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Unpacking Mathematics Reception and Problem-Solving Competence Among First-Year College Information Technology Students: A Grounded Theory Inquiry

Marilou Z. Lastrollo
DepEd, Naga City
marilou.lastrollo@unc.edu.ph

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ABSTRACT

This study explored the mathematics learning experiences of first-year Bachelor of Science in Information Technology students, focusing on their reception toward mathematics, problem-solving competence, challenges encountered, coping strategies, and the grounded theoretical explanation emerging from their responses. A qualitative grounded theory design was used, involving twenty (20) first-year BSIT students enrolled in Discrete Mathematics/Structures I at a university in the Bicol Region, Naga City, Philippines. Data were gathered through a researcher-made structured open-ended questionnaire and analyzed using grounded theory procedures, including open coding, axial coding, selective coding, constant comparison, and theoretical saturation. The analysis generated 168 significant statements, 32 initial codes, and 8 conceptual categories, which were integrated into the core category Adaptive Mathematical Engagement. Findings revealed that students initially experienced mathematics anxiety, fear, confusion, low confidence, and conceptual difficulty, particularly in algebraic operations and word problem interpretation. However, peer collaboration, teacher guidance, repeated practice, and digital learning strategies helped students gradually build understanding, confidence, and problem-solving competence. The study concludes that mathematical competence develops through a continuous interaction of emotional adjustment, cognitive struggle, social mediation, instructional scaffolding, and self-regulated learning. The findings imply that mathematics instruction for first-year IT students should be anxiety-sensitive, scaffolded, collaborative, and connected to students' program-related learning contexts.

Keywords: *Mathematics reception, problem-solving competence, grounded theory, mathematics anxiety, adaptive learning strategies, Information Technology students*

INTRODUCTION

Mathematics is a foundational discipline for logical reasoning, critical thinking, and problem-solving, particularly in technology-related programs such as Information Technology. For first-year college students, however, mathematics is often experienced not only as a cognitive requirement but also as an emotional and social challenge. Students entering higher education may encounter difficulty adjusting to abstract concepts, symbolic reasoning, and multi-step problem-solving tasks, especially when their prior mathematical foundation is uneven.

The concern is relevant in the Philippine context, where national and international assessments have pointed to persistent gaps in mathematical performance and problem-solving skills. The Programme for International Student Assessment showed that Filipino learners performed below the global average in mathematics, suggesting the need for stronger instructional support during transitions to more advanced mathematical learning (OECD, 2019). For college students in Information Technology programs, this concern becomes more important because discrete mathematics, logic, and structured problem-solving form part of their academic and professional preparation.

The literature explains mathematics learning through cognitive, social, and affective perspectives. Vygotsky (1978) emphasized that learning is strengthened through social interaction and scaffolding, while Polya (1957) framed problem solving as a process involving understanding the problem, planning, carrying out the plan, and reflecting on the solution. Schoenfeld (1985) further emphasized that mathematical problem solving involves strategic knowledge, monitoring, and beliefs about mathematics. These perspectives suggest that students' mathematical competence is shaped not only by content mastery but also by confidence, persistence, social support, and learning strategies.

Despite these insights, many studies examine mathematics anxiety, problem-solving skills, peer support, and learning strategies separately. There remains a need to understand how these factors interact in the lived experiences of first-year Information Technology students. This study addresses that gap by using grounded theory to generate an explanatory model of how students receive mathematics and develop problem-solving competence. Specifically, the study sought to describe students' perceptions of mathematics learning, identify factors influencing problem-solving competence, determine common challenges, explore coping strategies, examine emerging themes, and develop a grounded theory explaining the relationship between mathematics reception and problem-solving competence.

Literature Review

Mathematics Reception and Affective Barriers

Students' reception toward mathematics refers to the way they perceive, emotionally respond to, and engage with mathematical learning. Affective responses such as anxiety, fear, frustration, confidence, and interest shape students' willingness to participate in mathematical tasks. In mathematics education, Skemp (1987) explained that meaningful understanding requires learners to connect concepts rather than merely memorize procedures. When students lack such relational understanding, mathematics may be perceived as difficult, abstract, and threatening.

Mathematics reception is also connected to students' beliefs about their own capability. Schoenfeld (1985) emphasized that beliefs and self-monitoring influence how students approach mathematical problems. When students view mathematics as confusing or beyond their ability, they may avoid tasks or rely heavily on others. Conversely, when they receive support and experience gradual success, confidence may increase and engagement may become more active.

Problem-Solving Competence in Mathematics

Problem-solving competence refers to students' ability to understand mathematical problems, identify appropriate strategies, carry out procedures accurately, and evaluate solutions. Polya's (1957) problem-solving framework remains useful in explaining why students struggle with word problems, algebraic processes, and multi-step tasks. Students who cannot understand the problem or plan a solution often experience slow progress, computational errors, and reduced confidence.

Kilpatrick, Swafford, and Findell (2001) argued that mathematical proficiency includes conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. This means that competence involves more than correct answers; it includes the ability to reason, persist, and apply mathematics meaningfully. Hiebert and Grouws (2007) also highlighted the importance of classroom instruction that supports conceptual development and productive struggle.

Social Support, Scaffolding, and Self-Regulated Learning

Social interaction is central to learning. Vygotsky's (1978) social constructivist perspective suggests that learners develop higher cognitive functions through interaction with more capable peers and teachers. In mathematics classrooms, peer discussion and teacher guidance may help students clarify concepts, reduce anxiety, and develop strategies for solving problems.

Self-regulated learning also plays an important role in mathematical competence. Students who repeatedly practice, review examples, ask for help, and use learning resources are more likely to improve over time. Mayer (2009) emphasized that learning is supported when students actively process information through organized, meaningful, and multimodal experiences. In this study, these perspectives support the view that mathematical competence emerges through the interaction of emotional adjustment, social mediation, instructional support, and self-directed strategies.

METHODS

Research Design

This study employed a qualitative grounded theory research design. Grounded theory was appropriate because the study aimed to generate an explanatory concept grounded in participants' actual responses rather than test a predefined hypothesis. Following Glaser and Strauss (1967), the study used systematic coding and constant comparison to identify patterns, categories, and relationships that explain how first-year Information Technology students experience mathematics reception and problem-solving competence.

Research Locale

The study was conducted in a university in the Bicol Region, Naga City, Philippines. The research focused on first-year BSIT students enrolled in Discrete Mathematics/Structures I, a subject that requires abstract reasoning, logical thinking, and structured problem solving.

Participants and Sampling Technique

The participants were twenty (20) first-year Bachelor of Science in Information Technology students enrolled in Discrete Mathematics/Structures I. Participants were selected because they had direct experience with college-level mathematics and could provide meaningful reflections on their reception toward mathematics, problem-solving difficulties, and coping strategies.

Research Instrument

The primary research instrument was a researcher-made structured open-ended questionnaire. The questionnaire gathered students' reflections on their perceptions of mathematics, emotional responses, problem-solving challenges, factors affecting competence, coping mechanisms, and emerging insights about their learning experiences. The instrument was organized into sections covering respondent profile, mathematics reception, problem-solving competence factors, challenges, coping mechanisms, and open-ended reflections.

Data Gathering Procedure

The questionnaire was administered to selected first-year BSIT students who met the inclusion criteria. Participants were given sufficient time to answer the open-ended questions based on their actual experiences in Discrete Mathematics/Structures I. Their written responses served as the main data source for coding, comparison, and theory generation.

Data Analysis

Data were analyzed using grounded theory procedures. Open coding identified significant statements and assigned descriptive labels. Axial coding grouped related codes into broader categories, such as emotional challenges, learning strategies, and social support systems. Selective coding integrated the categories into a central explanatory concept. Constant comparison was used throughout the analysis to compare new data with previously coded data until theoretical saturation was reached. The process generated 168 significant statements, 32 initial codes, 8 conceptual categories, and the core category Adaptive Mathematical Engagement.

Ethical Consideration

The study observed ethical principles by informing participants of the purpose of the research and assuring them that participation was voluntary and for academic purposes only. Participants were free to decline or stop participation without consequence. Confidentiality was protected by using participant codes instead of names, and no identifying information was reported. The questionnaire was administered respectfully, and participants were encouraged to answer only items they were comfortable answering.

RESULTS AND DISCUSSION

The grounded theory analysis revealed that students' mathematics reception and problem-solving competence are shaped by interacting emotional, social, instructional, and cognitive processes. The analysis produced a core category labeled Adaptive Mathematical Engagement, which explains how students move from anxiety and difficulty toward gradual understanding and competence through support, practice, and self-regulated strategies.

Emotional Reception Toward Mathematics Learning

Table 1. *Emotional Reception Toward Mathematics Learning (n = 20)*

Emotional Experience	Frequency (n)	Percentage	Interpretation
Mathematics anxiety	12	60%	High anxiety during problem-solving
Frustration/confusion	15	75%	Difficulty understanding concepts
Low confidence	10	50%	Hesitation in answering tasks
Positive interest	8	40%	Presence of motivation in some learners

Open coding revealed repeated emotional descriptors such as fear, confusion, frustration, and lack of confidence. Frustration or confusion was the most frequent emotional experience, followed by mathematics anxiety and low confidence. These results indicate that students' initial reception toward mathematics is largely affective, and negative emotions often become the entry point of disengagement or difficulty in problem solving. However, the presence of positive interest among some learners shows that mathematics reception is not uniformly negative and can improve under supportive learning conditions.

Factors Influencing Problem-Solving Competence

Table 2. *Factors Influencing Problem-Solving Competence (n = 20)*

Influencing Factor	Frequency (n)	Percentage	Interpretation
Peer support	17	85%	Strongest learning influence
Teacher guidance	16	80%	Clarifies mathematical concepts
Self-study practices	14	70%	Supports independent learning

Mathematics anxiety	12	60%	Performance barrier
Lack of foundation	11	55%	Weak prior knowledge

Axial coding grouped the influencing factors under social and cognitive learning conditions. Peer support and teacher guidance emerged as the strongest enabling factors, suggesting that students' mathematical understanding is highly scaffolded through interaction. These findings support Vygotsky's (1978) view that learning is mediated through social interaction and guided support. At the same time, mathematics anxiety and weak prior knowledge functioned as barriers that limited students' problem-solving confidence and fluency.

Coping Strategies in Mathematics Learning

Table 3. *Coping Strategies in Mathematics Learning (n = 20)*

Coping Strategy	Frequency (n)	Percentage	Interpretation
Peer discussion	17	85%	Most preferred collaborative strategy
Repeated practice	15	75%	Strengthens understanding
Watching online tutorials	14	70%	Independent learning support
Asking teacher help	13	65%	Formal academic support
Avoidance behavior	8	40%	Negative coping response

Students used both adaptive and maladaptive coping mechanisms. Peer discussion, repeated practice, online tutorials, and teacher assistance were common constructive strategies. These strategies indicate that students do not rely solely on individual effort; rather, they combine social learning, guided support, and independent study. However, avoidance behavior remained present, showing that some learners respond to mathematical difficulty by disengaging instead of confronting the task.

Cognitive Challenges in Problem-Solving

Table 4. *Cognitive Challenges in Problem-Solving (n = 20)*

Challenge	Frequency (n)	Percentage	Interpretation
Difficulty in algebraic operations	16	80%	Major conceptual barrier
Word problem comprehension	14	70%	Difficulty in translation of problems
Computational errors	13	65%	Careless mistakes in solutions
Slow problem-solving speed	12	60%	Limited procedural fluency

The dominant cognitive challenges were algebraic operations and word problem comprehension. These difficulties reflect gaps in conceptual understanding, procedural fluency, and translation of written problems into mathematical processes. The frequent occurrence of computational errors and slow problem-solving speed suggests that students may know some procedures but still struggle to apply them accurately and efficiently. These findings are consistent with Polya's (1957) view that understanding the problem and planning a solution are essential stages in successful mathematical problem solving.

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Development of Mathematical Confidence

Table 5. *Development of Mathematical Confidence (n = 20)*

Indicator	Frequency (n)	Percentage	Interpretation
Confidence through practice	15	75%	Gradual improvement
Willingness to solve problems	14	70%	Emerging self-efficacy
Participation in class	13	65%	Moderate engagement
Persistent fear	9	45%	Partial reduction of anxiety

Selective coding showed that confidence develops gradually through repeated exposure and interaction. Students who engaged in peer discussion and practice were more likely to report improved confidence and willingness to solve problems. Nevertheless, persistent fear remained present among some participants, indicating that anxiety may lessen over time but does not automatically disappear. This finding reinforces the need for sustained instructional support and emotionally safe mathematics learning environments.

Grounded Theory Synthesis: Adaptive Mathematical Engagement

Table 6. *Summary of Key Patterns from Grounded Theory Synthesis*

Domain	Emergent Pattern
Emotional Reception	Dominated by anxiety and frustration
Influencing Factors	Peer support and teacher guidance are key drivers
Coping Strategies	Peer discussion and practice are primary responses
Cognitive Challenges	Algebra and word problems are major difficulties
Confidence Development	Gradual improvement through engagement

Through selective coding, all categories were integrated into the core category Adaptive Mathematical Engagement. This grounded theory explains that students' mathematical competence develops through a continuous process involving four interacting dimensions: emotional adjustment, social mediation, instructional scaffolding, and self-regulated learning. Initially, anxiety, confusion, and low confidence hinder engagement. Over time, peer collaboration, teacher guidance, repeated practice, and independent learning strategies help students develop understanding and confidence.

The theory emphasizes that mathematics learning is not a linear movement from ignorance to mastery. Rather, it is a cyclical and adaptive process in which students repeatedly encounter difficulty, seek support, apply strategies, and gradually build competence. This interpretation aligns with Vygotsky's (1978) social constructivism and Polya's (1957) problem-solving theory, both of which emphasize guided interaction, structured thinking, and reflective practice.

CONCLUSION

The study concludes that first-year Information Technology students generally experience mathematics as a challenging subject marked by anxiety, frustration, confusion, and low confidence. These emotional responses affect their willingness to participate in problem-solving activities and shape their initial reception toward mathematics. However, the presence of positive interest among some learners indicates that students' reception can improve when they experience support, clarity, and gradual success.

Problem-solving competence is influenced by both enabling and limiting factors. Peer collaboration, teacher guidance, self-study, and repeated practice support students' mathematical development, while mathematics anxiety and weak foundational knowledge hinder performance. Students'

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major challenges include algebraic operations, word problem comprehension, computational errors, and slow problem-solving speed.

The grounded theory generated from the data, Adaptive Mathematical Engagement, explains that mathematical competence develops through the interaction of emotional adjustment, social mediation, instructional scaffolding, and self-regulated learning. Students move from difficulty toward competence when they are supported by peers and teachers, given opportunities for practice, and encouraged to use adaptive learning strategies. Thus, mathematics learning among first-year IT students is dynamic, contextual, and shaped by affective, cognitive, and social processes.

RECOMMENDATION

For Mathematics Instructors

Mathematics instructors should use anxiety-sensitive and scaffolded instruction that provides step-by-step explanations, guided practice, and constructive feedback. Collaborative activities such as peer-assisted tasks and group problem solving should be strengthened to improve confidence and engagement.

For Students

Students should actively practice problem-solving exercises, participate in peer discussion, seek clarification from instructors, and use credible online learning resources. They should also view mathematical challenges as opportunities for growth rather than as reasons for avoidance.

For the Institution

The institution may establish academic support systems such as peer tutoring, mathematics enhancement sessions, and support centers for students who struggle in mathematics. Workshops on study strategies, problem-solving techniques, and anxiety management may help improve students' learning experiences.

For Curriculum and Program Developers

Curriculum developers should integrate contextualized and problem-based activities that connect mathematical concepts to Information Technology contexts. This may help students recognize the relevance of mathematics to their field and increase motivation.

For Future Researchers

Future researchers may replicate the study among students from other programs, year levels, or institutions. Longitudinal and mixed-method studies may also be conducted to examine how mathematical competence develops over time and how emotional, cognitive, and social factors interact in different learning environments.

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