manner. The result is in line with the study of Harsela and Asih [14] who viewed that the achievement of students' ability to solve mathematical problems affects their resiliency in mathematics. Similarly, the efficacy of problem-based learning in improving problem-solving abilities is demonstrated by the efficient application of active learning techniques to skill development, which is becoming more and more important in the modern world [37]. As a whole, by mastering these active strategies, students approach math with confidence, flexibility, and the ability to find effective solutions to any problem they encounter.

3.2.3. Supportive learning environment and teacher scaffolding

This theme captures the importance the role a SLE and effective TS play in fostering math resilience and students' success. This is not a one-sided affair, but rather a collaborative effort that empowers students to thrive in solving mathematics problems. The theme comprises three subthemes: clear communication and instruction, engaging activities and personalized support, and access to resources and support.

Clear communication and instruction. A SLE starts with a foundation of clear communication and instruction. Complex mathematical concepts can be daunting. Clear explanations that break down topics into manageable steps and utilize concrete examples are essentials for student understanding. The participants manifest the same experienced, as they mentioned:

> "*I'm improving because of our teacher. Before, I didn't feel good in math, but now our teacher is very approachable and easy to talk to. If you have any confusing questions, he can easily explain them, and his examples are very clear and easy to understand.*" (I1)
> "*Our teacher explains things very well, very clearly. You can't help but understand because his examples are directly related to the lesson and include every step, even small details. He elaborates on his explanations so I can understand them.*" (I2)

By establishing this, teachers equip students with a solid foundation for understanding mathematics. This would provide confidence to students to faced difficult mathematics problems.

Engaging activities and personalized support. This subtheme emphasized that incorporating engaging activities and personalized support creates an inclusive learning environment where students feel comfortable taking risks, asking questions, and persisting through challenges. Learning mathematics does not have to be dry and monotonous. Activities like games, hands-on projects, and group work can make the learning process more interactive and enjoyable. This was propounded by the participants when they mentioned in the interview. They said:

> "*Yes, especially when he gives pop quizzes. My classmates, instead of feeling sleepy, get excited because of the pop quizzes.*" (I3)
> "*He's very easygoing, but his mystery boxes motivate me to answer because he has something to give (as a reward).*" (I2)
> "*Yes sir, the activities you give us are things we can apply to ourselves, sir, like the coin toss activity.*" (I4)

Meanwhile, a SLE recognizes individual needs. Teachers who provide differentiated instruction can cater to different learning styles and paces. This may be involve providing additional explanations, alternative resources, or individualized feedback to students. Participants mentioned:

> "*I like how he teaches me. He'll say something like 'I8, this is how you can solve this equation,' and I can really catch up because I feel like Sir is a very good teacher. He really tries his best to explain things to his students.*" (I8)
> "*He provides a file with content related to the topic, and the information there is clearer.*" (I1)

Access to resources and support. This subtheme underscores the importance of providing students with the tools they need to thrive in mathematics. This includes clear instructional guides for independent practice, access to external learning resources that cater to different learning styles, visual aids like diagrams and formulas for reference, and a teacher who is consistently available for questions and guidance. The study of van de Pol *et al.* [26] clarifies the scaffolding process and its potential impact on students' learning. As a matter of fact, this subtheme was brought up by the participants during the interview. They said:

> "*Uhm, like the guides Sir sends us on how to solve a particular question.*" (I3)
> "*Sometimes he'll give us a YouTube source to understand the concept clearly or the easiest way to figure it out. Sometimes, he explains it himself.*" (I5)
> "*This semester, yes, he sends images with formulas on how to solve problems and explains what the topic is about.*" (I6)
> "*Maybe he's good, sir, although he might not always be there to teach us, sir. Sometimes, he gives just one example, then after that, he gives us a quiz.*" (I7)

By providing students with access to a variety of resources and ensuring consistent support, teachers empower them to take ownership of their learning and become independent problem-solvers. Ultimately, develop the resiliency to persevere through challenges in mathematics. Overall, a SLE and TS create a dynamic partnership between students and teachers. A SLE is a pivotal predictor in promoting student engagement, motivation, and overall academic success [38]. Students feel empowered to learn, ask questions, and tackle challenges. This in turn, fosters a positive attitude towards math.

3.3. Data integration

In a mixed methods study, data integration is an important aspect. It refers to the method of combining and interpreting the quantitative results and qualitative findings of the study by Creswell [39].

Also, the approach can be used when: i) participant-driven integration is crucial for capturing the target group's viewpoints; ii) visual support is necessary to lower language or knowledge barriers; and iii) real-time integration is necessary for quick interpretation. The practical impact of research in real-world settings can be increased by using this approach to help practitioners better understand research findings, actively participate in data interpretation as it is gathered, and use these insights to guide their practices [40]. Table 3 shows the data integration of this sequential explanatory study.

Table 3. Data integration

Topic	Quantitative data	Qualitative data
Predictors of mathematics resiliency	Problem solving skills predicts mathematics resilience (r=0.141, p=0.005)	R2: "*Understand, focus, try, and solve. Of course, if you understand the problem, you know what formula you need to use. You also need to focus... Then I try to solve it, and if I don't get the right answer, I try again using new things or strategies*." R3: "*First, I recall what Sir Sean taught us, different topics, and then I create my own questions that are more difficult to see if I can answer them or not*." R-4: "*Yes, sir, because I challenge myself to improve at home, sir, so that when I come to school, my knowledge in math is already improved*." R-1: "*With the help of practicing and reviewing the topic repeatedly, I can eventually understand it. ...learn from my mistakes in this specific topic and review and learn again for the next quiz so that I can get a higher score and improve my performance*."
	Growth mindset influenced math resilience (r=0.077, p=0.033)	Res3: "*Actually, sometimes I get excited and confident solving these problems. Like right now, with what Sir Sean taught us about probability, we already learned some of it in Grade 10 so we feel more confident solving it even though it's more difficult now*." Res5: "*Yes, sir. Because you can learn from doing it. So, by just trying, I think I can figure it out. So, it's not a problem for me to face new problems*." Res6: "*Yeah, because I think I can do it. I'll push myself harder to solve it because I'm a fast learner and I find math interesting, so I will definitely solve it*."
	Teacher scaffolding influenced mathematics resilience (r=0.107, p=0.035)	Resp1: "*He provides a file with content related to the topic, and the information there is clearer*." Resp3 (first part): "*Uhm, like the guides Sir sends us on how to solve a particular question*." Resp5: "*Sometimes he'll give us a YouTube source to understand the concept clearly or the easiest way to figure it out. Sometimes, he explains it himself*." Resp6: "*This semester, yes, he sends images with formulas on how to solve problems and explains what the topic is about*."

PSS and math resilience. It can be gleaned from the table that PSS predicts math resilience (r=0.141, p=0.005). this result was explained by the qualitative data highlighting the aspects of PSS and their connection to math resilience. It shows a process-oriented approach. While the statements from I2, I3, I1 (last sentence) showcase the importance of trying different approaches, learning from mistakes, and actively practicing to improve PSS. This perseverance in the face of challenges is a key aspect of resilience. Moreover, creating challenging problems for themselves (I3) and actively seeking ways to improve at home (I4) demonstrate a GM and a proactive approach to learning, leading to greater resilience.

As a whole, the statements explain and emphasize that understanding, applying strategies, persistence, self-challenge, and a GM provide the strongest justification for the quantitative result that PSS influence mathematics resilience. Furthermore, the result is confirmed in the research conducted by Cousins *et al.* [24] that students overcame their emotional barriers to learning mathematics support from any factors, there are sensitive support from others, specific teaching and learning strategies, and increasing their mathematical resilience. In addition, students with strong mathematical resilience, have adaptive attitudes or can adapt to the environment; can face uncertainty and challenge problems; solve problems logically and flexibly; look for creative solutions to challenges; are curious and learn from experience; have self-control ability; aware of his feelings; has a strong and easy social network [41].

GM and math resilience, the result showed that GM predicts math resilience (r=0.077, p=0.033). The result was explained by the statement of I3 which demonstrates a GM because the student connects prior knowledge to build confidence in tackling a more challenging problem. They view difficulty as an opportunity to grow their abilities. Also, I5 emphasizes a key aspect of a GM-the belief that intelligence and abilities can be developed through effort and learning. They approach new problems with the confidence that they can figure them out through trying. In addition, I6 showcases a GM by demonstrating a belief in their ability to learn and a willingness to push themselves. They find math interesting and see challenges as opportunities to learn and improve. In summary, statements from I3, I5, and I6 demonstrate a GM by highlighting the belief in their ability to learn, improve, and tackle challenges, which contributes to math resiliency.

The result is confirmed by Paunesku *et al.* [42] that GM play a crucial role in developing resilience, especially among disadvantaged students who frequently face academic setbacks. In addition, holding a GM increases an individual's resilience, perseverance, and attitudes toward learning [43], [44]. Students with a GM are more likely to perceive academic challenges as opportunities to improve their ability and learning skills, and therefore, they exhibit higher levels of resilience [45], [46].

TS and math resilience. It can be noted that quantitative findings revealed TS influenced math resilience (r-0.107, p=0.035). This result was explained by the qualitative data which highlighted the importance of providing additional resources, clear instructions, and differentiated instructions. In essence, supplying clear and concise guides (I1, I3, I5, and I6) or explanations tailored to student needs helps bridge understanding gaps and empowers students to approach problems independently. This fosters a sense of self-efficacy. Offering resources like videos or alternative explanations (I5) caters to different learning styles and ensures all students have the opportunity to grasp concepts effectively.

Overall, the statements that emphasize providing clear explanations, additional resources, and differentiated instruction provide the strongest justification for the result that TS predicts math resilience. The result is supported by Khumalo *et al.* [47] stated that teacher support, encouragement, and instructional strategies contribute to students' resilience in tackling mathematical challenges. In addition, the meta-analysis study of Veldhuis [48] teachers' training in instructional approaches foster resilience, such as scaffolding and formative assessment, positively impact students' mathematical resilience.

4. CONCLUSION

Based on the findings, it is concluded that the cognitive (PSS), psychological (GM), and social (TS) factors significantly influenced students' mathematics resiliency in problem-solving. Further, math resilience is fostered by a GM, a supportive environment, and TS. Thus, validated proposition 2 which states that cognitive, psychological, and social factors are influential to a students' resilience in solving mathematical problems. Research may be expected to include STEM-track students or students from different grade levels to determine if the predictors of resilience vary significantly across academic backgrounds.

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AUTHOR CONTRIBUTIONS STATEMENT

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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 author declares no conflict of interest.

DATA AVAILABILITY

Derived data supporting the findings of this study are available from the corresponding author [RAC] on request.

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