Mathematical Resilience, Critical Thinking and Collaborative Learning as Predictors of Perceived Problem-Solving of Grade 10 Learners

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Abstract

Poor problem-solving skills is a concern in education. The significance to forecast perceived problem-solving skills using mathematical resilience, critical thinking, and collaborative learning as predictors, was examined. Using predictive design, survey technique, stratified random sampling in selecting 200 Grade 10 learners, and multiple regression analysis in analyzing the data, it was found that perceived problem-solving skills were significantly forecasted by the predictors, partially supporting the Self-Determination Theory. Mathematics teachers may strengthen critical thinking and collaborative learning through interactive and collaborative classroom activities. Future research may explore other factors through qualitative approaches to further explain learners' problem-solving skills.

Keywords: Mathematical Resilience; Critical thinking; Collaborative learning; predictors of perceived problem-solving; grade 10 learners

1. Introduction

Poor problem-solving skills remain a major challenge for many learners, as students often struggle to apply mathematical concepts to real-world and non-routine tasks. These skills are widely recognized as essential competencies for 21st-century learning (Griffin & Care, 2015; OECD, 2023). However, many students resort to procedural memorization rather than deep conceptual reasoning and analytical thinking.

International tests repeatedly show widespread shortcomings in the skills needed to solve mathematical problems worldwide. The Program for International Student Assessment results from 2023 show that many students worldwide struggle to use math in different situations. In Southeast Asia, schools are not doing as well as they could because students struggle to apply complex ideas in real-life situations. The 2023 OECD report also says that students in this region are still below standards. On the one hand, some of the best education systems have found a good balance between following procedures and really understanding math concepts. This balance is key to helping students develop an understanding of math, according to Mullis in 2020. These global trends in student performance show that many schools are still focused on memorization rather than helping students think critically and apply math in creative ways. The Program for International Student Assessment and OECD reports highlight the need to promote mathematical reasoning skills.

The Philippines has many problems with solving math problems. Math is really tough for students in the Philippines. They have a hard time understanding math and using it to solve real-life problems. Many Filipino students are really struggling with math because they get very anxious when they have to do math problems. They also do not think they are good at math. The latest studies have found, as Bernardo's 2022

study did. All these problems with math make it hard for students to do well on tests and to think critically.

Local assessments of education mirror larger challenges at the national level. In some areas of Mindanao, many secondary students have large gaps in understanding. They tend to make mistakes in dealing with complicated algebraic or word problems. (Maňaz, 2023) Also, regional baseline studies have found that junior and senior high school students are having problems with academic persistence. This situation underscores the urgent need to develop classroom-based psychological support tools (Talikan, 2024). This local problem highlights the need for useful framework models to predict and handle poor problem-solving skills.

Although many studies have already examined the factors affecting students perceived problem-solving skills, most have done so separately. Very few have examined how mathematical resilience, critical thinking, and collaborative learning work together to influence learners' problem-solving ability, especially among Filipino junior high school students. The trick is knowing how these 3 things work together. Resilience can help students survive challenges. It enhances their reasoning skills. Critical thinking. Another benefit of collaborative learning is peer support. The absence of research in this area 2 makes it even more necessary to study these variables jointly. This is important because students with poor problem-solving skills are more likely to struggle in school, lose confidence, and have fewer opportunities in the future. These skills are important not only for success in mathematics but also for helping students face real-life challenges.

This study seeks to address gaps in students perceived problem-solving skills, critical thinking, resilience, and lifelong learning, thereby contributing to Sustainable Development Goal 4 (Quality Education). In the Philippine context, it addresses concerns raised by the PISA (2022) results, which showed learners' low performance in mathematics, indicating a need to improve foundational competencies. The results might be beneficial to school administrators to prepare effective programs, teachers to develop classroom teaching techniques by collaborating and critical thinking, and students to build up their self-confidence and use mathematics in real-life situations. The study may also inform curriculum development aligned with the MATATAG Curriculum and serve as a useful point of reference for future research in mathematics education and learner development.

This study examined the significance of forecasting perceived problem-solving skills, with mathematical resilience, critical thinking, and collaborative learning as predictors. Specifically, this study was aimed at the following objectives: 1. to determine the levels of mathematical resilience of students in terms of value, struggle and growth; critical thinking in terms of analyzing, evaluating, creating, remembering, understanding and applying; collaborative learning in terms of positive interdependence, promotive interaction, and individual accountability; and perceived problem solving in terms of understanding the problem, devising a plan, carrying out the plan, and looking back (Checking and Reflecting). 2.) To determine the significance of the correlation between mathematical resilience and perceived problem-solving skills, critical thinking and perceived problem-solving skills, collaborative learning and perceived problem-solving skills. 3.) to determine the model's significance, predict perceived problem-solving skills using mathematical resilience, critical thinking, and collaborative learning as predictors.

2. Methodology

2.1 Research Design

This study utilized a quantitative predictive design, which involves collecting and analyzing numerical data to determine whether one or more variables can forecast an outcome variable (Fraenkel et al., 2019). This design is supposed to look at how different things are connected and see how much certain things can affect what happens in the end. It is used when researchers want to identify which factors predict a variable's future values. Moreover, how these things help explain why the outcome is different sometimes. This way of doing things is good because it helps us make decisions based on information about how likely something is to happen under certain conditions. It can help us plan and come up with plans or strategies in

many areas of research. The design of this study is important because it helps us understand relationships among variables and assess the extent to which specific factors can influence or predict an outcome. Like what Best and Kahn said in 2016. Thus, the quantitative-correlational predictive research design is most suitable for this study as it allows the researcher to analyze not only the relationships among the variables but also their collective and individual contributions in predicting perceived problem-solving skills among Grade 10 learners.

2.2 Research Locale

The study was conducted in Cluster 6, Tugbok District, Davao City, under the supervision of the Department of Education, Division of Davao City. Cluster 6 is located in the south of the district and consists of thirteen (13) public secondary schools serving rural and semi-urban communities. The cluster is committed to education and continues to work on improving students' academic performance, especially in mathematics and science. The research sites for this study were three (3) public secondary schools within Cluster 6, hereafter referred to as School A, School B, and School C. The selection of these schools was purposive, based on accessibility, the availability of Grade 10 learners, and the willingness of the respective school administrators to participate in the research.

2.3 Sample and Sampling Technique

The respondents of this study were the Grade 10 students of three public secondary schools in Cluster 6, Tugbok District, Davao City: School A, School B, and School C, with a total population of 352 students (School A – 136, School B– 150, School C – 66). The Raosoft sample size calculator (Raosoft, Inc., 2004) was used to determine a sample size of 200 respondents, applying Cochran's (1977) formula for finite populations at a 95% confidence level, a 5% margin of error, and a 50% response rate. This sample size was slightly larger than the minimum needed to account for possible non-response and to achieve sufficient statistical power for analysis. Stratified random sampling with proportional allocation was used, with each school as a stratum. The distribution of the 200 respondents was: 77 from School A, 85 from School B, and 38 from School C. From the schools' class lists, respondents within each stratum were selected using simple random sampling. This guaranteed equal selection probability and representativeness across schools. The selected sample size also allows for multiple regression analysis, with sufficient statistical power to detect medium effect sizes at the 0.05 level of significance.

2.4 Data Gathering Technique

Data were collected through a survey method. This technique consists of systematically collecting data from a sample of respondents using standardized questionnaires or structured instruments to describe the characteristics, opinions, attitudes, or behaviors of a population. Researchers use it when they need structured primary data to answer specific research questions or to generalize findings (Stockemer, D., 2019). It has advantages 1 1 such as the quick gathering of data from large populations, reaching out to 1 varied populations, and structured answers facilitating quantitative analysis and generalizability (Fraenkel et al., 2019).

In this study, the researcher adapted four survey questionnaires, all using a 4 point Likert scale. The Mathematical Resilience Scale, adapted from Johnston Wilder and Lee (2010) and Talikan (2024), consisted of 30 items measuring the learners' ability to persist, value struggle, and maintain a positive attitude toward learning mathematics despite difficulties. It has a Cronbach's alpha of 0.863. The Critical Thinking Questionnaire was adopted from Muslem et al. (2017) and consists of 25 items that measure learners' ability to analyze, evaluate, and infer ideas or solutions in mathematical contexts. It has a Cronbach's alpha of 0.862. The Collaborative Learning Scale was adapted from Laal and Ghodsi (2012) and consists of 30 items that

assess the extent to which learners engage positively and productively in group learning situations. It has a Cronbach's alpha of 0.860. Lastly, the Problem-Solving Skills Scale was adapted by He et al. (2024) to assess students' ability to understand the problem, devise a plan, carry out plan, and reflect. It has a Cronbach's alpha of 0.859.

2.5 Data Analysis Technique

In this study, descriptive, correlation, and regression analyses were employed. Descriptive statistics were used to summarize and organize data, providing an overview of patterns, central tendencies, and variability; this was conducted using the mean and standard deviation (Bhandari, 2023). Furthermore, multiple linear regression analysis was employed to examine the relationship between one dependent variable and multiple independent variables. It was used to predict outcomes and assess the influence of predictors simultaneously. Beta (β) coefficients were interpreted to determine the strength and direction of each predictor (Hair, J. F., Page, M., & Brunsveld, N. (2023).

2.6 Ethical Considerations

This study strictly adhered to ethical research standards for the protection, rights, and well-being of all subjects in accordance with the ethics principles of the Holy Cross of Davao College Ethics Board – Society for Moral Integrity and Legal Ethics. All procedures were designed to minimize physical, psychological, and social harm as participation involved completing non-invasive mathematics-related questionnaires, and respondents could omit questions or withdraw at any time without penalty (Fraenkel et al., 2019). Participation was voluntary, and the students and their parents were fully informed of the purpose, procedures, and benefits of the study through consent forms that ensured understanding and voluntary agreement. The purpose of this study was to provide significant learning benefits by providing insights into how mathematical resilience, critical thinking, and collaborative learning influence perceived problem-solving skills, which might improve student performance, teacher strategies, and classroom engagement. Confidentiality and anonymity were maintained by not including names or personal identifiers on the questionnaires and reports, storing data in password-protected files, and using coded identifiers. Academic integrity was upheld by citing all sources and adapting instruments appropriately (Fraenkel, Wallen, & Hyun, 2019). The study was conducted in accordance with the National Commission for the Protection of Human Subjects (1979), and this research was carried out with integrity, transparency, and adherence to ethical principles of autonomy, beneficence, and justice. Respondents were treated with dignity and respect, and no harm or disadvantage was incurred.

3. Results and Discussions

3.1 Descriptive Analysis

Table 1 presents the descriptive statistical results of the study. Included in the table are the variables involved, namely, Mathematical Resilience, Critical thinking, Collaborative Learning, and Perceived Problem-Solving skills, with their respective indicators. Also presented are the number of respondents, means, standard deviation, and descriptive level.

Table 1. Descriptive Table **(N=200)**

Variables	Standard Deviation	Mean	Interpretation
Mathematical Resilience	**0.40**	**2.92**	**High**

Value	0.53	3.00	High
Growth	0.42	2.65	High
Struggle	0.52	3.10	High
Critical Thinking	**0.43**	**2.92**	**High**
Analyzing	0.52	2.74	High
Evaluating	0.63	3.11	High
Creating	0.48	2.92	High
Remembering	0.47	2.9	High
Understanding	0.49	2.89	High
Applying	0.61	2.98	High
Collaborative Learning	**0.61**	**3.08**	**High**
Positive Interdependence	0.58	3.02	High
Promotive Interaction	0.67	3.13	High
Individual Accountability	0.70	3.08	High
Perceived Problem-Solving Skills	**0.51**	**3.04**	**High**
Understanding the Problem	0.70	3.08	High
Devising a Plan	0.52	2.99	High
Carrying Out the Plan	0.61	3.04	High
Looking Back (Checking and Reflecting)	0.62	3.05	High

The table specifically shows that the mathematical resilience variable had a mean of 2.92, which is considered high. This indicates that the respondents' mathematical resilience is good. All indicators are described as high-level. The corresponding standard deviation of 0.40, which is considered low, reflects consistent responses among the students. Moreover, the results reveal that critical thinking had a mean of 2.92, which is high, indicating that critical thinking is good. All indicators are described as high-level. The low standard deviation of 0.43 indicates that participants' responses were consistent with one another. Evaluating had the highest mean among its indicators, while analyzing had the lowest mean, both considered high. Furthermore, the mean collaborative learning score was 3.08, indicating that learners are good at engaging productively in group settings. All indicators are defined at the higher level. The group responses are very similar, as indicated by the small standard deviation of 0.61. The mean of 3.04 for perceived problem-solving skills indicates that students can use reasoning and conceptual understanding to solve mathematical tasks. "Signs are said to be all high. The low standard deviation of 0.51 indicates that the participants' responses were consistent.

All variables, including mathematical resilience, critical thinking, collaborative skills, and perceived problem-solving skills, were interpreted at a high level. It is a classroom setting where students have the opportunity to think independently and work in groups, with high academic achievement maintained throughout the subject.

3.2 Correlation Results

Table 2 presents the correlation table. It contains the predictors and the criterion variable. Likewise, the r-value, p-value, decision regarding the hypothesis, and interpretation were included in the table.

Table 2. Correlation Table (N=200)

Variables	Perceived Problem-Solving Skills			
	r-value	p-value	Decision on HO	Interpretation
Mathematical Resilience	.638	0.000	Reject	Moderate Correlation
Critical Thinking	.804	0.000	Reject	Strong Correlation
Collaborative Learning	.857	0.000	Reject	Strong Correlation

Level of Significance: 0.05, Decision Rule: Reject HO if p < 0.05

The table shows that the correlation between mathematical resilience and perceived problem-solving skills had a p-value of 0.000, which was less than the 0.05 level of significance. Hence, the null hypothesis was rejected, showing that the correlation is significant. The corresponding r-value of 0.638 indicates 1 a moderate correlation. This means that as students become more resilient and persistent in mathematics, they are also better at solving problems. There was also a relationship between critical thinking and perceived problem-solving skills, with a p-value of 0.000, which is less than the 0.05 level of significance. Therefore, the null hypothesis was rejected, and the correlation was found to be significant. The r-value of 0.804 suggests a strong correlation. This means that higher-order critical thinking skills, such as analyzing and evaluating information, are strongly associated with better performance on mathematical problem-solving tasks. Similarly, the relationship between collaborative learning and perceived skills was significant at p = 0.000, which is less than the 0.05 level of significance. The null hypothesis was rejected, showing a significant correlation. The corresponding r-value is 0.857, indicating a strong correlation: the more engaged you are in peer support and interactive learning, the more it predicts that you have perceived problem-solving skills. All three variables were significantly correlated with perceived problem-solving skills, with collaborative learning showing the highest correlation coefficient, followed by critical thinking, while mathematical resilience showed the weakest.

3.3 Regression Results

Table 3 presents the regression analysis examining the association between mathematical resilience, critical thinking, and collaborative learning and perceived problem-solving skills among Grade 10 learners.

Table 3. Regression Table (n=200)

Independent Variables	Perceived Problem-Solving Skills					
	Estimate (β)	Std. Estimate	SE	t-value	*p-value*	Interpretation
(Constant)	0.291		0.132	2.201	0.029	Significant Predictor
Mathematical Resilience	0.024	0.019	0.064	0.375	0.708	Not Significant Predictor
Critical Thinking	0.397	0.33	0.075	5.267	0.000	Significant Predictor
Collaborative Learning	0.494	0.586	0.046	10.732	0.000	Significant Predictor

$R = 0.883$, $R^2 = 0.779$, Adjusted $R^2 = 0.776$, $F = 230.664$, p-value. = 0.000; Significant *Level of Significance: 0.05 Decision Rule: Reject H_0 if p < 0.05*

Table 3 specifically shows that the model predicting perceived problem-solving skills using mathematical resilience, critical thinking, and collaborative learning is: Perceived Problem-Solving Skills =

0.291 + 0.024(MR) + 0.397(CT) + 0.494(CL). The result shows an R2 of 0.779, indicating that the model significantly predicts perceived problem-solving skills in critical thinking and collaborative learning. On the other hand, mathematical resilience does not show a significant independent association. The corresponding p-value obtained is 0.000. Such a value is less than the 0.05 level of significance. Thus, the null hypothesis was rejected. It indicates that the said model to predict perceived problem-solving skills is significant. This finding implies that for every unit increase in mathematical resilience as a predictor in the model. The findings revealed that critical thinking and collaborative learning significantly predict perceived problem-solving skills, while mathematical resilience does not independently contribute to the prediction model.

3.4 Correlation of Mathematical Resilience and Perceived Problem-Solving Skills

The findings of this study demonstrate a strong positive relationship between 5 mathematical resilience and perceived problem-solving ability. This result is consistent with Fauziyah (2025), who stated that students with a higher level of mathematical resilience perform better at each stage of Polya's problem solving, especially in developing strategies and evaluating solutions. Also, the present finding aligns with the study by Goodall and Johnston-Wilder (2015), which highlights that mathematical resilience enables students to persist in solving complex mathematical modelling tasks. Hence, enhancing problem solving performance. However, this finding is contrary to Stupple's (2017) assertion that mathematical resilience alone does not always directly influence students perceived problem-solving skills, as other cognitive and environmental factors may contribute to problem-solving performance.

3.5 Correlation of Critical Thinking and Perceived Problem-Solving Skills

The findings of this study show that critical thinking has a significantly positive correlation with perceived problem-solving skills. This current finding supports the idea of Monteleone et al. (2023), which indicated that critical thinking significantly influences learners' problem-solving performance in 6 5 mathematics. Similarly, the present finding aligns with the study by Laurilla and Nabayra (2026), which highlighted a positive association between critical thinking and mathematical problem-solving skills among Grade 10 learners. However, the present finding is contrary to Carson (2015), who asserted that success in problem solving cannot be based solely on critical thinking skills, since mathematical knowledge, conceptual understanding, and knowledge transfer are essential components of effective problem solving.

3.6 Correlation of Collaborative Learning and Perceived Problem-Solving Skills

The results of this study indicate that collaborative learning is significantly positively correlated with perceived problem-solving skill. The present finding supports the notion of Insorio and Librada (2021) that collaborative group activities enhanced students' mathematical critical thinking and problem solving skills. Similarly, the present result supported the study by Webb (2009), which indicated that a collaborative learning environment encourages students to share ideas, develop multiple strategies for solving problems, and consolidate understanding in mathematics through shared learning experiences. These findings suggest that peer interaction promotes deeper engagement and enhances students' ability to solve mathematical problems. However, this current finding contradicts the claim by Johnson and Johnson (2002), who suggested that collaborative learning may not always directly improve perceived problem-solving skills, as some learners may become overly dependent on group members rather than develop independent problem-solving abilities.

3.7 Mathematical Resilience Does Not Predict Perceived Problem-Solving Skills

The current findings of this study conclude that mathematical resilience does not predict perceived problem-solving skills. This current finding supports the study of Bernardo (2022), which explained that emotional resilience alone does not directly translate to problem-solving accuracy without cognitive support. Likewise, the current finding supports the study by Callaman and Bonotan (2026), which showed that problem-solving skills, a growth mindset, and teacher scaffolding significantly predict mathematical resilience, suggesting that resilience may function more as an outcome or supporting factor than as a direct predictor of mathematical performance. However, this finding contradicts Fauziyah's (2025) study, which found that students with high mathematical resilience performed better across all stages of mathematical problem-solving.

3.8 Critical Thinking and Collaborative Learning Predict Perceived Problem-Solving Skills

The present study suggests that critical thinking is the most positive predictor 1 of perceived problem-solving skills, in that learners with higher-order thinking skills are more able to analyze and solve mathematical problems effectively. 2 2 The present finding lends support to an argument set forth by Monteleone et al. (2023) that critical thinking is an important predictor of the ability to work through mathematical problems efficiently. The present finding was supported by Laurilla and Nabayra (2026), who stated that students with better levels of critical thinking skills performed better in solving problems in mathematics. Also, the present study found a significant positive association between perceived problem-solving skills and collaborative learning. Webb (2009) explains that Webb's learning environments promote mathematical mastery present finding contradicts Capuno (2019), who cautioned that the effectiveness of collaborative tasks depends on the individual learner's preferences and a learner's classroom environment, since poor group dynamics may sometimes hinder independent reasoning and personal ownership of the mathematical steps.

4. Conclusion

Based on the findings, the perceived problem-solving skills were significantly predicted by mathematical resilience, critical thinking, and collaborative learning. However, mathematical resilience does not significantly predict the perceived problem-solving skills. With this result, the study partially affirms the Self-Determination Theory, stating that performance is primarily internal factors such as autonomy, competence, and relatedness.

5. Recommendation

Based on the conclusion, future studies may replicate this study using additional potential variables to determine the 22.1% variance in learners' 4 4 problem-solving skills. Studies may also explore learners' research design to identify underlying reasons why mathematical resilience does not significantly predict problem-solving skills. Furthermore, mathematics teachers may design more collaborative-based activities that challenge students' critical thinking. Students have been proven to be the predictors of success. Students may also implement programs focused on "growth mindset" interventions to help translate students' existing resilience and improve their problem-solving accuracy.

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