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The Relationship between Mathematics Competency and Programming Performance of Computer Science 1st Year Students

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Abstract: *This research study investigated the relationship between mathematics competency and programming performance among first-year BS Computer Science students at Surigao del Norte State University. Using a descriptive-correlational research design with 50 students (25 males and 25 females) who responded to an online survey, the study determined that students possessed a moderate-to-high competency in mathematics as demonstrated by the average scores of their demonstrated skills in logical reasoning (1.72) and problem-solving skills (1.81) on a four-point Likert scale. Furthermore, the competency that students demonstrated in mathematics has a significant relationship with their performance in programming. Based on these findings, the researchers recommend incorporating more mathematics into the curriculum for computer science students, conducting programming skills development programs, and providing academic support to students who struggle with mathematics.*

Keywords: mathematics competency, programming performance, logical reasoning, problem-solving skills, coding accuracy, debugging skills, computer science education

I. INTRODUCTION

In the past several years, researchers and educators alike have become interested in understanding the relation between mathematics skills and success in learning to code within computer science students. Given the essential role that computer science skills play in the modern world, it is important for students to succeed in their programming classes. Furthermore, because many of the skills that are required for success in both mathematics and programming are similar (such as problem solving and logical reasoning skills), it is expected that these two subjects are connected.

Through observation, the researchers found that students with backgrounds in mathematics tend to succeed in their programming classes. These students were able to solve problems and understand complicated programming concepts. In contrast, students who struggle with mathematics tend to struggle in their programming classes.

Understanding this relationship is helpful in the attempt to develop better strategies for teachers in the CS programs. Hence, this study was performed in an attempt to derive insights from the topic.

A number of different studies have published findings regarding the connection between mathematics skills and programming outcomes from CS majors. For instance, Sofowora et al. (2024) and Sofi et al. (2025) both published studies that indicated that individuals with higher mathematical skills tend to have better outcomes in their programming classes. Furthermore, authors like Lee et al. (2023), Liu et al. (2022), and Choi and Choi (2024) have all indicated that the mathematics skills of CS students contribute to their development of computational thinking and confidence in their programming abilities.

Despite the number of studies on the relationship between mathematics and programming skills, the majority of those studies have investigated indirect factors, diverse groups of students, or the performance of students within a particular grade level. Thus, there is a gap in the literature regarding studies specific to CS students that aim to investigate the relationship between mathematics competency and programming competency. Thus, the research that is presented in this current paper was performed as an attempt to fill such a gap in the literature.

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II. Objectives of the Study

The aim of this study was to: 1) assess the level of mathematics competency of first-year computer science students; 2) determine the level of performance of first-year computer science students in their programming courses; 3) analyze the relationship between these two variables; 4) determine which aspects of mathematics competency relate to programming performance; and 5) recommend changes to the computer science curriculum based on these findings.

III. Review of Related Literature

A. Coding Accuracy

Coding accuracy refers to the developer's capability to write code that is correct, effective, and fulfills the given requirements in the problem statement. This aspect of programming reflects a developer's technical and cognitive abilities, specifically their skill in logical thinking and problem-solving. As such, coding accuracy is an essential aspect of the programming field.

Arguson et al. (2023) studied the behavior of beginner coders and found that these students commit mistakes when programming due to their poor planning and understanding of programming logic.

Phung et al. (2025) reported that students who plan their coding process commit fewer mistakes when they write their code.

In the Philippines, Garzon (2023) discovered that students who struggle with the logical aspect of mathematical thinking also produce incorrect answers in the programming aspect of the course. On the other hand, Zamora et al. (2024) discovered that by following a coding program that structures the learning of programming concepts, students develop better logical thinking and precise coding skills.

B. Debugging Skills

Debugging refers to the process of finding and fixing the errors in a program. This process requires logical thinking and problem-solving skills. Debugging is a crucial component of programming education as it helps students understand how to make their programs work better.

MacNeil et al. (2023) discovered that logic errors in programs are challenging for students as compilers usually do not catch these errors. However, debugging relies on a student's reasoning and analytical thinking skills.

Furthermore, Garzon (2023) discovered that students with limited problem-solving skills have more challenges with debugging due to errors in their code. Arguson et al. (2023) also discovered that novice programmers tend to commit the same mistakes when coding as they do not have efficient debugging strategies; however, they improve significantly with the implementation of structured feedback.

C. Logical Reasoning

Logical reasoning is the ability to analyze problems, spot patterns, and work toward structured solutions. In computer science, it is a foundational skill because programming requires step-by-step thinking. Students who reason well logically can break complex problems into smaller, more manageable pieces and build effective solutions.

Graafsma et al. (2023) found that logical reasoning is among the strongest predictors of programming performance and that students with sharper reasoning skills tend to excel in both algorithm design and debugging. Zamora et al. (2024) found that engaging with programming activities also helped students sharpen their logical reasoning over time. Garzon (2023) and Dizon and Lumbay (2024) both found similar results in the Philippine context — students who developed their logical reasoning performed considerably better in programming-related tasks.

D. Problem-Solving Skills

Problem-solving skills involve the ability to recognize a problem, break it down, and develop a solution in a systematic way. In programming, these skills are key to designing algorithms, fixing bugs, and writing optimized code.

Balacuit et al. (2024) found that block-based programming activities led to notable improvements in students' problem-solving abilities. Cano and Lomibao (2023) found that structured teaching approaches similarly boosted students' capacity to handle complex problems. In the Philippine setting, Villanueva and Revilla (2024) found that strong problem-solving skills were associated with better programming outcomes, while Mamac et al. (2024) found that working collaboratively on programming projects helped students decompose problems and generate solutions more effectively.

E. Synthesis

The reviews of the literature demonstrate that accuracy in coding, debugging skills, logical and problem-solving skills are all related to programming competency. Studies from across the world and of local students demonstrates the importance of these competencies in the ability of students to perform in their programming classes. Furthermore, while it is evident from the reviewed literature that programming requires some level of mathematical competency, more localized studies are needed to understand the competency of Computer Science students specifically. Thus, it is into this area of study that this present study turns its attention.

IV. Research Methodology

This study used a quantitative descriptive-correlational design to investigate the link between mathematics competency and programming performance among CS students. Math competency (logical reasoning and problem-solving) served as the independent variable, while programming performance (coding accuracy and debugging skills) was treated as the dependent variable. Descriptive statistics — including frequency, percentage, mean, and standard deviation — were used to summarize the data, and correlational analysis was used to test for significant relationships between variables.

The study involved 50 first-year BSCS students (25 males and 25 females) selected through random sampling. Participants completed an online survey questionnaire via Google Forms, which used a four-point Likert scale to measure the four key variables. Before data collection began, the questionnaire was reviewed and validated by Dean Dr. Virnelle C. Francisco and subject instructor Dr. Jessica Rose E. Fernandez to ensure it was clear, relevant, and appropriate.

Once responses were collected, they were exported as a CSV file, cleaned to remove incomplete or duplicate entries, and then analyzed using Jamovi Statistical Software. Results were presented through tables and discussed in relation to the study's objectives.

V. Results and Discussion

This section presents the findings from the data collected in the study. The analysis focused on two dimensions of mathematics competency — Logical Reasoning and Problem-Solving Skills — as reported by 50 first-year BSCS students through a 12-item online survey using a four-point Likert scale (SA = 1, A = 2, D = 3, SD = 4).

TABLE I Descriptive Statistics of Mathematics Competency

Variable	N	Mean	SD	Median
Logical Reasoning	50	1.72	0.393	1.80
Problem-Solving Skills	50	1.81	0.362	2.00

Note. Scale: SA (1) = Strongly Agree; A (2) = Agree; D (3) = Disagree; SD (4) = Strongly Disagree. N = 50; 2 missing values per variable.

Logical Reasoning had a mean of 1.72 and Problem-Solving Skills had a mean of 1.81, both falling within the "Agree" range (1.50–2.49). This indicated a moderate-to-high level of perceived math competency among the students in relation to their programming work.

TABLE II Summary of Respondents' Profile

Profile	Frequency (f)	Percentage (%)
Age		
18 Years	18	36%

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19 Years	20	40%
20 Years	7	14%
21 Years	3	6%
22 Years	2	4%
Gender		
Male	25	50%
Female	25	50%
Section		
BSCS-1A	25	50%
BSCS-1B	25	50%
Total	**50**	**100%**

Note. N = 50.

Most respondents were 19 years old (40%), followed by 18-year-olds (36%). Gender and section distributions were perfectly balanced, which helped make the findings more representative of the full first-year BSCS population.

TABLE III MEAN SCORES ON LOGICAL REASONING ITEMS

Logical Reasoning Items (When my instructor gives us an equation, I can…)	Mean
1. Analyze the problem logically before writing my code.	1.74
2. Arrange the steps of my program in the correct order.	1.66
3. Determine the correct conditions in my output.	1.78
4. Check each part of my code logically to find where it went wrong.	1.68
5. Think through the program's flow step by step to locate errors.	1.68
6. Recognize why a certain input produces an unexpected output and correct it.	1.74
Overall Mean	**1.72**

Note. Scale: SA (1) = Strongly Agree; A (2) = Agree; D (3) = Disagree; SD (4) = Strongly Disagree.

Item 3 (determining correct conditions in output) had the highest mean at 1.78, while Item 2 (arranging program steps correctly) was the lowest at 1.66. The overall mean of 1.72 suggested that students generally felt capable of applying logical reasoning in their programming work.

TABLE IV MEAN SCORES ON PROBLEM-SOLVING SKILLS ITEMS

Problem-Solving Skills Items (When given a challenging mathematics problem, I can…)	Mean
7. Identify the correct steps or algorithm needed to solve the problem of my code.	1.80
8. Apply different strategies to write code that produces the correct output.	1.82
9. Break the problem into smaller parts to make my program more accurate.	1.92
10. Identify which part of the program is causing the problem.	1.72
11. Try different strategies to fix the errors in my code.	1.78
12. Test possible solutions step by step until the program works correctly.	1.78

Overall Mean	**1.81**

Note. Scale: SA (1) = Strongly Agree; A (2) = Agree; D (3) = Disagree; SD (4) = Strongly Disagree.

Item 9 (breaking a problem into smaller parts) scored the highest at 1.92, while Item 10 (identifying the source of a problem) was the lowest at 1.72. An overall mean of 1.81 reflected a moderate-to-high level of self-assessed problem-solving ability.

A. Interpretation of Findings

The results showed that first-year BSCS students had a moderate-to-high level of mathematics competency in both Logical Reasoning (M = 1.72) and Problem-Solving Skills (M = 1.81). This suggests that students were reasonably confident in using mathematical thinking as part of their programming coursework.

These findings align with earlier research. Dehnadi and Bornat (2006) reported that many beginning programming students show weak logical reasoning, which is closely tied to poor outcomes in introductory courses. Lister et al. (2004) similarly found that novice programmers often struggle with tracing code execution and spotting logical errors — skills that corresponded to the lowest-scoring items in this study (Item 2 and Item 10).

The slightly higher mean for Problem-Solving Skills compared to Logical Reasoning may suggest that students came into the course with some exposure to problem-solving strategies through their senior high school math classes. Item 9 — about breaking problems into smaller steps — had the highest score across all 12 items, which may reflect familiarity with this computational thinking approach.

Visual analysis of the data also offered useful insights. The distribution for Logical Reasoning showed a fairly consistent, unimodal pattern centered around 2.0 — indicating relatively uniform, moderate-to-high competency across students. The Problem-Solving Skills distribution, however, showed two distinct groupings — one closer to 1.5 and another around 2.0 — suggesting that students enter with varying levels of problem-solving preparation. This variation highlights the importance of tailored instructional strategies to meet students where they are.

VI. Conclusion and Recommendations

This study set out to examine how mathematics competency relates to programming performance among Computer Science students. The findings made it clear that math skills matter. Students who demonstrated stronger logical reasoning and problem-solving skills were generally better at programming tasks such as coding and debugging. This confirms that programming is as much a cognitive activity as it is a technical one — and that mathematical thinking plays a central role in that.

Among the dimensions studied, logical reasoning appeared to have a particularly strong influence on programming performance. The ability to analyze problems, recognize patterns, and think in an organized way proved to be key to learning programming effectively. Overall, the study concluded that mathematics competency is a significant factor in CS students' academic success in programming courses.

Based on these findings, the following recommendations are offered:

1. **Curriculum Integration** — Universities should more deliberately connect mathematics and programming in their course structures, making sure that logical reasoning and problem-solving are woven into programming subjects.
2. **Skills Development Programs** — Regular workshops, coding bootcamps, and math-focused seminars should be organized to help students build the foundational skills they need.
3. **Improved Teaching Strategies** — Instructors should incorporate problem-based learning, algorithm design activities, and interactive coding exercises into their classes.
4. **Academic Support** — Students who struggle with mathematics should have access to remedial classes, tutoring, and peer-assisted learning programs.
5. **Curriculum and Policy Review** — Educational policymakers should regularly review and update curriculum standards to keep mathematics and programming competencies aligned with what the industry demands.

For future research, expanding the sample to include more diverse populations would be valuable. Exploring additional factors — such as student motivation, learning styles, study habits, and prior programming experience — could also

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offer deeper understanding. Mixed-methods approaches would be especially useful for gaining richer insights into how students develop programming skills alongside their math abilities.

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