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Bridging the Math Gap: Assessing the Effectiveness of the Advanced Mathematics Bridging Program in the Mathematical Competencies of Incoming BSCS Students

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Index Terms:

advanced mathematics, bridging program, BSCS students, mathematical competencies, transition theory, quasi-experimental design, academic preparedness, colegio de la ciudad de Tayabas

Abstract. Incoming college students often exhibit diverse levels of mathematical preparation, leading to critical achievement gaps in computer science programs where mathematical competence is fundamental. Grounded in mathematical transition theory, this study evaluated the effectiveness of the Advanced Mathematics Bridging Program in enhancing the mathematical competencies of incoming Bachelor of Science in Computer Science (BSCS) students at Colegio de la Ciudad de Tayabas, addressing academic hurdles during the secondary-to-tertiary shift. The study employed a quasi-experimental pre-test and post-test research design without a control group, focusing on a cohort of voluntarily enrolled incoming BSCS freshmen. Data collection instruments consisted of a standardized Mathematics Competency Test—measuring algebra, functions, basic calculus, and problem-solving skills—administered before and after the intervention, alongside a structured student perception survey. Quantitative analysis using paired t-tests revealed a statistically significant improvement in overall mathematical competencies ($p < .05$). The most pronounced gains occurred in college algebra and functions, while basic calculus remained a challenging area. Qualitative thematic analysis of the perception survey indicated high satisfaction with the program's collaborative pedagogy and a marked increase in self-reported post-program academic confidence. In conclusion, the Advanced Mathematics Bridging Program effectively mitigates secondary-to-tertiary transition barriers and closes initial developmental gaps. Based on these findings, it is highly recommended that Colegio de la Ciudad de Tayabas institutionalize this program as a standard preparatory pathway for all incoming computing students. Future iterations should adjust instructional hours to allocate more time to foundational calculus. Finally, the institution should establish longitudinal tracking systems to monitor the long-term academic retention and performance of participants in advanced computer science coursework.

Introduction

Mathematics investigates order, relationships, and patterns, originating from basic counting and measuring and evolving into a sophisticated discipline that serves as the universal language of science and technology (Devlin, 2000). It provides a logical and precise foundation for critical thinking and effective communication (National Council of Teachers of Mathematics [NCTM], 2000). Essential Mathematics focuses on equipping students to apply mathematical reasoning efficiently and critically in real-life decision-making, both personally and professionally (Department of Education, 2016). Through authentic problem-solving in various contexts—such as the workplace, education, and the community—students develop the skills and understanding necessary for lifelong learning and future studies. Fostering a genuine interest in mathematics is crucial for building a strong foundation for further learning and practical application (Boaler, 2016).

Bridging courses in advanced mathematics have been widely implemented to support students transitioning from secondary to tertiary education, particularly in science, technology, engineering, and mathematics (STEM) programs. These courses are designed to address gaps in mathematical knowledge and prepare students for the rigor of higher-level mathematics required in their chosen fields. According to Rylands and Coady (2009), mathematics bridging courses have a positive impact on student retention and success rates in university-level mathematics, as they provide foundational support and reduce anxiety associated with the subject. Similarly, Kajander and Lovric (2005) found that students who participated in bridging programs demonstrated improved understanding and confidence, leading to better performance in introductory university mathematics courses. These bridging interventions are especially valuable for students with diverse educational backgrounds, as they help standardize mathematical competencies and promote equitable access to advanced studies (Clark & Lovric, 2008). Furthermore, a study by Engelbrecht, Harding, and Du Preez (2010) highlighted the importance of bridging courses in promoting critical thinking and fostering a deeper conceptual understanding of mathematics, rather than rote memorization. These programs often incorporate problem-solving, active learning, and real-world applications to engage students and illustrate the relevance of mathematics in various contexts. In line with this, Colegio de la Ciudad de Tayabas remains committed to providing its Bridging Learning Program in key areas such as Mathematics, English, and Computer Literacy for incoming first-year students. This program aims to ensure that students are thoroughly prepared with the essential knowledge, skills, and values required for these subjects in the upcoming semester. The implementation of the Bridging Learning Program is aligned with CHED Memorandum Order No. 10, series of 2017, which grants higher education institutions the flexibility to either offer bridging programs or require students to enroll in courses under the revised General Education Curriculum (Commission on Higher Education [CHED], 2017).

Bridging the gap in mathematical competencies among incoming BSCS students remains a crucial step toward ensuring academic success in the computer science program. This research on the effectiveness of the Advanced Mathematics Bridging Program aims to assess the effectiveness of the Advanced Mathematics Bridging Program in enhancing the mathematical competencies as they transition from secondary education to a demanding university curriculum that will provide valuable insights into how targeted interventions can better prepare learners for higher-level coursework and problem-solving tasks. Assessing the outcomes of this bridging program will contribute to the broader conversation on educational support and equity, particularly for students with diverse academic backgrounds. The results are expected to inform educators and policymakers about the importance of preparatory programs in STEM education, guiding future initiatives that support student retention and achievement. Ultimately, this research aspires to lay the foundation for data-driven improvements in curriculum development, with the goal of empowering all BSCS students to excel in their mathematical studies and future careers.

Research Questions

This study aimed to assess the effectiveness of the Advanced Mathematics Bridging Program in enhancing the mathematical competencies of incoming Bachelor of Science in Computer Science (BSCS) students at Colegio de la Ciudad de Tayabas during the academic transition phase.

Specifically, the study sought to answer the following research questions:

1. What is the baseline mathematical competency level of incoming BSCS students prior to participating in the bridging program in terms of:
   1.1 College Algebra;
   1.2 Functions;
   1.3 Basic Calculus; and
   1.4 Problem-Solving Skills?
2. What is the mathematical competency level of the students after completing the Advanced Mathematics Bridging Program in terms of the aforementioned domains?
3. Is there a statistically significant difference between the pre-test and post-test scores of the students, indicating the program's overall effectiveness?
4. In which specific mathematical domains (algebra, functions, basic calculus, problem-solving) did the students demonstrate the most and least significant competency gains?
5. How do the student participants perceive the Advanced Mathematics Bridging Program in terms of:
   5.1 Pedagogy and content delivery;
   5.2 Academic usefulness for their upcoming coursework; and
   5.3 Self-reported post-program academic confidence?
6. Based on the quantitative and qualitative findings of the study, what institutional policies, curriculum adjustments, or support systems can be recommended to optimize the bridging program for future cohorts?

Assumptions of the Study

In conducting this study to evaluate the effectiveness of the Advanced Mathematics Bridging Program for incoming Bachelor of Science in Computer Science (BSCS) students at Colegio de la Ciudad de Tayabas, the researchers proceeded based on the following foundational assumptions:

1. It is assumed that the standardized Mathematics Competency Test is a psychometrically sound, valid, and reliable diagnostic instrument capable of accurately measuring student proficiency across the distinct mathematical domains of college algebra, functions, basic calculus, and problem-solving skills. The researchers assume that the test items were meticulously aligned with the cognitive levels of the target student demographic, undergo rigorous expert validation to establish content validity, and are pilot-tested to ensure internal consistency. Consequently, any variation in test performance is assumed to reflect a true representation of the students' actual mathematical capabilities rather than construct irrelevance or measurement error. It is assumed that the curriculum, instructional resources, and active learning pedagogical strategies designed for the bridging program were delivered with high fidelity, uniformity, and pedagogical consistency by all participating facilitators. This premise implies that all instructors adhered strictly to the prescribed lesson plans, timeline, and interactive teaching methodologies without introducing unscheduled educational deviations. Establishing this instructional uniformity ensures that the academic gains observed in the post-test can be attributed directly to the structured bridging program itself rather than to discrepancies in teaching quality, individual instructor biases, or variations in class environment. For the quantitative analysis, it is assumed that the pre-test and post-test score differences satisfy the underlying assumptions of the parametric paired-samples t-test, specifically that the differences are approximately normally distributed and measured on an interval scale. The researchers assume that the continuous nature of the test scores is appropriate for parametric analysis and that the sample size is sufficiently robust to support the Central Limit Theorem. This assumption justifies the mathematical validity of the inferential statistics used to determine whether the program produced a statistically significant shift in academic performance. It is assumed that the duration of the bridging program was long enough to facilitate meaningful cognitive acquisition, yet short enough to rule out cognitive maturation or external historical events (such as independent parallel enrollment in math courses or private tutoring) as major confounding variables influencing the post-test results. The researchers assume that the observed mathematical improvements occurred as a direct consequence of the targeted intervention rather than natural intellectual development over time or external academic support, thereby maintaining the internal validity of the quasi-experimental pre-test and post-test design.
2. It is assumed that the time elapsed between the administration of the pre-test and the post-test was sufficient to minimize memory-recall bias and testing sensitization, meaning the post-test improvements represent genuine cognitive gains rather than mere familiarity with the test items. The study assumes that the diagnostic questions did not act as an instructional tool in themselves and that students did not actively memorize specific questions, which guarantees that the post-intervention assessment is a pure measure of conceptual development rather than rote procedural recall. It is assumed that the voluntarily enrolled student participants completed both the pre-test and post-test independently, with optimal cognitive effort, and without utilizing unauthorized digital tools, AI assistance, or peer collaboration. Because these assessments carry no direct bearing on their formal university grades, the researchers assume that the students possessed the necessary intrinsic motivation to perform genuinely and to the best of their academic abilities, ensuring that the collected data accurately reflects their true unassisted mathematical competence. It is assumed that the respondents completed the structured student perception survey with complete candor, and that their responses were free from social desirability bias, fear of academic repercussions, or grading anxieties. The study proceeds on the basis that the student feedback regarding pedagogy, content usefulness, and self-reported post-program confidence levels is honest and reflective of their actual lived experience, uninfluenced by a desire to please the program facilitators or the institutional administration.
3. In accordance with mathematical transition theory, it is assumed that there exists a structural, pedagogical, and cognitive gap between secondary school mathematics preparation and the rigorous computational demands of a tertiary BSCS curriculum. This assumption frames the entire study, establishing that incoming university students naturally face a demanding epistemic shift in mathematical abstraction and problem-solving, which necessitates a structured scaffolding mechanism to prevent initial academic shock, systemic frustration, and early student attrition. It is assumed that the observed math deficiencies among incoming freshman students are developmental and instructional rather than permanent, meaning they can be systematically corrected through targeted academic interventions during the critical transition phase. The researchers assume that mathematical intelligence and procedural competency are malleable constructs that can be rapidly reconstructed and enhanced when students are exposed to high-quality, focused, and timely preparatory coursework. It is assumed that the mathematical concepts selected for the bridging program (algebra, functions, and introductory calculus) are the actual foundational prerequisites needed to ensure academic survival and success in advanced, computationally intensive computer science courses. The researchers assume that by mastering these specific mathematical

domains, incoming BSCS students will possess the prerequisite cognitive frameworks required to easily grasp complex computer science topics such as discrete structures, algorithm analysis, and computer graphics.

Methodology

This study employed a quasi-experimental pre-test/post-test design without a control group. This approach is suitable for educational interventions where random assignment is not feasible, but where measuring change over time within the same group can provide valuable evidence of program effectiveness.

The participants were incoming first-year BSCS students at Colegio de la Ciudad de Tayabas, School Year 2025-2026, who voluntarily enrolled in the Advanced Mathematics Bridging Program prior to the start of formal classes. Only students who completed both the pre-test and post-test were included in the final analysis.

Instruments and Data Collection

Mathematics Competency Test: A standardized test aligned with the content of the bridging program (covering algebra, functions, introductory calculus, and problem-solving) administered as both pre-test (before the program) and post-test (after the program).
Student Perception Survey: A structured questionnaire distributed at the end of the program that gathers data on students' experiences, perceived improvement, confidence in mathematics, and feedback on the program content and instruction.

Data Analysis

Quantitative Analysis: Pre- and post-test scores analyzed using descriptive statistics (mean and standard deviation) and inferential statistics (F-test, degrees of freedom, effect size, and p-value) to determine if statistically significant improvements in mathematical competencies occurred.
Qualitative Analysis: Survey responses transcripts will be coded and thematically analyzed to identify recurring themes, student attitudes, and recommendations for enhancement.

Results and Discussion

The results are organized according to the specific objectives of the study and are presented using appropriate statistical treatments, including descriptive and inferential statistics. The results presented serve as the basis for determining whether the bridging program successfully addressed gaps in mathematical competencies and contributed to students' preparedness for higher-level coursework in computer science program.

Variable	N	Mean Grade	Standard Deviation
High School Math		84.5593	5.1738
Pre-Test	59	75.8814	7.4117
Overall		80.22	7.7129

Table No. 1. Descriptive Statistics of Final Grade of High School Mathematics and Preliminary Test Score of Advanced Mathematics Bridging

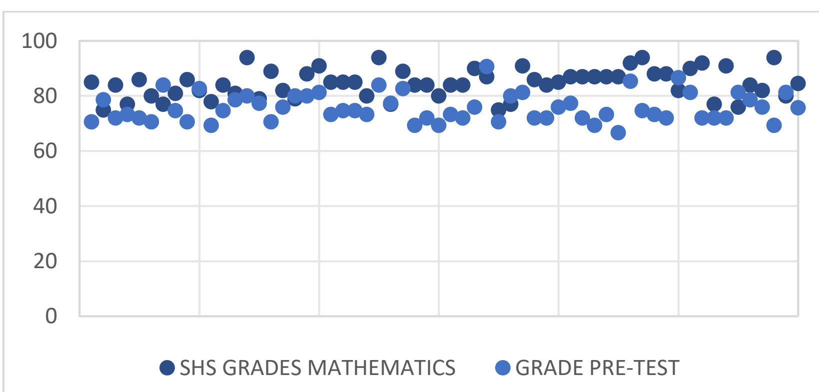

Figure No. 1. Comparison of Final Grade of High School Mathematics and Preliminary Test Score of Advanced Mathematics Bridging

Table 1 presents the descriptive statistics of the respondents' final grades in High School Mathematics and their preliminary test scores in the Advanced Mathematics Bridging Program. The results show that the 59 incoming BSCS students obtained a mean High School Mathematics grade of 84.5593 with a standard deviation of 5.1738. This indicates that, on average, the respondents achieved a satisfactory level of performance in Mathematics during their secondary education. The relatively low standard deviation suggests that the students' grades were fairly consistent, with only slight variations among respondents. Meanwhile, the preliminary test (pre-test) scores yielded a mean of 75.8814 and a standard deviation of 7.4117. Although the students had satisfactory high school mathematics grades, their pre-test scores were noticeably lower than their previous mathematics grades. This suggests that some students may have experienced difficulties in retaining or applying mathematical concepts required for higher-level mathematics. The higher standard deviation of the pre-test scores also indicates greater variability in students' mathematical competencies upon entering the bridging program.

Overall, the combined mean score of 80.22 with a standard deviation of 7.7129 reflects a moderate level of mathematical preparedness among the students. The discrepancy between the High School Mathematics grades and the pre-test scores implies that while students generally performed well in secondary school mathematics, gaps in foundational knowledge and advanced mathematical skills may still exist. These findings support the need for the Advanced Mathematics Bridging Program as an intervention to strengthen students' mathematical competencies before they begin their BSCS coursework.

The results indicate that the students entered the Advanced Mathematics Bridging Program with varying levels of mathematical competence. While the average High School Mathematics grade suggests satisfactory academic achievement, the lower pre-test mean score reveals a decline in mastery when assessed using a standardized mathematics competency examination. This may be attributed to differences in curriculum coverage, retention of previously learned concepts, or varying instructional experiences during secondary education. The results are consistent with the observations of Clark and Lovric (2008) and Kajander and Lovric (2005), who noted that students transitioning from secondary to tertiary education often experience difficulties in mathematics due to gaps in foundational knowledge and differences in academic expectations. Therefore, the observed performance supports the rationale for implementing the Advanced Mathematics Bridging Program to address these learning gaps and better prepare incoming BSCS students for the mathematical demands of their degree program.

Source of Variation	**SS**	**df**	**MS**	**F**	**Effect Size, η2**	**p-value**	**Interpretation**
Between Treatments	2221.5593	1	2221.5593				
Within Treatments	4738.7119	116	40.851	54.3821	0.3192	<0.00001	Significant
Total	6960.2712	117					

Note: "If p-value is less than or equal to the level of significance (0.05), reject Ho, otherwise failed to reject Ho."

Table No. 2. Significant Difference of Final Grade of High School Mathematics and Preliminary Test Score of Advanced Mathematics Bridging

Table 2 presents the results examining the difference between the respondents' High School Mathematics final grades and their Preliminary Test Scores in the Advanced Mathematics Bridging Program. The results reveal an F-value of 54.3821 with a corresponding p-value of less than 0.00001, which is substantially lower than the 0.05 level of significance. Therefore, the null hypothesis (H0) is rejected, indicating that there is a statistically significant difference between the High School Mathematics grades and the Preliminary Test Scores of the respondents. Furthermore, the computed effect size (η^2 = 0.3192) indicates a large effect, suggesting that approximately 31.92% of the variance in the scores can be attributed to the difference between the two assessment measures. According to Cohen's guidelines for eta squared, values above 0.14 are considered large, indicating that the observed difference is not only statistically significant but also practically meaningful.

The results suggest that the mathematical competencies demonstrated by students during their high school education differ significantly from those reflected in the preliminary assessment administered before the bridging program. Specifically, although students obtained relatively satisfactory grades in High School Mathematics (Mean grade of 84.56), their preliminary test grades were considerably lower (Mean Grade of 75.88), indicating possible deficiencies in knowledge retention, conceptual understanding, or readiness for advanced mathematical topics. This disparity may reflect the challenges students experience when transitioning from secondary to tertiary education, where mathematical concepts become more abstract and require higher-order thinking skills.

The significant difference between the High School Mathematics grades and the Preliminary Test Scores implies that high school academic performance alone may not fully represent students' actual preparedness for advanced mathematics in a BSCS program. The lower preliminary test scores indicate that many students may have forgotten previously learned concepts or may struggle to apply mathematical knowledge in more rigorous contexts. These findings support the arguments of Clark and Lovric (2008) and Rylands and Coady (2009), who emphasized that students entering tertiary education often encounter difficulties due to gaps in foundational mathematical knowledge and differences in academic expectations. Moreover, the large effect size demonstrates that the discrepancy between previous academic achievement and actual competency is substantial. This finding strengthens the justification for implementing the Advanced Mathematics Bridging Program, as it highlights the need for targeted interventions that reinforce foundational mathematical concepts before students begin their formal BSCS coursework. The results suggest that the bridging program serves an important role in addressing learning gaps and preparing students for the mathematical demands of computer science program.

Variable	N	Mean Grade	Standard Deviation
High School Math		84.5593	5.1738
Post-Test	59	82.2629	5.9967
Overall		83.4110	5.1939

Table No. 3. Descriptive Statistics of Final Grade of High School Mathematics and Post Test Score of Advanced Mathematics Bridging

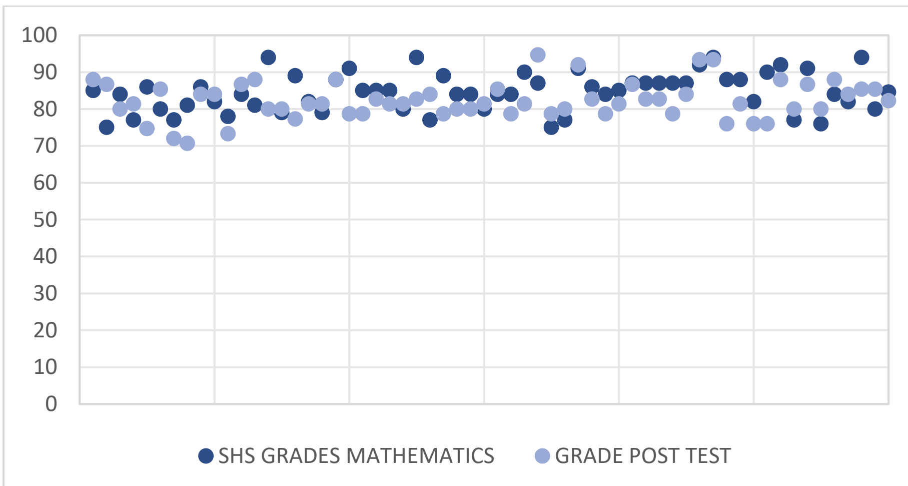

Figure No. 2. Comparison of Final Grade of High School Mathematics and Post Test Score of Advanced Mathematics Bridging

Table 3 shows the descriptive statistics of the students' Final Grade in High School Mathematics and their Post-Test Scores after completing the Advanced Mathematics Bridging Program. The results indicate that the 59 incoming BSCS students obtained a mean High School Mathematics grade of 84.5593 with a standard deviation of 5.1738, reflecting a generally satisfactory level of mathematical performance during their secondary education. The relatively small standard deviation suggests that the students' grades were fairly homogeneous, indicating minimal variation in their academic achievement. After participating in the Advanced Mathematics Bridging Program, the students achieved a mean post-test score of 82.2629 with a standard deviation of 5.9967. The post-test mean is notably higher than the preliminary test mean reported in Table 1 (Mean Grade of 75.8814), suggesting an improvement in students' mathematical competencies following their participation in the bridging program. The standard deviation indicates a moderate spread of scores, implying that while students generally improved, differences in individual learning outcomes still existed.

The overall mean score of 83.4110 with a standard deviation of 5.1939 demonstrates that the students possessed a relatively strong level of mathematical competency after completing the bridging program. Furthermore, the post-test mean score is much closer to the students' High School Mathematics grade average (84.5593), indicating that the bridging program may have helped students regain, reinforce, and apply mathematical concepts that were previously learned but not fully retained.

The findings suggest that the Advanced Mathematics Bridging Program contributed positively to the mathematical competencies of incoming BSCS students. While the preliminary assessment revealed gaps between students' high school mathematics performance and their actual mathematical readiness, the post-test results demonstrate a noticeable improvement in competency levels after the intervention. The increase in mean scores from the pre-test (75.8814) to the post-test (82.2629) indicates that the bridging program effectively reinforced foundational mathematical concepts and enhanced students' problem-solving abilities.

Moreover, the closeness of the post-test mean to the average High School Mathematics grade suggests that the program helped students recover and strengthen mathematical skills that may have weakened during the transition from secondary to tertiary education. This finding aligns with the studies of Rylands and Coady (2009) and Engelbrecht, Harding, and Du Preez (2010), which reported that mathematics bridging programs improve students' mathematical performance, confidence, and preparedness for university-level coursework. The results further imply that the bridging program serves as an effective preparatory intervention for incoming BSCS students by reducing learning gaps and promoting a smoother transition into higher-level mathematics courses. Consequently, the program may contribute to improved academic performance and greater success in mathematics-intensive subjects within the BSCS curriculum.

Source of Variation	SS	df	MS	F-value	Effect Size, η2	p-value	Interpretation
Between Treatments	155.5724	1	155.5724				
Within Treatments	3000.6394	116	25.8676	6.0142	0.0493	0.0157	Significant
Total	3156.2118	117					

Note: "If p-value is less than or equal to the level of significance (0.05), reject Ho, otherwise failed to reject Ho."

Table No. 4. Significant Difference of Final Grade of High School Mathematics and Post Test Score of Advanced Mathematics Bridging

Table 4 shows the results comparing the students' Final Grade in High School Mathematics and their Post-Test Scores after completing the Advanced Mathematics Bridging Program. The results show an F-value of 6.0142 with a corresponding p-value of 0.0157, which is lower than the 0.05 level of significance. Therefore, the null hypothesis (H0) is rejected, indicating that there is a statistically significant difference between the High School Mathematics grades and the Post-Test Scores of the students. The computed effect size ($\eta^2 = 0.0493$) indicates a small effect size, meaning that only about 4.93% of the variance in the scores can be explained by the difference between the two measures. Although the difference is statistically significant, its practical magnitude is relatively small, suggesting that the post-test scores closely approximate the students' previous mathematics achievement.

The findings reveal that the students' mean High School Mathematics grade (84.5593) remains slightly higher than their mean post-test score (82.2629). However, compared with the preliminary test mean of 75.8814, the post-test mean demonstrates a substantial improvement. This indicates that after participating in the Advanced Mathematics Bridging Program, students were able to significantly improve their mathematical competencies and narrow the gap between their current competency level and their previous academic performance in mathematics.

The significant difference observed between the High School Mathematics grades and the Post-Test Scores suggests that although students improved after the intervention, their post-test performance had not yet fully reached the level reflected in their high school grades. Nevertheless, the relatively small effect size indicates that the disparity between the two measures is minimal. This finding implies that the Advanced Mathematics Bridging Program was successful in helping students regain and strengthen mathematical competencies that may have declined during the transition from secondary to tertiary education.

When compared with the results presented in Table 2, the magnitude of difference between High School Mathematics grades and the Preliminary Test Scores was much larger ($\eta^2 = 0.3192$) than the difference between High School Mathematics grades and the Post-Test Scores ($\eta^2 = 0.0493$). This reduction in effect size suggests that the bridging program effectively reduced the competency gap that initially existed among incoming BSCS students. The findings support the studies of Rylands and Coady (2009) and Engelbrecht, Harding, and Du Preez (2010), which reported that mathematics bridging programs improve students' readiness for university-level mathematics by strengthening foundational knowledge and increasing academic confidence. The results indicate that the bridging program contributed positively to students' mathematical development and helped align their competency levels more closely with their previous academic achievement.

Variable	N	Mean Grade	Standard Deviation
High School Math		84.5593	5.1738
CS102	59	88.5005	3.5748
Overall		88.5300	4.8499

Table No. 5. Descriptive Statistics of Final Grade of High School Mathematics and Final Grade in CS102-Fundamentals of Programming

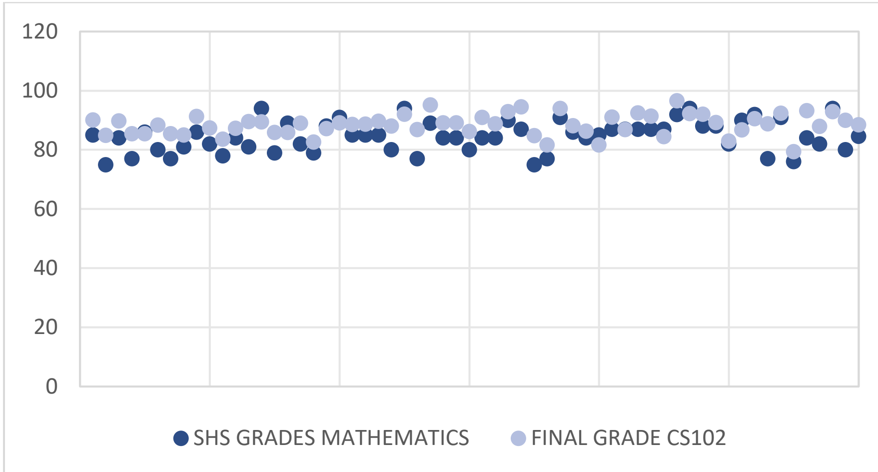

Figure No. 3. Comparison of Final Grade of High School Mathematics and Final Grade of CS102-Fundamentals of Programming

Table 5 compares the students' academic performance in High School Mathematics and Fundamentals of Programming (CS102). A review of the descriptive statistics shows that the students achieved a higher mean grade in CS102 (88.5005) than in High School Mathematics (84.5593). Although both measures indicate satisfactory academic performance, the higher score in CS102 suggests that students were able to perform more effectively in their introductory programming course than in their previous mathematics coursework.

Another notable observation is the difference in score variability between the two measures. High School Mathematics grades recorded a standard deviation of 5.1738, whereas CS102 grades yielded a lower standard deviation of 3.5748. This indicates that students' performance in programming was more consistent than their performance in mathematics during secondary education. Such consistency may suggest that students adapted successfully to the learning environment of the BSCS program and achieved a relatively uniform level of competence in programming.

Rather than simply reflecting academic achievement, the higher CS102 grades may indicate the successful transfer of mathematical reasoning skills into a computer science context. Programming requires students to apply logical thinking, abstraction, sequencing, and problem-solving abilities, which are competencies commonly developed through mathematics education. The findings suggest that students were able to utilize these competencies effectively when learning programming concepts and solving computational problems.

The results further imply that mathematical preparation acquired during secondary education, together with the reinforcement provided by the Advanced Mathematics Bridging Program, may have contributed to students' ability to understand and apply programming concepts. As students progressed through the program, they appear to have transformed foundational mathematical knowledge into practical computational skills, enabling them to perform successfully in Fundamentals of Programming.

These findings support the observations of Kajander and Lovric (2005), who emphasized that mathematical competence provides a foundation for higher-order analytical thinking and problem-solving in tertiary education. Likewise, Rylands and Coady (2009) reported that students with stronger mathematical preparation are generally more successful in STEM-related disciplines. The findings also align with Engelbrecht, Harding, and Du Preez (2010), who found that bridging interventions strengthen foundational knowledge and improve students' readiness for university-level coursework. Taken together, the results suggest that the Advanced Mathematics Bridging Program contributed positively to students' transition into computer science education and supported their academic performance in CS102.

Source of Variation	SS	df	MS	F-value	Effect Size, η2	p-value	Interpretation
Between Treatments	2221.5593	1	2221.5593				
Within Treatments	4738.7119	116	40.8510	54.3821	0.3192	<0.00001	Significant
Total	6960.2712	117					

Note: "If p-value is less than or equal to the level of significance (0.05), reject Ho, otherwise failed to reject Ho."

Table No. 6. Significant Difference of Final Grade of High School Mathematics and Final Grade in CS102-Fundamentals of Programming

Table 6 provides statistical evidence regarding the relationship between students' High School Mathematics grades and their performance in Fundamentals of Programming (CS102). The analysis yielded an F-value of 54.3821 and a p-value of less than 0.00001, indicating that the difference between the two measures is statistically significant at the 0.05 level. Consequently, the null hypothesis was rejected. In addition, the computed effect size ($\eta^2 = 0.3192$) demonstrates a large practical effect, suggesting that the observed difference is substantial and meaningful in an educational context.

The significance of this result extends beyond the numerical comparison of grades. A large effect size indicates that the difference between High School Mathematics and CS102 performance reflects a meaningful change in students' academic outcomes rather than random variation. This finding suggests that students' competencies evolved as they progressed through their first year in the BSCS program. Their higher achievement in CS102 indicates that they were able to utilize foundational knowledge acquired from mathematics and apply it in a more specialized discipline.

One possible explanation for this outcome is the nature of programming itself. Unlike traditional mathematics courses that often focus on procedures and calculations, programming requires students to integrate logical reasoning, abstraction, algorithmic thinking, and problem-solving into practical applications. The higher performance observed in CS102 may therefore reflect students' ability to adapt these mathematical competencies to computational tasks and real-world problem-solving situations.

The findings also provide insight into the role of the Advanced Mathematics Bridging Program in supporting academic transition. The significant difference suggests that students did not remain at the same level of competency demonstrated during their secondary education. Instead, they appear to have developed stronger analytical and computational skills through exposure to structured academic experiences and reinforcement of mathematical concepts. Such development is particularly important in computer science, where mathematical reasoning serves as a foundation for understanding algorithms and computational processes.

The results support the observations of Clark and Lovric (2008), who emphasized that students often encounter challenges when transitioning from secondary to tertiary education due to increased academic expectations and more abstract forms of learning. Similarly, Rylands and Coady (2009) reported that mathematical preparedness significantly influences success in STEM-related disciplines. The findings are further reinforced by Engelbrecht, Harding, and Du Preez (2010), who concluded that bridging programs enhance students' conceptual understanding and readiness for higher education. Collectively, these studies support the present finding that strengthening mathematical competencies contributes positively to achievement in computer science coursework.

Variable	N	Mean Grade	Standard Deviation
Pre-Test		75.8814	7.4117
CS102	59	88.5005	3.5748
Overall		82.1910	7.7941

Table No. 7. Descriptive Statistics of Score in Preliminary Test Score of Advanced Mathematics Bridging and Final Grade in CS102-Fundamentals of Programming

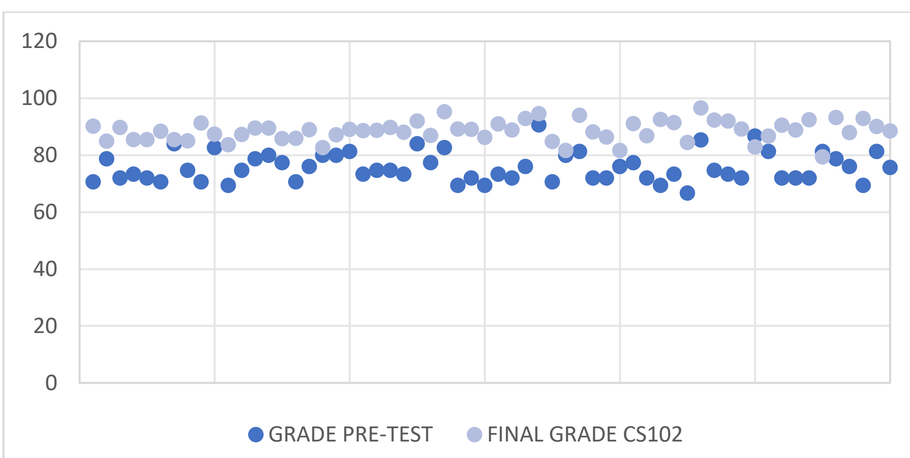

Figure No. 4. Comparison of Preliminary Test Score of Advanced Mathematics Bridging and Final Grade of CS102-Fundamentals of Programming

Table 7 highlights the academic condition of students before entering the BSCS curriculum and how their performance changed after progressing through the program. The preliminary test results show that students entered the Advanced Mathematics Bridging Program with a mean score of 75.8814 and a relatively high standard deviation of 7.4117. This pattern indicates that incoming students possessed varying levels of mathematical preparedness, suggesting that some students were better equipped for college-level mathematics than others.

A different picture emerges when examining the CS102 results. Students achieved a mean grade of 88.5005 with a lower standard deviation of 3.5748, indicating not only improved performance but also greater consistency across the group. The reduction in variability suggests that the differences in students' initial mathematical competency became less pronounced as they progressed through the bridging program and their introductory programming course.

These findings point to the existence of preparedness gaps among incoming BSCS students. Such gaps are common among first-year college students due to differences in educational background, learning experiences, and prior exposure to mathematical concepts. However, the substantial increase in performance from the preliminary test to CS102 indicates that students were able to overcome many of these initial disadvantages. The results imply that the bridging program provided opportunities for students to strengthen weak areas and develop a more uniform level of competency.

Another important implication is that initial performance may not accurately predict future academic success. Although some students entered the program with lower mathematical competency, many were still able to achieve strong performance in Fundamentals of Programming. This suggests that academic readiness is not fixed and can be improved through targeted support, guided instruction, and continuous learning experiences. The findings therefore emphasize the importance of intervention programs that provide students with opportunities to close learning gaps before they become barriers to academic achievement.

The observed improvement aligns with the findings of Clark and Lovric (2008), who reported that many students encounter challenges during the transition from secondary to tertiary education because of differences in academic preparation. Likewise, Kajander and Lovric (2005) emphasized that addressing deficiencies in foundational mathematical knowledge is essential for success in university-level coursework. Rylands and Coady (2009) further noted that mathematical preparedness influences achievement in STEM disciplines, particularly in courses that require analytical and problem-solving skills. The present findings suggest that the Advanced Mathematics Bridging Program helped reduce disparities in preparedness and contributed to students' successful adaptation to computer science education.

Overall, the results demonstrate that while incoming students may begin their studies with different levels of mathematical competency, appropriate academic support can help narrow these differences and promote more equitable learning outcomes. The bridging program appears to have played an important role in helping students establish a stronger foundation for success in Fundamentals of Programming (CS102).

Source of Variation	SS	df	MS	F-value	Effect Size, η2	p-value	Interpretation
Between Treatments	4826.4984	1	4826.4984				
Within Treatments	2281.0184	116	19.6640	245.4491	0.6791	<0.00001	Significant
Total	7107.5167	117					

Note: "If p-value is less than or equal to the level of significance (0.05), reject Ho, otherwise failed to reject Ho."

Table No. 8. Significant Difference in Preliminary Test Score of Advanced Mathematics Bridging and Final Grade in CS102-Fundamentals of Programming

Table 8 provides one of the strongest indicators of the effectiveness of the Advanced Mathematics Bridging Program. The statistical analysis revealed a highly significant difference between the students' preliminary test scores and their final grades in Fundamentals of Programming (CS102), as evidenced by an F-value of 245.4491 and a p-value of less than 0.00001. More importantly, the computed effect size ($\eta^2 = 0.6791$) indicates a very large effect, suggesting that the observed improvement is substantial and educationally meaningful.

The magnitude of change is clearly reflected in the mean scores. Students initially recorded a mean score of 75.8814 in the preliminary test, whereas their mean CS102 grade increased to 88.5005. This gain of approximately 12.62 points represents a notable improvement in academic performance. Such a large increase suggests that students were able to strengthen the competencies necessary for success in computer science coursework.

Rather than focusing solely on the numerical increase, the results point to the effectiveness of structured academic interventions. The preliminary test was administered before students participated in the bridging program, reflecting their initial level of mathematical preparedness. In contrast, the CS102 grades represent performance after students had undergone academic support, classroom instruction, and exposure to programming concepts. The difference between these two measures suggests that the intervention helped students develop stronger analytical and problem-solving abilities.

The very large effect size further strengthens this interpretation. Educational interventions often produce modest improvements, yet the magnitude observed in this study indicates a substantial transformation in student performance. This suggests that the bridging program did more than simply review mathematical concepts; it appears to have enhanced students' readiness to engage with higher-level learning tasks. By reinforcing foundational competencies, the program likely provided students with the confidence and skills needed to succeed in programming-related subjects.

Support for this interpretation can be found in the work of Engelbrecht, Harding, and Du Preez (2010), who reported that mathematics bridging programs improve academic achievement by addressing deficiencies in prior knowledge and strengthening conceptual understanding. Similarly, Clark and Lovric (2008) emphasized the importance of support mechanisms that help students adapt to the academic demands of tertiary education. Rylands and Coady (2009) also noted that mathematical preparedness is closely associated with achievement in STEM disciplines because it supports analytical thinking and problem-solving.

Taken together, these findings provide strong evidence that the Advanced Mathematics Bridging Program fulfilled its intended purpose of improving students' preparedness for university-level coursework. The substantial increase from the preliminary test scores to CS102 performance demonstrates that targeted interventions can effectively strengthen foundational competencies and contribute to improved academic outcomes in computer science education. Mathematical foundations can contribute directly to improved performance in computer science subjects.

Variable	N	Mean Grade	Standard Deviation
Post-Test		82.2629	4.9967
CS102	59	88.5005	3.5748
Overall		85.3820	5.3406

Table No. 9. Descriptive Statistics of Score in Post Test Score of Advanced Mathematics Bridging and Final Grade in CS102-Fundamentals of Programming

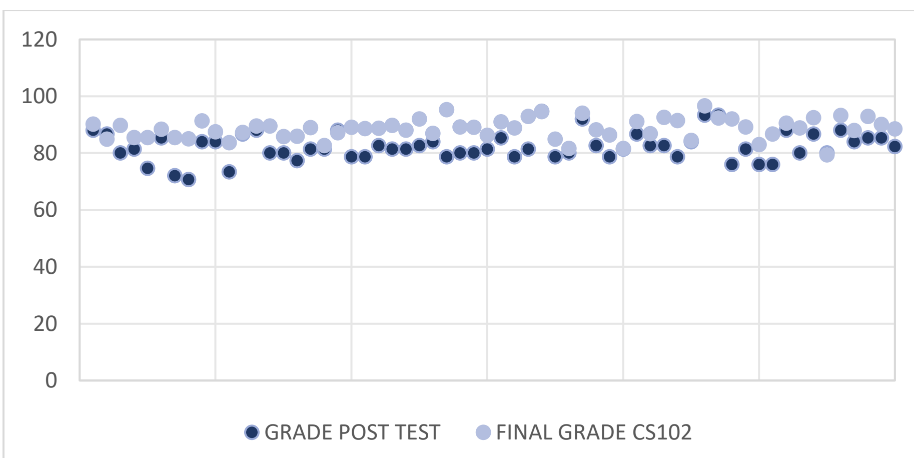

Figure No. 5. Comparison of Post Test Score of Advanced Mathematics Bridging and Final Grade of CS102-Fundamentals of Programming

Table 9 provides an overview of students' competency levels after completing the Advanced Mathematics Bridging Program and compares these outcomes with their performance in Fundamentals of Programming (CS102). The descriptive statistics indicate that students obtained a mean post-test score of 82.2629, reflecting a relatively strong level of mathematical competency following the intervention. While some variation remained among students, the overall results suggest that the majority successfully developed the foundational skills targeted by the program.

A closer examination of the data shows that students achieved an even higher mean grade of 88.5005 in CS102. This outcome suggests that the competencies measured during the post-test were not only retained but also applied effectively in a different academic context. Rather than serving as an endpoint, the mathematical skills acquired through the bridging program appear to have become tools that students utilized in understanding programming concepts and solving computational problems.

The relationship between mathematics and programming helps explain this pattern. Both disciplines require logical reasoning, analytical thinking, abstraction, and systematic problem-solving. Students who develop stronger mathematical competencies are often better prepared to understand algorithms, program structures, and computational processes. The higher CS102 grades therefore indicate that students were able to transform mathematical understanding into practical programming skills, allowing them to perform successfully in their introductory computer science course.

Another noteworthy aspect of the findings is the reduced variability observed in CS102 performance. The lower standard deviation suggests that students reached a more consistent level of achievement after applying their acquired competencies in programming. This consistency may indicate that the bridging program provided students with a common foundation upon which they could build more advanced skills throughout the semester.

The findings support the observations of Rylands and Coady (2009), who argued that mathematical preparedness contributes significantly to success in STEM-related disciplines by strengthening analytical and problem-solving abilities. Similarly, Kajander and Lovric (2005) emphasized that mathematical competence forms the basis for higher-order thinking skills required in tertiary education. The present results suggest that students were able to carry these competencies beyond mathematics and apply them effectively in programming-related tasks.

Overall, the data indicate that the Advanced Mathematics Bridging Program contributed not only to the development of mathematical knowledge but also to the cultivation of transferable skills that support learning in computer science. The higher CS102 performance demonstrates that students were able to apply and extend the competencies acquired during the program, thereby enhancing their academic achievement within the BSCS curriculum.

Source of Variation	SS	df	MS	F-value	Effect Size, η^2	p-value	Interpretation
Between Treatments	1147.7858	1	1147.7858				
Within Treatments	2189.3025	116	18.8733	60.8153	0.3439	<0.00001	Significant
Total	3337.0883	117					

Note: "If p-value is less than or equal to the level of significance (0.05), reject Ho, otherwise failed to reject Ho."

Table No. 10. Significant Difference in Post Test Score of Advanced Mathematics Bridging and Final Grade in CS102-Fundamentals of Programming

Table 10 examines whether the competencies acquired during the Advanced Mathematics Bridging Program continued to influence students' academic performance beyond the intervention period. The results revealed a statistically significant difference between the post-test scores and the final grades in Fundamentals of Programming (CS102), as indicated by an F-value of 60.8153 and a p-value of less than 0.00001. In addition, the effect size ($\eta^2 = 0.3439$) was classified as large, suggesting that the difference between the two measures has substantial educational significance.

At first glance, the higher mean grade obtained in CS102 (88.5005) compared to the post-test score (82.2629) may appear surprising, considering that the post-test was administered after students completed the bridging program. However, this pattern suggests that learning did not stop when the intervention ended. Instead, students continued to refine and expand the competencies they had acquired as they progressed through their programming coursework.

The findings indicate that the bridging program served as a foundation rather than a final outcome. The mathematical reasoning, analytical thinking, and problem-solving skills strengthened during the intervention appear to have supported students in meeting the academic demands of CS102. As students encountered programming tasks, algorithm development, and computational problem-solving activities, they were able to build upon previously acquired competencies and apply them in increasingly complex situations.

The large effect size further supports the idea that the benefits of the intervention extended beyond short-term learning gains. Rather than producing only immediate improvements in mathematical performance, the program appears to have contributed to the development of durable skills that remained relevant throughout the students' first semester in the BSCS program. Such outcomes are particularly valuable because they suggest that the intervention enhanced students' readiness for future coursework rather than merely improving test performance.

These results align with the observations of Clark and Lovric (2008), who emphasized the importance of preparing students for the academic challenges associated with tertiary education. Their work highlighted the need for interventions that help students bridge the gap between secondary and university-level learning. Likewise, Engelbrecht, Harding, and Du Preez (2010) found that mathematics bridging programs produce lasting benefits by improving conceptual understanding, confidence, and academic achievement. The present findings support these conclusions by demonstrating that the positive effects of the Advanced Mathematics Bridging Program remained evident even after students had transitioned into their introductory programming course.

Taken as a whole, the results suggest that the Advanced Mathematics Bridging Program contributed to students' long-term academic readiness. The higher performance observed in Fundamentals of Programming indicates that students were able to sustain and further develop the competencies acquired during the intervention. This provides evidence that the program not only addressed immediate learning needs but also helped prepare students for continued success in computer science education.

Conclusion and Recommendations

This study examined whether the Advanced Mathematics Bridging Program at Colegio de la Ciudad de Tayabas meaningfully improved the mathematical competencies of incoming BSCS students, and the evidence gathered consistently points toward a positive answer. Before the intervention, a statistically significant and practically large gap existed between students' high school mathematics grades (M = 84.56) and their preliminary test scores (M = 75.88), with an effect size of $\eta^2 = 0.3192$ confirming that prior academic records alone did not reflect actual readiness for tertiary-level work. This finding is consistent with Clark and Lovric (2008) and Kajander and Lovric (2005), who recognized the secondary-to-tertiary transition as a documented point of academic vulnerability rather than a smooth continuation of prior achievement.

Following the bridging program, post-test scores rose to a mean of 82.26, and the effect size between high school grades and post-program performance dropped sharply to $\eta^2 = 0.0493$ a reduction that signals the program closed a substantial portion of the initial competency gap. More compelling still, students went on to achieve a mean grade of 88.50 in Fundamentals of Programming (CS102), with a very large effect size of $\eta^2 = 0.6791$ when compared against pre-test scores. The bridging program, in other words, did not simply improve scores on a mathematics test; it appears to have strengthened the kind of logical and analytical thinking that carries forward into programming work. These results align with the observations of Rylands and Coady (2009) and Engelbrecht, Harding, and Du Preez (2010), who found that well-designed bridging interventions improve student performance, confidence, and readiness across STEM disciplines.

Given the positive outcomes documented in this study, the Advanced Mathematics Bridging Program should be formally institutionalized and treated as a core component of the BSCS admission process rather than a supplementary offering. The administration of Colegio de la Ciudad de Tayabas is encouraged to allocate dedicated resources—instructional hours, trained facilitators, and updated instructional materials—toward sustaining and improving the program across academic years. Given that the preliminary test scores revealed considerable variability in incoming students' mathematical backgrounds, the program design could further benefit from a differentiated instructional approach that allows students with more significant gaps to receive targeted reinforcement in specific topic areas such as algebra and functions, while those with stronger foundations engage in more advanced preparatory content.

Advanced Mathematics Bridging program facilitators are likewise encouraged to incorporate active learning strategies, collaborative problem-solving, and regular formative assessment into the bridging curriculum, as the literature consistently identifies these features as hallmarks of effective pre-entry interventions (Johnson & O'Keeffe, 2016; Mayerhofer, Lüftenegger, & Eichmair, 2025). Since the post-test scores showed a closer alignment with high school grades but did not yet fully recover the gap, extending the duration of the program or adding a follow-up support module during the first semester may help students consolidate gains made during the bridging period. Additionally, program administrators should consider using post-test results as an early diagnostic tool: students who complete the bridging program but still score below an established benchmark could be identified for continued academic support before high-stakes coursework begins.

For institutional practice, the results reinforce the value of treating mathematical readiness as a prerequisite concern rather than an outcome to be addressed after enrollment difficulties arise. The measurable reduction in score variability from the pre-test to students' CS102 grades indicates that the bridging program contributed to a more equitable academic starting point a result that carries particular significance given the diverse secondary school backgrounds of students entering Colegio de la Ciudad de Tayabas. In this sense, the program serves not only as an academic intervention but as a mechanism for promoting educational equity in line with the goals of CHED Memorandum Order No. 10, series of 2017, and the broader principle articulated by the National Council of Teachers of Mathematics (2000) that all learners deserve access to high-quality mathematics education regardless of prior circumstance.

At the BSCS curriculum level, the strong performance of bridging program participants in CS102 points to a meaningful connection between mathematical preparation and programming achievement. Faculty teaching foundational computer science courses may find it useful to explicitly build on the algebraic and logical reasoning skills developed during the bridging period, reinforcing those connections rather than treating mathematics and programming as separate domains. For policymakers and CHED, the outcomes documented here support the continued relevance of bridging programs as part of a broader strategy to improve retention and performance in STEM degree programs, particularly for students from regions or schools with historically uneven mathematics instruction.

Several avenues deserve attention in subsequent work. The most pressing limitation of this study is the absence of a comparison group, which makes it difficult to rule out alternative explanations for the observed gains. Future researchers are encouraged to employ quasi-experimental designs with matched comparison groups using propensity score matching based on incoming high school grades and demographic characteristics to more rigorously isolate the program's effect from other factors such as instructor quality, student motivation, and the natural learning that occurs during the first semester.

Longitudinal tracking represents another critical gap. The current study captured performance only through the first semester, specifically through CS102 grades. Whether the competency gains from the bridging program persist into later mathematics-intensive subjects such as discrete mathematics, data structures, or algorithms remains an open question. A cohort-based longitudinal study tracking students through their second and third years would provide much stronger evidence of the program's lasting academic value and help identify at which point, if any, the initial advantage tends to diminish.

Beyond academic performance, future studies could investigate the affective dimensions of the bridging program experience. The current study relied primarily on quantitative measures; incorporating instruments that assess mathematical self-efficacy, anxiety, and growth mindset before, during, and after the program would provide a more complete picture of how the intervention influences not just what students know but how they feel about mathematics as they enter college. Boaler (2016) and Mayerhofer et al. (2025) have both shown that motivational and psychological factors are as influential as content knowledge in predicting sustained engagement in STEM fields, and this dimension of the bridging experience remains underexplored in the local context. Expanding the study to include other BSCS cohorts, or replicating it across different degree programs and institutions in the Philippines, would further strengthen the generalizability of the findings and contribute to a growing evidence base on bridging program effectiveness in Southeast Asian higher education.

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Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study; all data used were obtained from previously published sources as cited in the reference list.

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Appendices

No appendices are attached to this study.