

Problem-Solving Tasks in Relation to Critical Thinking Skills of Elementary Mathematics Learners

Aiza O. Crodua

Abstract. This study aimed to determine the extent of integrating problem-solving tasks to enhance critical thinking skills in elementary mathematics instruction. Specifically, it examined four domains of problem-solving tasks—real-world problem solving, open-ended questions, mathematical investigations, and collaborative problem-solving—and their relationship to four domains of critical thinking skills, namely scaffolding technique, questioning technique, exploration and discovery, and problem-based learning. Using a descriptive-correlational design with 86 elementary teachers as respondents, data were collected through a validated survey instrument and analyzed using descriptive statistics, Pearson correlation, and multiple linear regression. Findings revealed that real-world problem solving was extensively integrated, while other domains were moderately practiced. Critical thinking skills were found to be extensively developed, with exploration and discovery having the highest rating. A significant positive correlation ($r = 0.226$, $p = 0.036$) was found between problem-solving task integration and critical thinking skill development. However, regression analysis indicated that none of the individual domains significantly predicted critical thinking outcomes ($p \geq 0.05$). These results suggest that while problem-solving tasks contribute to enhancing critical thinking, their combined implementation is more influential than any single domain.

KEY WORDS

1. problem-solving tasks 2. critical thinking skills 3. elementary mathematics

Date Received: April 05, 2025 — Date Reviewed: May 15, 2025 — Date Published: June 18, 2025

1. Introduction

Participating in problem-solving tasks greatly improves the critical thinking skills of elementary math students. For example, a class of fifth graders faced a complex word problem that required dividing resources among team members. They initially had difficulty grasping the problem's context, but with guided questioning and collaborative discussions, they started breaking it down into smaller, more manageable parts. By encouraging the exploration of various strategies such as diagram drawing, us-

ing manipulatives, and hypothesis testing, they were able to systematically tackle the problem. As time passed, their confidence increased as they learned to analyze issues, assess their solutions, and justify their reasoning. This experience not only improved their mathematical capabilities but also nurtured creativity, persistence, and logical thinking. Witnessing how problem-solving tasks reshaped their approach to challenges underscored the importance of such activities in cultivating well-rounded learn-

ers. One significant issue in the international context is the cultural and contextual variability in problem-solving tasks, which can affect the enhancement of critical thinking abilities in young mathematics students. Research indicates that problem-solving activities frequently represent the cultural standards and values of the nation where they are conducted designed, which may not resonate with learners from diverse backgrounds (Smith et al., 2021). For example, word problems involving unfamiliar contexts, such as currency or measurement systems, can confuse students and hinder their ability to engage critically with the task. This disparity underscores the necessity for culturally responsive problem-solving tasks that are adaptable to diverse educational settings, thereby ensuring equitable opportunities for all learners to develop critical thinking skills. A significant challenge is the varying degrees of teacher preparedness to effectively implement problem-solving tasks in elementary mathematics classrooms. Research shows that many teachers worldwide do not have adequate training to create and facilitate activities that encourage critical thinking (Ahdhianto, et.al, 2022). In certain instances, time constraints or curriculum demands lead teachers to revert to traditional rote-learning approaches, which restrict students' chances to participate in higher-order thinking. Furthermore, the absence of professional development programs centered on problem-solving pedagogy intensifies this issue. To bridge this gap, it is essential to provide targeted training and resources that empower teachers to promote critical thinking through problem-solving tasks. A third challenge is the difficulty in evaluating and standardizing critical thinking skills gained through problem-solving tasks in various international contexts. Although problem-solving tasks are commonly seen as effective for fostering critical thinking, there is no agreement on the best ways to measure these skills (Evendi et al., 2023). Standardized tests often overlook

the intricate thinking processes that problem-solving entails, focusing too much on correct answers instead of the reasoning behind them. This limitation underscores the necessity for innovative assessment methods that emphasize qualitative insights into students' critical thinking capabilities, ensuring a more thorough evaluation of their learning outcomes. In the Philippines, one major issue is the insufficient access to quality problem-solving resources that enhance critical thinking skills among elementary mathematics students. Many schools, especially in rural regions, are deficient in up-to-date textbooks, digital tools, and manipulatives essential for engaging in problem-solving activities (Llurag, 2024). This lack of resources is worsened by the unequal distribution of educational materials nationwide, resulting in numerous students missing out on developing higher-order thinking abilities. In the absence of appropriate resources, teachers frequently resort to traditional rote-learning techniques, which are ineffective in promoting critical thinking. Tackling this issue calls for increased investment in educational resources and infrastructure to guarantee equal access for all students. Another pressing issue is the insufficient training of Filipino teachers in designing and implementing problem-solving tasks that promote critical thinking. Studies have shown that many elementary teachers in the Philippines struggle with integrating problem-based learning into their mathematics instruction due to a lack of professional development opportunities (Cagatan Quirap, 2024). Additionally, the heavy reliance on standardized testing often leads teachers to focus on memorization rather than fostering analytical and creative thinking. To address this, there is a need for targeted teacher training programs that emphasize problem-solving strategies and critical thinking pedagogy, enabling educators to support their students' cognitive development better. Socioeconomic barriers also hinder the fostering critical thinking

skills via problem-solving activities within the Philippine setting. Numerous students from low-income households encounter difficulties, including malnutrition, insufficient parental support, and restricted access to resources technology, which negatively impact their ability to engage in complex problem-solving activities (Torres Ramos, 2023). The digital divide further compounds these barriers, as students without internet access or devices are unable to participate in online learning platforms that offer interactive problem-solving tasks. Addressing these socioeconomic issues requires holistic interventions, including community support programs and policies that prioritize the well-being and educational needs of disadvantaged learners. In Gov. Generoso, Davao Oriental, addressing problem-solving and critical thinking in elementary mathematics is crucial for community development and resilience. This coastal municipality faces natural disasters, such as typhoons, making it essential that its educational system equips students with the skills to adapt and address local challenges. Developing these skills enables students to analyze community issues, such as resource allocation and sustainable fishing, which are crucial to the town's economy. Incorporating culturally relevant tasks related to local agriculture or conservation can enhance students' connection to their community and improve academic performance. Prioritizing critical thinking, Gov. Generoso can nurture socially responsible problem solvers, ensuring long-term community development and resilience.

1.1. Theoretical/Conceptual Framework of the Study—Atkinson's theory of mathematics (1970) and David Premack's theory offer distinct yet complementary perspectives on learning and motivation. Atkinson's theory emphasizes the role of achievement motivation in

mathematical learning, suggesting that individuals are driven by a desire to succeed and avoid failure. According to this theory, students' engagement in mathematics is influenced by their expectations of success and the value they place on achieving mathematical goals. This highlights the importance of creating a supportive learning environment that builds students' confidence and reduces their fear of failure, thereby enhancing their motivation to tackle mathematical challenges. On the other hand, Premack's principle, often referred to as the "Premack principle," focuses on using preferred activities as rewards to reinforce less preferred behaviors, such as engaging in mathematical tasks. This theory suggests that students are more likely to engage in mathematics if a rewarding or enjoyable activity follows it. By leveraging this principle, educators can design learning experiences that pair mathematical problem-solving with motivating incentives, thereby increasing students' willingness to participate and persist in mathematical activities. Together, these theories underscore the importance of addressing both intrinsic and extrinsic factors, such as motivation, confidence, and reinforcement, to foster a positive and productive approach to learning mathematics. Atkinson's theory of mathematics (1970) and David Premack's principle are highly relevant to the study of problem-solving tasks related to the critical thinking skills of elementary mathematics learners. Atkinson's theory, which focuses on achievement motivation, highlights the importance of fostering students' confidence and reducing the fear of failure in mathematical problem-solving. In the context of problem-solving tasks, this theory suggests that students are more likely to engage deeply and think critically when they believe in their ability to succeed and value the outcomes of their efforts.

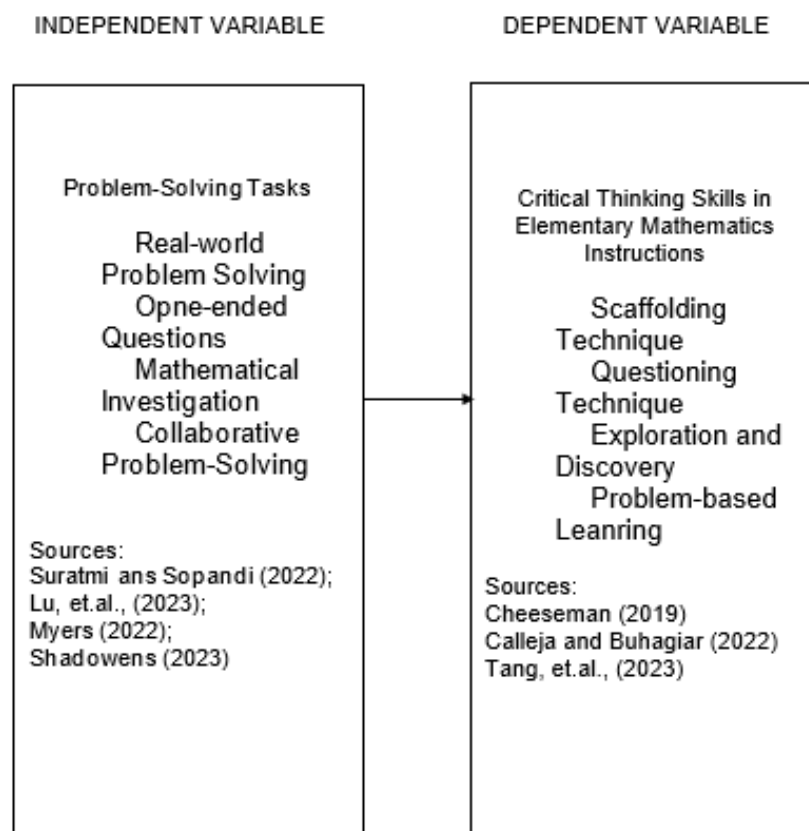


Fig. 1. Theoretical/Conceptual Framework

2. Methodology

This chapter outlines the processes and steps involved in conducting the study. This includes the selection of the study design, the respondents and their sampling method, the research instruments to be used in data collection, the procedure, and the ethical considerations, as well as the data analysis. These steps are considered essential to ensure the appropriateness and correctness of producing sound data through collection, analysis, and interpretation.

2.1. Research Design—The study employed a non-experimental, descriptive-correlational research design. This design, as described by Creswell (2014), examines the relationship between two or more variables without manipulating any of the variables. Instead, it focuses on measuring and analyzing the existing relationship between them. Furthermore, the descriptive-correlational research design serves to describe and explain the relationship between variables. Its primary objective is to identify connections between variables and can be applied to make predictions about future events. Typically employed in exploratory studies or when researchers aim to establish the existence of a relationship between variables, the descriptive-correlational research design is valuable for its ability to shed light on the associations among variables without experimental manipulation. The non-experimental, descriptive-correlational research design employed in the study, which focused on integrating problem-solving tasks to enhance critical thinking skills in elementary mathematics instruction, served as a valuable framework for investigating the relationship between various instructional practices and student outcomes. This research design allowed the researchers to gather descriptive data on the implementation of problem-solving tasks within elementary mathematics instruction, as well as to examine potential correlations between the use of these tasks and students' critical thinking skills. Through surveys, observations, and possibly interviews, the researchers collected rich, qualitative data on how problem-solving tasks were integrated into the curriculum, the instructional strategies employed by teachers, and the impact of these practices on students' critical thinking abilities. By analyzing the data using correlational techniques, such as regression analysis or Pearson's correlation coefficient, the researchers could explore the extent to which the integration of problem-solving tasks was associated with improvements in students' critical thinking skills. While this research design does not establish causality, it provides valuable insights into the relationships between variables. It offers a foundation for future experimental research to investigate further the effectiveness of specific instructional practices in enhancing critical thinking skills in elementary mathematics instruction. Overall, the non-experimental, descriptive-correlational research design proved to be a valuable tool for exploring the complex dynamics of integrating problem-solving tasks into elementary mathematics instruction and their impact on critical thinking skills.

2.2. Ethical Consideration—The ethical consideration section of this study will address the key principles that ensure the protection and well-being of the teacher-respondents involved. This includes adhering to confidentiality, obtaining informed consent, and ensuring the voluntary nature of participation, thereby ensuring that the research is conducted with integrity and respect for the rights of all respondents.

Social Value This holds significant social value as it addresses the essential need to cultivate critical thinking skills in young learners, which are vital for their academic success and future societal contributions. By examining how

problem-solving tasks enhance critical thinking, the study provides insights into effective teaching strategies that can empower students to analyze, evaluate, and solve real-world challenges. This research supports the development of more innovative and engaging mathematics curricula, fostering students' confidence and competence in decision-making. Ultimately, the study contributes to creating a generation of problem-solvers equipped with the skills necessary to thrive in an increasingly complex and dynamic world.

Informed Consent and Assent Ensuring the ethical integrity of research involving human participants, particularly minors. Informed consent demonstrates respect for the autonomy and rights of participants by providing clear and comprehensive information about the study's purpose, procedures, risks, and benefits, enabling participants to make an informed decision about their involvement. Assent, meanwhile, recognizes the developmental stage of minors, ensuring that their agreement is sought in an age-appropriate manner while formal consent is obtained from their guardians. These processes reflect a commitment to fostering trust, transparency, and respect in the research endeavor, safeguarding the welfare of participants and upholding ethical standards that contribute positively to both the participants and the broader research community.

Vulnerability of Research Respondents

The researcher underscores the ethical responsibility to protect participants who may be at a heightened risk of harm or exploitation during the research process. Vulnerable respondents, such as children, individuals with disabilities, or those from marginalized communities, require special considerations to ensure their rights, dignity, and well-being are upheld. This involves implementing safeguards like obtaining informed consent, ensuring confidentiality, and minimizing risks while maximizing benefits. Addressing vulnerability also includes

creating an inclusive and supportive research environment where respondents feel safe to participate without coercion or undue influence. These measures reflect a commitment to ethical research practices that prioritize protecting and respecting all participants, particularly those in vulnerable circumstances.

Privacy and Confidentiality Adherence to the Data Privacy Act of 2012 is paramount in this study to protect the respondents' personal information. These are fundamental to ethical research, emphasizing the protection of participants' personal information and maintaining trust in the research process. Privacy ensures that respondents have control over the extent and nature of the information they share, while confidentiality safeguards this information from unauthorized access or disclosure. These principles are upheld through measures such as anonymizing data, securely storing records, and restricting access to authorized personnel only. Ensuring privacy and confidentiality fosters a safe environment for participants to share honest and meaningful responses without fear of judgment or repercussions. These practices not only protect individual rights but also reinforce the integrity and credibility of the research process.

Risk, Benefits and Safety

Assessing risk involves identifying potential physical, psychological, or social harm that may arise from participation and implementing measures to minimize these risks. Benefits focus on the potential positive outcomes of the study, such as advancing knowledge, improving practices, or contributing to societal well-being, ensuring that these outweigh any risks involved. Safety encompasses creating a supportive and secure environment for participants, with protocols in place to address emergencies or concerns promptly. Upholding these principles demonstrates a commitment to conducting research responsibly, balancing the pursuit of knowledge with the rights and welfare of participants.

Justice In addressing the ethical principle of justice, ensures that no individual or group is unfairly excluded from the potential benefits of the study or disproportionately subjected to its risks. Justice requires that participants be selected based on research objectives rather than convenience or bias, ensuring that vulnerable populations are neither overburdened nor neglected. This principle also involves transparency in communicating the purpose, processes, and outcomes of the study to all stakeholders. By adhering to justice, research upholds the values of equality and fairness, fostering trust and respect among participants and contributing to ethical and socially responsible practices.

Transparency Transparency involves clearly communicating the purpose, objectives, methodology, potential risks, and benefits of the study to participants, ensuring they have a comprehensive understanding of their involvement. It also includes openly sharing findings, methodologies, and any conflicts of interest with stakeholders and the public. By prioritizing transparency, researchers create a foundation of trust, encourage informed participation, and promote the ethical integrity of the study. This commitment to openness not only safeguards participants' rights but also enhances the credibility and societal impact of the research.

Qualification of the Researcher The researcher leading this study holds advanced degrees in educational psychology and has received specialized training. A qualified researcher possesses the necessary academic background, expertise, and skills relevant to the research topic, enabling them to design and execute the study effectively. This includes a strong understanding of research methodologies, ethical principles, and data analysis techniques. Additionally, the researcher must demonstrate competence in managing participants, particularly when dealing with vulnerable populations or sensitive topics, to ensure their rights and well-being are upheld. Proper

qualifications also involve the ability to adapt to challenges, maintain objectivity, and uphold transparency throughout the research process. By meeting these standards, the researcher ensures the validity and reliability of the findings while fostering trust and accountability among participants and stakeholders.

Conflict of Interest Addressing conflict of interest is essential to maintaining ethical standards and the credibility of the research. Researchers must disclose any potential conflicts transparently to stakeholders, participants, and relevant oversight bodies. This includes relationships with funding sources, affiliations, or personal biases that could influence the study's design, data interpretation, or dissemination of results. Implementing measures to manage or mitigate conflicts, such as independent reviews or clear ethical guidelines, ensures that the research remains unbiased and trustworthy. Prioritizing the management of conflict of interest reinforces public confidence in the research process and its findings, safeguarding the integrity of academic and professional endeavors.

Adequacy of Facilities Adequate facilities include well-equipped spaces for data collection, secure storage for sensitive information, and access to tools and equipment necessary for conducting experiments, surveys, or interviews. Proper facilities also ensure the comfort and safety of both researchers and participants, fostering an environment conducive to accurate and ethical data collection. Additionally, access to reliable technological resources, such as data analysis software or virtual interview communication platforms, is essential for maintaining efficiency and precision. Ensuring the adequacy of facilities demonstrates a commitment to high research standards, enhances the credibility of the study, and contributes to reliable and meaningful outcomes.

Community Involvement Engaging the community in the research process fosters collaboration and trust, creating a sense of shared own-

ership and accountability. This involvement can take many forms, including consultation during the planning phase, active participation in data collection, and input on the interpretation and dissemination of findings. Community involvement also helps identify culturally relevant practices, address local challenges, and ensure that the study's outcomes are meaningful and beneficial to the participants and stakeholders. By prioritizing community engagement, researchers enhance the relevance, ethical integrity, and practical application of their work, fostering a stronger connection between research and real-world impact.

2.3. Research Respondents—To determine the number of sample respondents from a population of 285 teachers in Gov Generoso North District, Davao Oriental Schools Division, Slovin's formula can be applied. Assuming a margin of error of 5%, the calculation results in a sample size of approximately 167 teachers. This means that 167 teachers should be surveyed to ensure the sample is representative of the entire population while maintaining a 5% margin of error. This approach provides a reliable basis for gathering insights and making informed conclusions about the larger group. The justification for using this sample size lies in its ability to balance practicality and accuracy. Surveying all 285 teachers may be time-consuming and resource-intensive, while a smaller sample size could compromise the reliability of the results. By selecting 167 teachers, the study ensures that the data collected is both manageable and statistically significant, offering a credible representation of the entire population. This method is particularly valuable in educational research, where resources are often limited, yet the need for accurate and actionable insights remains high. Recognized as qualified professionals, these teachers have consistently made significant contributions to school improvement, fostering heightened awareness among teachers in the context of the new normal learning sys-

tem during the academic year 2023-2024. Additionally, they have been regular participants in seminars, training sessions, focusing on curriculum implementation and Learning Action Cell regular meetings. Moreover, assumptions in the respective schedule of classes during data collection were explicitly discussed with the respondents and even observance to health protocol was strictly implemented based on the Executive Order 31 S 2020, to avoid possible and lower the risk of contamination.

2.4. Research Instrument—In this research study, the researcher employed an adapted instrument derived from a comprehensive review of literature and related studies. A dedicated effort was made to collect and scrutinize literature to extract concepts that informed the content and offered support for the instrument and its associated strands. This meticulous process aimed to articulate a set of question-items, thereby addressing potential threats to validity in the study. Items were adapted from the contents of the reviewed literatures as argued by the authors. There were two parts of the survey questionnaire which consists of determining the extent of integrating problem-solving tasks are in terms of real-world problem solving, open-ended questions, mathematical investigation and collaborative problem solving. Likewise, the second part of the survey measured the extent of critical thinking skills in elementary Mathematics instruction, encompassing scaffolding technique, questioning technique, exploration and discovery, and problem-solving-based learning. Further, the survey statements were subjected to a test-retest or validity and reliability testing using Cronbach Alpha at .05 level of confidence and generated an alpha Cronbach of 0.839 which means that 83.9 percent level of confidence of the validity and reliability of the survey statement constructs (Palant 2010). The questionnaire employed a 5-point Likert scale to assess the extent to which problem-solving tasks were integrated in real-

world contexts, including open-ended questions, mathematical investigations, and collaborative problem-solving. Scale, descriptive rating and interpretation are provided below:

Scale Descriptive Ratings and Interpretation on Problem-Solving Tasks

Scale	Descriptive Rating	Interpretation
4.20 – 5.00	Very Extensive	The problem-solving tasks is always manifested.
3.40 – 4.19	Extensive	The problem-solving tasks is oftentimes manifested.
2.60 – 3.39	Moderately Extensive	The problem-solving tasks is sometimes manifested.
1.80 – 2.59	Less Extensive	The problem-solving tasks is rarely manifested.
1.00 – 1.79	Not Extensive	The problem-solving tasks is not manifested.

2.5. Data Gathering Procedure—In the data gathering procedure of the research project, several critical steps are involved, one of which is the ethical acquisition of permission to conduct the study. This step is indispensable for upholding fundamental principles such as respect, transparency, and responsible research conduct. The guidelines for this process adhere strictly to the policies of Rizal Memorial Colleges. As part of the formal request, researchers outline their intentions regarding data collection, analysis, and dissemination, ensuring alignment with the overarching research goals. Any anticipated concerns or questions from recipients are proactively addressed in this communication, offering assurances on ethical safeguards, confidentiality measures, and the potential benefits of the study. The formal permission request explicitly seeks authorization to proceed, underscoring the pivotal role of their support in ensuring the research's success.

Permission to conduct the study

In January 2025, prior to data collection, the researcher obtained necessary permissions from the relevant authorities, including the research adviser, the Dean of Rizal Memorial Colleges,

and the top management of DepEd Davao Oriental Schools Division through the appropriate channels. This involved submitting a comprehensive research proposal outlining study design, procedures, and potential risks and benefits. The researcher provided detailed information about the study's purpose, goals, and the methods for data collection, analysis, and reporting. Furthermore, in February 2025, the researcher took steps to ensure that all participants were fully informed about the study, their rights, and the nature of their involvement. Informed consent was obtained from each participant before their participation in the study. For the distribution and retrieval of questionnaires during the first week of February 2024, the researcher maintained a commitment to data accuracy and completeness. These processes were conducted with a standardized and systematic approach, ensuring reliability in the collection of responses from participants. She went into considering the following conditions: Identifying the target population: The researcher identified the appropriate target population of the study and ensured that the questionnaire was distributed only to individuals who met the inclusion criteria.

Scale Descriptive Ratings and Interpretation on Critical Thinking Skills in Elementary Mathematics Instruction

Scale	Descriptive Rating	Interpretation
4.20 – 5.00	Very Extensive	The critical thinking skills in elementary Mathematics instruction is always manifested.
3.40 – 4.19	Extensive	The critical thinking skills in elementary Mathematics instruction is oftentimes manifested.
2.60 – 3.39	Moderately Extensive	The critical thinking skills in elementary Mathematics instruction is sometimes manifested.
1.80 – 2.59	Less Extensive	The critical thinking skills in elementary Mathematics instruction is rarely manifested.
1.00 – 1.79	Not Extensive	The critical thinking skills in elementary Mathematics instruction is not manifested.

2.6. *Data Analysis*—Mean scores and standard deviation Were used to address statement problems posed in number one (1) extent of integrating problem-solving tasks, and statement problem number two (2) on the extent of critical thinking in elementary mathematics instruction in Gov Generoso North District, Davao Oriental Schools Division.

Pearson Product Moment Correlation Coefficient or Pearson-r Was used to determine its strength / direction significant relationship between integrating problem-solving tasks and

critical thinking in elementary mathematics instruction.

Simple Linear Regression analysis

Was used to address statement problem number 4, on the indicators of integrating problem-solving tasks that significantly influence critical thinking in elementary mathematics instruction (Pallant, 2000) and (Gujarati, 2000). All data processing and analysis were treated using the Jeffrey's Statistics Amazing Program (JASP) version 0.12.20. Discussions and interpretations then followed when results yield.

3. Results and Discussion

This chapter presents the statistical results of the study, which aimed to determine the extent to which problem-solving tasks contribute to the enhancement of critical thinking skills in elementary mathematics instruction. The analysis focuses on the descriptive statistics of both independent and dependent variables, as well as the inferential results derived from linear regression. The findings are organized in alignment with the specific research questions posed in Chapter 1, and are discussed in relation to existing literature to provide comprehensive insights into the effectiveness of integrating problem-solving strategies in mathematical pedagogy.

3.1. Extent of Problem-Solving Tasks— Problem-solving tasks in mathematics refer to structured or open-ended instructional activities that require learners to identify problems, explore possible solutions, and apply mathematical reasoning to arrive at conclusions. These tasks aim to cultivate not only computational fluency but also higher-order thinking skills, such as reasoning, analysis, and logical deduction (Schoenfeld, 2021). They typically include real-world problem-solving scenarios, open-ended questions, mathematical investigations, and collaborative exercises that challenge students to go beyond rote memorization and apply their understanding in diverse contexts. The integration of problem-solving tasks is essential in modern mathematics instruction because it fosters active learning and aligns with constructivist approaches, where students build knowledge through exploration and engagement. According to Kapur and Bielaczyc (2022), productive failure embedded in complex problem-solving tasks enhances students' conceptual understanding and resilience in mathematical learning. This perspective is echoed in the findings of Guerra Ayala et al. (2024), who found that problem-based learning approaches significantly improved problem-solving disposition and cognitive flexibility among elementary learners in the Philippines. Moreover, in a quasi-experimental study conducted by Castro and de Leon (2023), Filipino elementary students exposed to real-world problem-solving scenarios demonstrated a marked improvement in critical thinking and application of mathematical principles compared to those taught through traditional lecture methods. Similarly, Yamaguchi and Hirashima (2022) noted that collaborative mathematical problem-solving tasks in Japanese elementary classrooms led to improved group reasoning skills and peer-assisted learning outcomes. In the context of 21st-century learning, problem-solving tasks are also aligned with the goals of mathematics education that emphasize creativity, communication, and critical thinking. As highlighted by Sarabi and Ututalum (2023), contextualized and inquiry-driven problem tasks not only increase student motivation but also deepen their engagement with content, particularly when local examples and culturally relevant scenarios are used. Summary of the Extent of Problem-Solving Tasks Table 1 presents a consolidated summary of the extent to which various types of problem-solving tasks are integrated into elementary mathematics instruction. The overall mean of 3.28, interpreted as "Moderately Extensive," indicates that while problem-solving tasks are generally employed in teaching practices, their application is not yet fully optimized across all domains. Among the four dimensions, real-world problem solving received the highest mean score ($M = 3.44$, Extensive), suggesting that teachers frequently employ contextualized mathematical activities that relate to students' everyday experiences. This reflects a positive shift toward constructivist pedagogies where learners can apply abstract concepts in authentic situations, enhancing both relevance and engagement. On the other hand, open-ended questions obtained the lowest mean ($M = 3.05$, Moderately Extensive), which may reflect specific challenges in designing and implementing such tasks, particularly in classrooms that are highly structured or assessment-driven. Meanwhile, both mathematical investigation ($M = 3.32$) and collaborative problem-solving ($M = 3.34$) were also rated as Moderately Extensive, indicating that while these strategies are present, their integration may vary depending on teacher familiarity, resource availability, or classroom dynamics.

Table 1. Summary of the Extent of Problem-Solving Tasks

No	Extent of Problem-Solving Tasks	n	Mean	Descriptive Interpretation
1	Real-world problem solving	86	3.44	Extensive
2	Open-ended questions	86	3.05	Moderately Extensive
3	Mathematical investigation	86	3.32	Moderately Extensive
4	Collaborative problem-solving	86	3.34	Moderately Extensive
Mean Average		86	3.28	Moderately Extensive

Overall, these findings suggest a moderately consistent implementation of problem-solving approaches in elementary mathematics. While the positive presence of these tasks reflects awareness of best instructional practices, the data also imply the need for targeted professional development programs that will deepen teacher expertise in designing and facilitating open-ended, investigative, and collaborative problem-solving activities that foster critical thinking.

3.2. Extent of Critical Thinking Skills in Elementary Mathematics Instruction—Critical thinking in elementary mathematics instruction refers to learners' ability to actively and skillfully conceptualize, analyze, evaluate, and apply mathematical information to solve problems in meaningful ways. It involves higher-order cognitive processes such as reasoning, justification, inference, interpretation, and self-regulation, which go beyond mere procedural computation or memorization (Facione, 2021). In mathematics, critical thinking enables students to question assumptions, make logical connections between ideas, reflect on their problem-solving strategies, and justify their solutions with evidence-based reasoning. At the elementary level, fostering critical thinking is essential for developing

mathematical proficiency and cultivating life-long learning habits. According to Doleck et al. (2021), critical thinking must be nurtured early in the educational process to promote adaptive problem-solving and resilience in mathematical tasks. Techniques such as scaffolding, strategic questioning, exploration-based tasks, and problem-based learning environments provide learners with opportunities to engage in deeper cognitive processing and collaborative reflection. Furthermore, the integration of critical thinking into mathematics instruction supports the development of metacognitive skills, as students begin to monitor their understanding, recognize errors, and revise their strategies accordingly. This aligns with Vygotsky's Zone of Proximal Development (ZPD), which posits that guided instruction within students' potential level of development fosters meaningful cognitive growth (as cited in Nguyen Reyes, 2022). Recent shifts in global mathematics curricula emphasize critical thinking as a core competency. In the Philippine context, the Department of Education's MATATAG Curriculum highlights the importance of critical and analytical thinking across all learning areas, especially in mathematics, to better prepare students for real-life decision-making and aca-

demic rigor (DepEd, 2023). Teachers, therefore, are tasked with designing learning experiences that are inquiry-oriented, cognitively demanding, and reflective of real-world scenarios. Summary of the Extent of Critical Thinking Skills in Elementary Mathematics Instruction

Table 2 summarizes the extent to which various instructional strategies contribute to the development of critical thinking skills in ele-

mentary mathematics instruction. The overall mean score of 3.89, interpreted as “Extensive,” reflects a strong and consistent integration of pedagogical practices aimed at enhancing learners’ analytical, reflective, and problem-solving capacities. This suggests that the majority of teachers actively employ instructional methods designed to foster higher-order thinking in mathematics.

Table 2. Summary of the Extent of Critical Thinking Skills in Elementary Mathematics Instruction

No	Extent of Problem-Solving Tasks	n	Mean	Descriptive Interpretation
1	Scaffolding technique	86	3.78	Extensive
2	Questioning technique	86	3.97	Extensive
3	Exploration and discovery	86	4.00	Extensive
4	Problem-based learning	86	3.84	Extensive
Mean Average		86	3.89	Extensive

Among the four domains assessed, Exploration and Discovery received the highest mean score ($M = 4.00$), highlighting the significant role of inquiry-based learning in fostering critical thinking. This approach encourages students to investigate mathematical ideas, make connections, and draw conclusions based on their discoveries, aligning with constructivist and experiential learning theories. Questioning Technique followed closely ($M = 3.97$), emphasizing the value of strategic questioning in promoting justification, reasoning, and metacognitive awareness. Problem-Based Learning ($M = 3.84$) and Scaffolding Technique ($M = 3.78$) also demonstrated extensive application. These strategies support learners by gradually releasing responsibility, encouraging independent problem-solving, and contextualizing mathematical content in real-life scenarios. Collectively, these results affirm that teachers perceive critical thinking as an essential goal of mathematics instruc-

tion and are actively employing diverse and effective methods to cultivate it. The consistently high scores across all domains suggest a pedagogical shift towards more reflective and student-centered mathematics teaching. This implies a growing recognition of the importance of empowering learners with not only computational skills but also the cognitive tools necessary for analyzing complex problems, making decisions, and applying knowledge in dynamic contexts. These findings align with recent studies such as those by Doleck et al. (2021) and Francisco and Ballado (2023), which affirm that critical thinking can be effectively developed when learners are engaged in problem-solving environments that emphasize exploration, discourse, and independent inquiry. Moreover, as noted by Alonzo and Domingo (2022), critical thinking should not be treated as an isolated skill but rather as an integrated component of daily mathematics instruction, scaffolded by de-

liberate pedagogical strategies.

3.3. *Relationship Between Problem-Solving Tasks and Critical Thinking Skills in Elementary Mathematics Instruction*—Table 3 presents the result of the Pearson product-moment correlation analysis conducted to determine the relationship between problem-solving tasks and the development of critical thinking skills in elementary mathematics instruction. The analysis yielded an r-value of 0.226 with a corresponding p-value of 0.036, indicating a significant

positive relationship at the 0.05 level of significance. Based on this outcome, the null hypothesis (H) stating that there is no significant relationship between problem-solving tasks and critical thinking skills is rejected. This implies that the more problem-solving strategies are utilized in instruction, such as real-world scenarios, open-ended questions, mathematical investigations, and collaborative tasks, the more likely students are to demonstrate enhanced critical thinking abilities.

Table 3. Relationship between Problem-Solving Tasks and Critical Thinking Skills in Elementary Mathematics Instruction

Variables	r-value	p-value	Interpretation	Decision
Problem-Solving Tasks	0.226	0.036	Significant	Reject H_0

**Significant at $p < 0.05$.*

While the correlation is positive and weak, its statistical significance suggests that integrating problem-solving tasks meaningfully contributes to developing students' capacity for reasoning, analysis, and reflective thinking. This underscores the instructional value of incorporating diverse and authentic mathematical problem-solving experiences to support higher-order learning outcomes in the elementary classroom. Several recent empirical studies substantiate these findings. For instance, Doleck et al. (2021) highlighted that learners exposed to frequent problem-solving activities exhibit stronger self-regulation and critical thinking abilities due to their repeated engagement with non-routine problems that require interpretation and strategic responses. Similarly, Sarabi and Ututalum (2023) found that contextualized and inquiry-based math instruction significantly predicted students' cognitive engagement and evaluative reasoning in Sulu public schools. Moreover, Kapur and Bielaczyc (2022) emphasized that problem-solving envi-

ronments—especially those that allow space for productive struggle—encourage learners to develop and refine their critical thinking skills by confronting challenges, testing solutions, and concluding. This was echoed in the work of Francisco and Ballado (2023), who demonstrated that Filipino elementary students who participated in investigation-based tasks showed measurable improvement in logical reasoning and the ability to justify solutions. The present study adds to the growing body of evidence supporting the integration of problem-solving as a cornerstone of critical thinking development in mathematics, reinforcing the call for pedagogical models that prioritize inquiry, reasoning, and meaningful problem engagement.

3.4. *Domains Of Problem-Solving Tasks Significantly Influence Critical Thinking Skills in Elementary Mathematics Instruction*—This table presents the individual contribution of each domain of problem-solving tasks to the prediction of critical thinking skills. None of the predictors showed statistically significant

contributions at $p < 0.05$. The highest beta value came from Real-World Problem Solving ($\beta = 0.285$); however, its p -value = 0.184 indicates it is not significant. Open-Ended Questions, Mathematical Investigations, and Collaborative Problem Solving also failed to demonstrate substantial influence, with all p -values well above 0.05. These findings are in contrast with studies such as Lee and Park (2022) and Francisco and Bal-

lado (2023), who found significant associations between problem-based, inquiry-driven tasks and improved student reasoning and problem-solving abilities. However, the weak but positive correlation in the earlier Pearson analysis ($r = 0.226$, $p = 0.036$) implies that while a relationship exists, it may not be strongly predictive when partitioned across multiple overlapping domains.

Table 4. Domains of Problem-Solving Tasks that Significantly Influence Critical Thinking Skills in Elementary Mathematics Instruction

Model	Unstandardized	Standard Error	Standardized	t	p	Decision
M Intercept	3.901	0.037	–	105.582	< .001	–
M Intercept	3.589	0.167	–	21.468	< .001	–
Real-world Problem Solving	0.107	0.080	0.285	1.341	0.184	Accept Null
Open-ended Questions	-0.004	0.055	-0.010	-0.075	0.940	Accept Null
Mathematical Investigations	-0.031	0.120	-0.079	-0.261	0.795	Accept Null
Collaborative Problem Solving	0.018	0.084	0.052	0.212	0.833	Accept Null

4. Conclusions and Recommendations

This chapter presents a summary of the key findings, conclusions drawn from the statistical results, and corresponding recommendations based on the study's objectives. The conclusions are grounded in the analysis of the extent to which problem-solving task integration is related to the development of critical thinking skills in elementary mathematics instruction. Recommendations are offered to inform future instructional practices, policy formulation, and further research directions aimed at enhancing mathematics pedagogy and learner outcomes.

4.1. Findings—The extent of problem-solving tasks in elementary mathematics instruction was generally regarded as moderately extensive. Among the identified domains, real-world problem solving emerged as the most consistently applied, highlighting the frequent integra-

tion of authentic and contextualized mathematical activities. The use of open-ended questions was also evident, though only moderately utilized, indicating limited opportunities for students to explore diverse perspectives and varied solution strategies. Similarly, mathematical in-

vestigations and collaborative problem-solving were present to a moderate degree, suggesting that while inquiry and teamwork are incorporated into instruction, their application is not yet consistently observed across all classrooms. These findings underscore the importance of recognizing problem-solving strategies in instruction, albeit with room for further emphasis and integration. Regarding the development of critical thinking skills through mathematics instruction, the results revealed a generally extensive implementation across all domains. Scaffolding techniques were commonly employed to support students in developing metacognitive and independent problem-solving capabilities. Questioning strategies were widely practiced, fostering deeper reasoning and analytical thinking. Exploration and discovery activities were highly utilized, indicating strong engagement with inquiry-based learning. Additionally, problem-based learning approaches were extensively applied, reinforcing students' capacity to apply critical thinking when addressing real-world mathematical challenges. These observations confirm the pivotal role of instructional strategies in fostering learners' critical and reflective thinking processes. A positive relationship was identified between the use of problem-solving tasks and the development of critical thinking skills, suggesting that as the integration of such tasks increases, so too does the development of learners' higher-order thinking abilities. However, the analysis also indicated that no individual domain emerged as a significant predictor of critical thinking skills, implying that critical thinking is most effectively fostered through a combination of instructional strategies rather than reliance on a single approach.

4.2. Conclusions—The integration of problem-solving tasks in elementary mathematics instruction is generally evident, with real-world problem solving being the most extensively practiced. However, the domains

of open-ended questions, mathematical investigations, and collaborative problem-solving are only moderately emphasized, indicating areas for pedagogical improvement. The development of critical thinking skills among learners is strongly supported through the use of scaffolding techniques, questioning strategies, exploration-based tasks, and problem-based learning. These strategies are extensively implemented, with exploration and discovery being the most emphasized, suggesting that instructional practices are aligned with learner-centered and inquiry-based approaches. A significant positive relationship exists between problem-solving tasks and critical thinking skills in elementary mathematics instruction. This affirms the theoretical assumption that engaging students in mathematical problem-solving enhances their capacity for reasoning, analysis, and reflective thinking. Despite the overall positive correlation, none of the specific domains of problem-solving tasks significantly influenced critical thinking skills when examined through multiple regression. This implies that critical thinking may be a cumulative result of various instructional factors working in combination, rather than any single problem-solving strategy acting as a dominant predictor.

4.3. Recommendations—In light of the findings, several recommendations are proposed to enhance the integration of problem-solving tasks and the development of critical thinking skills in elementary mathematics instruction. For the learners, it is recommended that they be provided with regular opportunities to engage in meaningful and challenging mathematical activities that foster independence, creativity, and collaboration. Students should be encouraged to explore multiple solution paths, reflect on their reasoning, and actively participate in inquiry-based learning to strengthen their critical thinking dispositions. For teachers, it is recommended to consistently incorporate open-ended questions, mathematical investigations, and col-

laborative tasks into daily instruction. Teachers should undergo targeted professional development that equips them with practical strategies for scaffolding and questioning, as well as designing lessons that promote exploration, discovery, and real-world problem-solving. Emphasis must be placed on integrating various domains rather than relying on a single technique, as the development of critical thinking is best supported through a multifaceted instructional approach. For the school heads, it is essential to provide systematic support for teachers by fostering a school culture that prioritizes higher-order thinking and inquiry-based practices in mathematics. School leaders should allocate time and resources for collaborative lesson planning, classroom-based research, and ongoing mentoring programs that emphasize instructional improvement in problem-solving and critical thinking. For the DepEd officials,

there is a need to develop policies and curriculum guidelines that embed problem-solving and critical thinking as core competencies in mathematics instruction. Investment in capacity-building initiatives and instructional supervision mechanisms will be vital in scaling up effective practices. Furthermore, monitoring tools should be designed to evaluate the implementation and effectiveness of these strategies at the school level. For future researchers, it is recommended that they conduct longitudinal and experimental studies to investigate further the causal relationships between specific instructional strategies and the development of critical thinking skills. Qualitative inquiries may also provide deeper insights into classroom dynamics, learner experiences, and contextual factors that influence the success of problem-solving integration in diverse educational settings.

5. References

- Ahdhianto, E., Marsigit, M., Haryanto, H., & Nurfauzi, Y. (2020). Improving fifth-grade students' mathematical problem-solving and critical thinking skills using problem-based learning. *Universal Journal of Educational Research*, 8(5), 2012–2021. <https://doi.org/10.13189/ujer.2020.080539>
- Alonzo, R. C., & Domingo, M. F. (2022). Enhancing mathematical thinking through scaffolding strategies in elementary classrooms. *Philippine Journal of Mathematics Education*, 14(2), 78–92.
- Alrashdi, Y. (2023). Understanding teachers' instructional strategies.
- Aziza, M. (2021). A teacher questioning activity: The use of oral open-ended questions in the mathematics classroom. *Qualitative Research in Education*, 10(1), 31–61. <https://doi.org/10.17583/qre.2021.6475>
- Bayani, F., & Prayogi, S. (2022). Assessing students' critical thinking skills viewed from cognitive style: Implementation of problem-based e-learning model in mathematics courses. *EURASIA Journal of Mathematics, Science and Technology Education*, 18(7), em2129. <https://doi.org/EJ1353307>
- Bingölbali, E., & Bingölbali, F. (2021). An examination of the affordances of open-ended mathematics questions. *International Journal of Progressive Education*, 17(4), 1–16. <https://doi.org/10.29329/ijpe.2021.366.1>
- Bingölbali, E., & Cevik, H. F. (2022). How do middle school mathematics teachers conceptualize open-ended questions? *Mimbar Sekolah Dasar*, 9(1), 140–160. <https://doi.org/10.53400/mimbar-sd.v9i1.43742>

- Borgonovi, F., Han, S. W., & Greiff, S. (2023). Gender differences in collaborative problem-solving skills from a cross-cultural perspective. *Journal of Educational Psychology*, 115(5), 747–766. <https://doi.org/10.1037/edu0000788>
- Bulková, K., Medová, J., & Čeretková, S. (2020). Identification of crucial steps and skills in high achievers' solving complex mathematical problems within mathematical contests. *Journal on Efficiency and Responsibility in Education and Science*, 13(2), 67–78. <https://doi.org/10.7160/eriesj.2020.130202>
- Cagatan, A. N. P., & Quirap, E. A. (2024). Collaborative learning and learners' academic performance. *International Journal of Multidisciplinary Research and Analysis*, 7(03). <https://doi.org/10.47191/ijmra/v7-i03-57>
- Calor, S. M., Dekker, R., van Drie, J. P., & Volman, M. L. L. (2022). Scaffolding small groups at the group level: Improving the scaffolding behavior of mathematics teachers during mathematical discussions. *Journal of the Learning Sciences*, 31(3), 369–407. <https://doi.org/10.1080/10508406.2021.2024834>
- Castro, M. D., & de Leon, R. A. (2023). Enhancing elementary learners' critical thinking through real-world mathematics problem-solving: A quasi-experimental study. *Philippine Journal of Basic Education Research*, 14(1), 45–58.
- Çayir, A., & Balci, E. (2023). The effect of differentiated instruction on gifted students' critical thinking skills and mathematics problem-solving attitudes. *Educational Research and Reviews*, 18(12), 392–398. <https://doi.org/10.5897/ERR2023.4235>
- Characteristics of gifted learners: Implementing the real engagement in active learning problem solving (reaps) teaching model [<https://search.informit.org/doi/abs/10.3316/INFORMIT.134952943259460>]. (2021). *Australasian Journal of Gifted Education*, 30(2), 5–25.
- Cheeseman, J. (2019). Young children are natural inquirers: Posing and solving mathematical problems. *Waikato Journal of Education*, 24(2), 11–22. <https://doi.org/10.15663/wje.v24i2.664>
- Coleman, T. D., & Walkoe, J. D. K. (2020). Productive technology use in commognitive processes of collaborative problem solving in mathematics classrooms. *Asia-Pacific Education Researcher*, 32(5), 615–628. <https://doi.org/10.1007/s40299-022-00681-2>
- Copp, S. B., Cabell, S. Q., Gabas, C., Slik, D., & Todd, J. (2023). The rising star scaffolding guide: Supporting young children's early spelling skills. *The Reading Teacher*, 76(3), 245–260. <https://doi.org/10.1002/trtr.2156>
- Creswell, J. W. (2020). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.
- Dela Cruz, R. L., & Santiago, M. V. (2023). Collaborative learning in mathematics: Enhancing problem-solving skills among filipino elementary learners. *Philippine Journal of Educational Innovation*, 8(1), 55–70.
- Department of Education. (2023). Matatag curriculum framework.
- Dicdiquin, J. B., Mobo, F. D., & Cutillas, A. L. (2023). Evaluating the differences in collaborative problem-solving skills in a cross-country perspective. *Journal of Educational Psychology*, 115(5), 747–766. <https://doi.org/10.1037/edu0000788>
- Doleck, T., Bazelais, P., Lemay, D. J., & Saxena, A. (2021). Predictive relationships between self-regulation, critical thinking, and academic achievement in elementary mathematics.

- Educational Studies in Mathematics*, 107(2), 251–270. <https://doi.org/10.1007/s10649-020-09996-7>
- Dynamic exploration of dataviz. (2023). *Canadian Journal of Science, Mathematics and Technology Education*, 23(3), 497–508. <https://doi.org/10.1007/s42330-023-00292-z>
- Effectiveness of professional development programs for junior high school mathematics teachers in improving mathematics instruction in the k to 12 curriculum in the philippines. (2023). *International Journal of Multidisciplinary: Applied Business and Education Research*, 4(4), 1143–1153.
- Evendi, E., Al Kusaeri, A., Pardi, M. H., & Sucipto. (2022). Evolution of instrumented schemes: A case study of learning programming for mathematical investigations. *Educational Studies in Mathematics*, 110(2), 353–377. <https://doi.org/10.1007/s10649-021-10133-1>
- Evendi, E., Retnawati, H., & Istiyono, E. (2023). Assessment of critical mathematical thinking skills: A literature review. *Beta Jurnal Tadris Matematika*, 16(2), 85–97.
- Facione, P. A. (2021). *Critical thinking: What it is and why it counts* (8th). Insight Assessment.
- Francisco, M. T., & Ballado, J. F. (2023). Enhancing metacognitive awareness through mathematical investigations: A classroom-based study among filipino grade schoolers. *Journal of Mathematics Education in Southeast Asia*, 12(2), 85–100.
- Guerra Ayala, R., Mendoza, L., & Tulabing, A. (2024). Enjoyment and oral english proficiency in future teachers: Implications for content-based and problem-solving instruction. *REiLA: Journal of Research and Innovation in Language*, 6(1), 15–27. <https://doi.org/10.31849/reila.v6i1.12345>
- Kapur, M., & Bielaczyc, K. (2022). Productive failure in mathematics instruction: A review of studies and implications for classroom practice. *Educational Psychologist*, 57(3), 176–190. <https://doi.org/10.1080/00461520.2022.2052109>
- Karaman, P., & Büyükkıdık, S. (2023). Teachers’ use of open-ended questions: A mixed-methods study. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 96(2), 79–87. <https://doi.org/10.1080/00098655.2023.2166891>
- Kensington-Miller, B., Sneddon, J., & Stewart, S. (2014). Crossing new uncharted territory: Shifts in academic identity as a result of modifying teaching practice in undergraduate mathematics. *International Journal of Mathematical Education in Science and Technology*, 45(6), 827–838. <https://doi.org/10.1080/0020739X.2013.872305>
- Khusna, A. H., Siswono, T. Y. E., & Wijayanti, P. (2024). Mathematical problem design to explore students’ critical thinking skills in collaborative problem solving. *Mathematics Teaching Research Journal*, 16(3), 217–240. <https://doi.org/EJ1442273>
- Lee, J. H., & Park, Y. S. (2022). Developing students’ reasoning skills through mathematical investigations: An empirical study in korean classrooms. *International Journal of Educational Research Open*, 3(1), 100–111. <https://doi.org/10.1016/j.ijedro.2022.100111>
- Li, R., Cao, Y., Tang, H., & Kaiser, G. (2024). Teachers’ scaffolding behavior and visual perception during cooperative learning. *International Journal of Science and Mathematics Education*, 22(2), 333–352. <https://doi.org/10.1007/s10763-023-10379-6>
- Lingefjård, T., & Hatami, R. (2020). The beauty of abstraction in mathematics. *Policy Futures in Education*, 18(4), 467–482. <https://doi.org/10.1177/1478210319895104>
- Llurag, S. M. (2024). University of the visayas, cebu city, philippines, and tecoy porter college prep, sacramento, ca, usa [ORCID: 0009-0004-5008-5804].

- Lu, J., Wu, S., Wang, Y., & Zhang, Y. (2023). Visualizing the cognitive and affective processes of collaborative problem solving in mathematics classrooms. *The Asia-Pacific Education Researcher*, 32(5), 615–628. <https://doi.org/10.1007/s40299-022-00681-2>
- Maker, C. J., & Pease, R. (2021). Building on and extending the characteristics of gifted learners: Implementing the real engagement in active problem solving (reaps) teaching model. *Australasian Journal of Gifted Education*, 30(2), 5–25. <https://doi.org/10.21505/ajge.2021.0012>
- Manousaridis, T. (2021). Promoting inquisitiveness, mathematical problems [Originally presented 2019]. *Waikato Journal of Education*, 25(2), 11–22. <https://doi.org/EJ1236901>
- Myers, A.-A. M. (2022). *Analyzing mathematical critical-thinking skills apply real-world problem-solving in integrated stem education* [Ph.D. dissertation]. ProQuest LLC. <https://eric.ed.gov/?q=real-world+problem+solving%5C&id=ED640254>
- Nguyen, H. T., & Reyes, M. D. (2022). Teaching mathematics through open-ended questions: Strategies and barriers among filipino educators. *Asia Pacific Journal of Education Research*, 5(2), 91–106.
- Nizaruddin & Kusmaryono, I. (2023). How are critical thinking skills related to students' self-regulation and independent learning? *Pegem Journal of Education and Instruction*, 13(4), 85–92.
- Nurlaily, V. A., Soegiyanto, H., & Usodo, B. (2019). Elementary school teachers' obstacles in implementing the problem-based learning model in mathematics education. *Journal on Mathematics Education*, 10(2), 229–238.
- Pallant, J. (2020). *Spss survival manual: A step-by-step guide to data analysis using spss for windows* (4th). McGraw-Hill Education.
- Palmer, R., & Choi, I. (2023a). Constructing problems in context: A pedagogy for gifted mathematicians in further education: A diary-interview study. *Journal of Further and Higher Education*, 47(4), 492–512. <https://doi.org/10.1080/0309877X.2022.2142103>
- Palmer, R., & Choi, I. (2023b). Constructing problems in context: A synthesized model of dialectical problem-framing. *Educational Technology Research and Development*, 71(4), 1525–1545. <https://doi.org/10.1007/s11423-023-10188-0>
- Palmér, H., & van Bommel, J. (2023). Young students explore measurement through problem-solving and problem-posing. *The Mathematics Educator*, 31(1), 30–54. <https://doi.org/10.63301/tme.v31i1.2477>
- Rivera, G. M., & Santos, C. A. (2023). Teacher-guided scaffolding and its effect on critical thinking skills in mathematics among grade 6 learners. *Asian Journal of Education Research*, 18(1), 23–37.
- Rodney, S., & Mamolo, A. (2023). Relational-curiosity and mathematics: A dynamic exploration of data visualization (dataviz). *Canadian Journal for Science, Mathematics and Technology Education*, 23(3), 497–508. <https://doi.org/10.1007/s42330-023-00234-6>
- Rothman, S. J., Wylie, C., Reber, S., & Kang, S. (2023). *Real-world problem solving and social studies: A study of teaching and learning in high school classrooms* (tech. rep.) (Retrieved from <https://eric.ed.gov/?id=ED640254>). Institute of Education Sciences.
- Sarabi, M., & Ututalum, M. (2023). Effectiveness of english teaching methods and problem-based learning strategies in public higher education institutions in sulu. *Journal of Education and Society*, 17(2), 89–104.

- Sarwanto, Fajari, L. E. W., & Chumdari. (2024). Open-ended questions scaffolding behavior and visual perception during cooperative learning. *International Journal of Science and Mathematics Education*, 22(2), 333–352. <https://doi.org/10.1007/s10763-023-10379-6>
- Schoenfeld, A. H. (2021). Problem solving in mathematics education: From research to practice. *ZDM – Mathematics Education*, 53(1), 25–37. <https://doi.org/10.1007/s11858-020-01164-5>
- Shadowens, E. (2023). *Critical thinking in the elementary classroom: Engaging young minds with meaningful content*. ASCD.
- Smith, J., Patel, R., & Kim, H. (2021). Cultural responsiveness in mathematics education: A global perspective [Retrieved from <https://eric.ed.gov/?id=EJ1437410>]. *Educational Studies in Mathematics*, 108(2), 201–220.
- Suratmi & Sopandi, W. (2022). Knowledge, skills, and attitudes of synthesized model of dialectical problem-framing. *Educational Technology Research and Development*, 71(4), 1525–1545. <https://doi.org/10.1007/s11423-023-10246-9>
- Tan, M. R., & Reyes, V. C. (2021). Contextualizing mathematical investigations to improve learner problem-solving resilience. *Philippine Journal of STEM Education*, 5(1), 47–63.
- Thatcher Day, C. (2021). Discovering area models: The giant sicilian pizza task. *Mathematics Teacher: Learning and Teaching PK–12*, 114(12), 964–968.
- Torres, J., & Ramos, M. (2023). Socioeconomic barriers to the development of critical thinking in philippine elementary education. *International Journal of Educational Equity*, 10(1), 201–215.
- Tuong, H. A., Nam, P. S., Hau, N. H., Tien, V. T. B., Lavicza, Z., & Houghton, T. (2023). Utilising stem-based practices to enhance mathematics teaching in vietnam: Developing students' real-world problem solving and 21st century skills. *Journal of Technology and Science Education*, 13(1), 73–91. <https://doi.org/10.3926/jotse.1790>
- van Gog, T., Hoogerheide, V., & van Harsel, M. (2020). The role of mental effort in fostering self-regulated learning with problem-solving tasks. *Educational Psychology Review*, 32(4), 1055–1072. <https://doi.org/10.1007/s10648-020-09544-y>
- Vygotskian scaffolding techniques as motivational through additional instructional time* [Ed.D. dissertation]. ProQuest LLC [Retrieved from <https://eric.ed.gov/?id=ED640771>]. (2023).
- Wulandari, T., & Nuraini, S. (2021). The role of scaffolding in developing metacognitive skills in elementary mathematics learning. *Journal of Educational Practice*, 12(6), 115–123.
- Yamaguchi, T., & Hirashima, T. (2022). Collaborative mathematical problem-solving in elementary education: Effects on reasoning and peer learning. *International Journal of STEM Education*, 9(1), 101–115. <https://doi.org/10.1186/s40594-022-00347-9>
- Yildizli, H., & Günaydin, G. (2022). An investigation of elementary young minds with meaningful content [<https://www.ascd.org/books/critical-thinking-in-the-elementary-classroom?variant=123012>].