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Advanced Algebra Proficiency and Academic Performance of Civil Engineering Sophomores in Engineering Mathematics

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A Thesis Presented to the Faculty of the Graduate School University of La Salette, Inc Santiago City, Philippines

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APPROVAL SHEET

This Thesis entitled "ADVANCED ALGEBRA PROFICIENCY AND ACADEMIC PERFORMANCE OF CIVIL ENGINEERING SOPHOMORES IN ENGINEERING MATHEMATICS," prepared and submitted by KRISELLE B. OBENA, has been approved and accepted as partial fulfillment of the requirements for the degree Master of Arts in Education major in Mathematics.

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The Researcher

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DEDICATION

This researcher lovingly dedicates this researcher to her parents, Alejandro Obena and Nely Obena, whose unwavering support and sacrifices made this achievement possible; to her siblings, Hazel, Roselle, Loraine and Jake, for their constant encouragement; and to her friends, who provided inspiration and joy throughout this journey.
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ABSTRACT

This study aimed to assess advanced algebra proficiency and its relationship to academic performance in engineering mathematics (Calculus 1, Calculus 2, Differential Equations) among civil engineering sophomore students, examining profile differences by sex and senior high school strand, and proposing an intervention program aligned with SDG 4 for quality education. Conducted at the University of La Salette, Inc., Santiago City, Philippines, the research employed a quantitative documentary analysis design on registrar records of 70 sophomores randomly sampled from 85 in Raosoft calculator at 95% confidence, 5% margin of error; 58.57% male, 85.71% STEM strand, using instruments including a demographic (sex, strand) and final grades from Advanced Algebra (PCEA 020), Calculus 1 (PCEA 001), Calculus 2 (PCEA 002), and Differential Equations (PCEA 005), analyzed using the frequencies and percentages, Mann-Whitney U, Kruskal-Wallis, and Spearman's rho (α=0.05). Key findings showed very good Advanced Algebra performance (mean=88.00, 47.14% very good), declining to passing/fair in engineering mathematics: Calculus 1 (mean=77.34, 61.43% passing), Calculus 2 (mean=79.09, 61.43% fair), Differential Equations (mean=76.57, 68.57% passing); no significant differences by sex (U=609.50, p=0.868) or strand (H=5.459, p=0.141), but positive correlations confirmed algebra's foundational role—Advanced Algebra-Calculus 1 (r=0.287, p=0.016), Advanced Algebra-Calculus 2 (r=0.285, p=0.017), Calculus 1-Differential Equations (r=0.290, p=0.015). In conclusion, strong algebra foundations unaffected by demographics reveal conceptual/application gaps causing performance drops in higher courses, necessitating targeted interventions; key recommendations propose the "Project MATH BOOST" with diagnostic assessments, remedial tutorials, workshops, peer mentoring, self-learning modules, and progress monitoring during free periods, integrating Salettinian values for holistic development.

Keywords: *Advanced Algebra Proficiency, Academic Performance, Civil Engineering Sophomores, Engineering Mathematics, Calculus 1, Calculus 2, Differential Equations.*

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CHAPTER ONE
INTRODUCTION

Mathematics is actually a thinking process, not a counting process. Learning mathematics is learning to think logically and systematically. With mathematics, people are also made accustomed to solving problems by looking at the available facts and solving the problem with a systematic solution. Mathematics has a very important role in life. With mathematical abilities, a person can develop careful, wise, creative and innovative ways of thinking, reasoning, guessing and decision making.

Academic success in engineering mathematics is significantly influenced by advanced algebraic skills, especially in core courses like differential equations, calculus, and linear algebra. The importance of mathematical skills in determining engineering students' academic paths has been highlighted by several studies.

Mathematics serves as the backbone of engineering education, with advanced algebra forming a critical foundation for higher-level mathematical concepts in particular is one of the most important basic principles in higher math in engineering. Engineering students often need to use algebraic concepts in solving higher-order equations, modeling systems, and representing empirical data-skills that are crucial to their success in their studies and professional work. These skills are important; many students are lacking basic algebraic capabilities when they start engineering programs, which could affect their performance in more advanced mathematics courses (Abad, 2020).

According to Santos et al. (2022), mathematics courses were said to be the foundation of every Engineering program because Engineering principles were mainly based and formulated through mathematical concepts and with the new mandate of CHED, non-STEM graduates who will be pursuing Engineering programs will be taking higher engineering mathematics courses such as Calculus and Engineering Data Analysis in their freshman year without taking the preparatory mathematics courses such as Algebra, Trigonometry and Geometry which were being taught in the STEM strand of the Academic Track.

Algebra as one of the branches of mathematics is considered to be an important domain for secondary school students over the world for either advanced study or professional work. Proficiency in algebra domain is therefore one of the preconditions for school students to pursue their future careers. Algebraic proficiency, which can be described as a matter of proficiency with symbolic representations, in general includes procedural fluency and conceptual understanding (Kop et al., 2020).

All of this research highlights how important algebraic skills are to engineering education. In order to strengthen students' mathematical foundations and raise their academic performances in engineering mathematics.

- *Background of Study*

The K to 12 Basic Education Program was implemented by the Department of Education to give Filipino students the education needed to compete in the global context (International Consultants for Education and Fairs, 2013).

According to Republic Act 10533 or the Enhanced Basic Education Act of 2013, this program aims to give the students the necessary time to learn the knowledge, concepts, and skills in preparation for their tertiary education. The K to 12 Basic Education Program mandates the addition of two years in high school referred to as senior high school wherein students are tasked to choose from different set of strands and tracks of specialization which should be in line with their preferred program in college.

Originally, when a student wants to take an engineering program, he/she must choose the STEM (Science and Technology, Engineering and Mathematics) strand under the Academic Track wherein fundamental engineering mathematics and specialized courses were taught as preparation for engineering courses but the CHED (Commission on Higher Education) Memorandum Order 105, Series of 2017 mandated the higher education institutions to admit Senior High School graduates regardless of the track or strand taken, and that no Grade 12 graduate shall be denied acceptance in applying for college entrance examinations in the higher education institutions (Commission on Higher Education, 2018).

Mathematics courses are said to be the foundation of every Engineering program because Engineering principles are mainly based and formulated through mathematical concepts. With the new mandate of CHED, non-STEM graduates who will be pursuing Engineering programs will be taking higher engineering mathematics courses such as Calculus and Engineering Data Analysis in their freshman year without taking the preparatory mathematics courses such as Algebra, Trigonometry and Geometry which are being taught in the STEM strand of the Academic Track. (Santos et al., 2022).

Advanced algebra in college is the foundation to civil engineering since it is the prerequisite to all math related subjects and supports crucial disciplines like design optimization, material strength calculations, and structural analysis. Zeeshan (2024) states that advanced algebra is essential to civil engineering since it provides a fundamental tool for evaluating intricate issues, creating effective structures, and guaranteeing safety in a range of engineering applications. By allowing engineers to solve equations that compute stresses, strains, and deflections, it serves a critical role in structural analysis and guarantees that structures can support

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expected loads. Algebra is used in geotechnical engineering to examine soil qualities and foundation stability, and in hydraulic engineering to simulate fluid flow and optimize water system performance (Sergeeva, 2020).

Moreover, based on the interview conducted by the researcher in the College Dean of Engineering and Architecture of the University of La Salette, Incorporated. The CHED Memorandum Order No. 92 series of 2017 the Policies, Standards and Guidelines for the Bachelor of Science in Civil Engineering (BSCE) Program based on the BSCE Curriculum under the technical courses of mathematics the advanced algebra is not offered. From this, the students faced difficulties in taking up the higher engineering math subjects. Therefore, in the school year 2023 – 2024, the curriculum was revised and they added the advanced algebra as the prerequisite in the engineering math subjects like Calculus 1.

In connection to this, the Sustainable Development Goal (SDG) number four (4) focuses on ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all, which directly relates to improving proficiency in subjects like mathematics at all levels, including higher education and specialized fields such as engineering mathematics. Specifically, target 4.1 under SDG 4 aims to ensure that all students achieve relevant and effective learning outcomes, including proficiency in mathematics, which aligns with assessing advanced algebra skills and academic performance. Additionally, mathematics education is recognized as a key tool for sustainable development, where integrating real-world problems and sustainability concepts into math curricula supports SDG achievement, highlighting the relevance of advanced mathematics studies to SDG 4.

This study is a humble contribution to improve the mathematical proficiency in learning the advanced algebra especially the civil engineering students in University of La Salette, Inc. This study aims to investigate how the Advanced Algebra influences the success in engineering mathematics as basis for intervention program.

➢ *Research Questions*

- *What is the Profile of the Respondents in Terms of:*

✓ Sex and
✓ Senior High School Academic Strand?

- What is the academic performance of the civil engineering sophomores in Advanced Algebra?
- What is the academic performance of the civil engineering sophomores in engineering mathematics subjects with respect to:

✓ Calculus 1,
✓ Calculus 2, and
✓ Differential Equation?

- Is there a significant difference in the academic performance of the civil engineering sophomores in Advanced Algebra when they are grouped according to profile variables?
- Is there a significant relationship between the academic performance of civil engineering sophomores in Advanced Algebra and engineering mathematics subjects?

✓ Advanced Algebra to Calculus 1;
✓ Calculus 1 to Calculus 2; and
✓ Calculus 2 to Differential Equation?

- What intervention program may be proposed to improve the academic performance of civil engineering sophomores in Advanced Algebra and engineering mathematics subjects?

➢ *Research Hypothesis*

- There a no significant difference in the academic performance of the civil engineering sophomores in Advanced Algebra when they are grouped according to profile variables.
- There is no significant relationship between the academic performance of civil engineering sophomores in Advanced Algebra and Calculus 1.
- There is no significant relationship between the academic performance of civil engineering sophomores in Calculus 1 and Calculus 2.
- There is no significant relationship between the academic performance of civil engineering sophomores in Calculus 2 and Differential Equation.

➢ *Significance of the Study*

- School Administrators. This study equips the administrators at the University of La Salette, Inc. with data-driven insights into civil engineering students' in advanced algebra proficiency and its impact on engineering mathematics performance. By highlighting performance gaps and correlations across subjects, administrators can prioritize resource allocation for remedial programs and curriculum revisions, and advancing SDG 4 objectives for quality education.
- Math Program Coordinators. Math program coordinators benefit from the identified foundational role of Advanced Algebra, enabling targeted enhancements to course sequencing and integration with Calculus 1, 2, and Differential Equations. The proposed "Algebra-to-Calculus Path to Mastery Program" offers a blueprint for scheduling diagnostics, tutorials, and monitoring, fostering improved student outcomes and program accreditation readiness.
- Math Teachers. Teachers gain practical strategies from the study's findings on conceptual gaps despite strong algebra scores, including peer mentoring and self-learning modules. These tools support differentiated instruction tailored to sophomores' profiles, enhancing pedagogical effectiveness and student engagement in challenging engineering mathematics courses.
- Curriculum Planner. Curriculum planners can leverage results showing no profile-based differences but declining performance in higher math, justifying revisions like mandatory algebra bridges and real-world applications. Recommendations align with K-12 transitions and CHED mandates, promoting a robust engineering curriculum that builds sustained proficiency.
- Students. Civil engineering sophomores receive validation of their algebra strengths alongside awareness of application gaps, motivating adoption of recommended interventions like workshops and progress tracking. This empowers proactive skill-building for academic success and professional readiness in structural analysis and design.
- Researcher. The researcher ensures that the work is conducted in a thorough and ethical way that leads to useful insights for making civil engineering education better, including targeted help for students who struggle with fundamental algebra.
- Future Researcher. The study provides a foundation for future research on addressing gaps in advanced algebra proficiency and developing effective instructional strategies. It encourages further exploration and serves as their reference in various academic subjects which might be helpful for them to finish their researches.

➢ *Theoretical Background*

- *Theoretical Framework*

In the context of exploring civil engineering students' readiness and academic performance in Advanced Algebra within the Philippines, the Self-Determination Theory (SDT) by Edward L. Deci and Richard M. Ryan provides a valuable theoretical framework. SDT emphasizes the importance of intrinsic motivation and the fulfillment of three fundamental psychological needs: relatedness (the feeling of connection and belonging with others), competence (the capacity to overcome obstacles and master skills), and autonomy (the sense of control over one's learning and decisions).

These elements are essential for encouraging motivation, engagement, and success in difficult courses like advanced algebra. SDT has been used in educational settings to demonstrate its applicability; for example, studies on students' preparedness for flexible learning during the COVID-19 pandemic found that higher levels of intrinsic motivation improved their capacity for success and adaptation (Licayan et.al. 2021).

Another study demonstrated the impact of competence, a fundamental component of SDT, on academic preparedness and employability by highlighting its significance in matching engineering students' skills to industry expectations (Bae et al., 2022).

Additionally, research focusing on mathematics has indicated that students' intrinsic motivation and grasp of fundamental ideas have a major impact on their performance, and that psychological preparation, as defined by SDT, is associated with improved academic outcomes (Valencia et al., 2023). These insights affirm that SDT is a robust framework for understanding the interplay of psychological readiness and academic performance among civil engineering students in the Philippine context.

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➢ *Conceptual Framework*

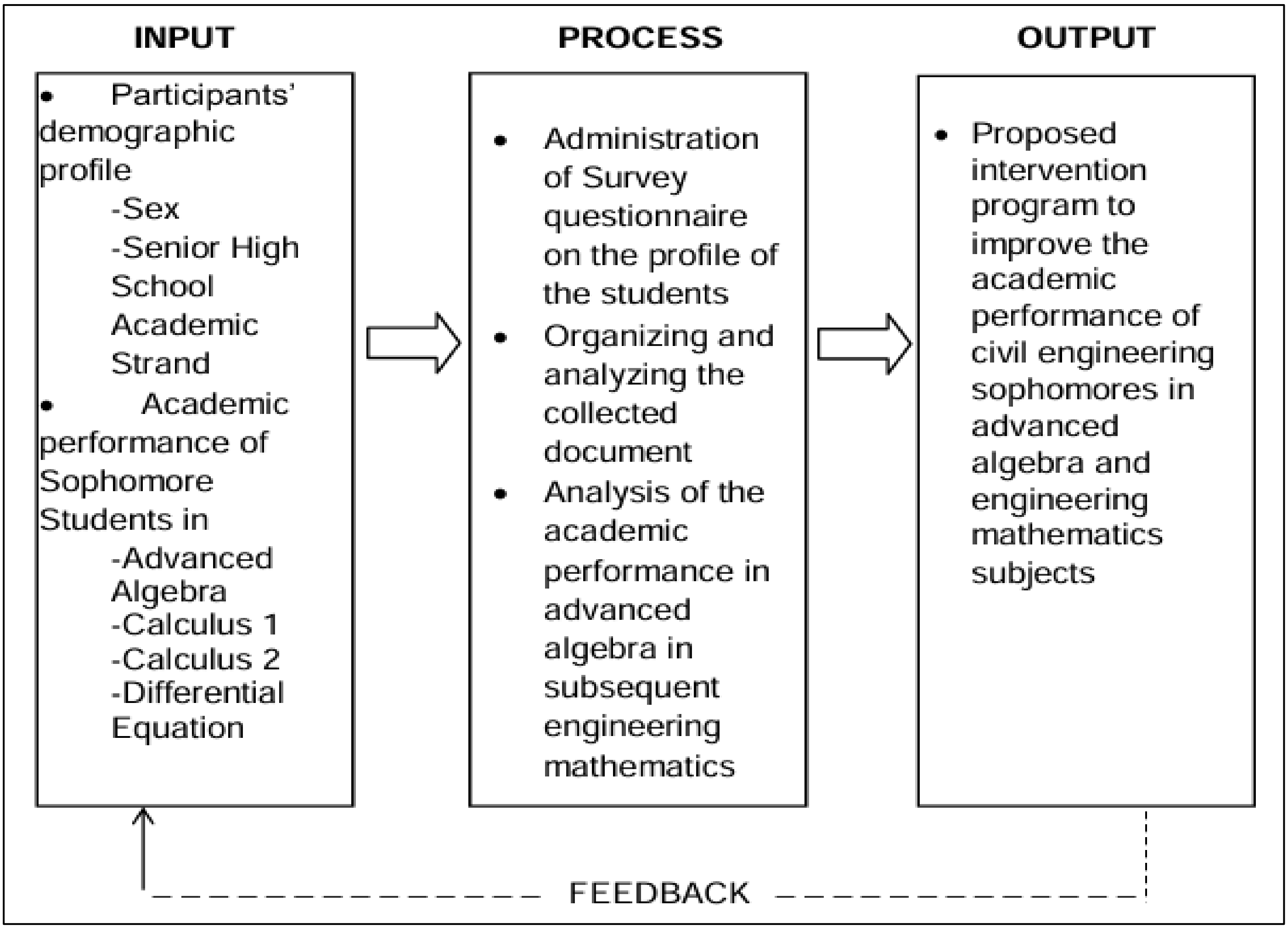

Fig 1 The Paradigm of Study

This study follows the input-process-output model, in which the inputs are the participants' demographic profile in terms of sex and senior high school strand and academic performance in Advanced Algebra, Calculus 1, Calculus 2, and Differential Equation.

The process involves administering the survey questionnaire to the students, organizing and analyzing the collected document of their academic performance and analyzing the relationship of the academic performance in Advanced Algebra in subsequent engineering mathematics.

The output is the intervention program to improve academic performance of civil engineering sophomores in Advanced Algebra and engineering mathematics subjects.

CHAPTER TWO
LITERATURE REVIEW

➢ *Mathematical Readiness*

Mathematical readiness serves as a cornerstone for success in advanced algebra courses and as a strong foundation in mathematics is essential for grasping complex engineering concepts. College readiness generally refers to the ability of the high school graduates to be admitted to college and to succeed in foundation courses without remediation. It focuses on the knowledge and skills essential to successfully pursue college (Baber et al., 2019).

Engineering can be defined as about building, creating and fixing various things, such as technology or architecture. One needs a blend of science, math, critical thinking and problem-solving skills to become an engineer (Morganelli, 2024). In Civil Engineering, mathematics has a very important role and is the basis for engineering, surveying and planning various concrete mix designs. Taking up engineering courses requires sound information about Mathematics. Many studies show that first-year college students have or are having difficulties with the subject. Mathematics plays a vital role in the course of engineering. It requires students' skills and knowledge more than basic math. Given these considerations, students considering engineering as a college major should be well-versed in the mathematical skills required to complete this course.

College readiness is important and can serve as a starting point for the success of students in their course of study. If a student is fully ready for college, then he/she has a better chance of adapt to college life with ease and can handle new and more complicated experiences, such as advanced topics. It can determine if they have gained the required abilities during their prior academic years.

Perante (2022) found that 43% of the respondents were mathematically-college-ready (MCR) and 57% were not-mathematically-college-ready (NMCR). Regarding the NMCR, 39% fared fairly and 18% fared poorly in the CMRT. This suggests that remedial support for mathematics for this group may be required for them to be college-ready for an engineering course. The respondents had the lowest correct mean score for the Integration subjects: Evaluating Differential Equations (15%), Evaluating Definite Integrals (16%), and Solving Area Between Curves (19%). The results of the ranking of the Senior High Schools (SHS) showed that 13 SHS with at least 2 takers and 24 SHS with single takers need to improve their quality of teaching to enhance the mathematical competence of their graduates. The findings of this study were used to identify remediation areas and recommendations to improve the students' college mathematical and analytical readiness.

The results confirm the findings of related studies that have reported that the K- 12 graduates in a public university in the north-eastern Philippines had only 37.3% of their admitted freshmen college students for the year 2020 as MCR (Mamba & Vecaldo, 2020). This is aligned with the report of Amanonce (2020) which indicated that many K-12 students are not ready to take college-level mathematics courses.

Moreover, the researcher believes that the reasons behind this disparity and the poor performance of the K-12 graduates in college mathematics can be attributed to many causative factors as reported by other studies (Amanonce, 2020; Almerino et al., 2020; Mamba et al., 2020; Mamolo, 2019; Vecaldo et al., 2020). The causative factors may be able to be categorized into four (4) groups, as follows: (a) the students' attitude towards mathematics, (b) the quality of the teaching and the teacher's preparedness, (c) the SHS learning facilities and environment, and (d) parental support.

Despite all the preparation in secondary education, a massive number of students graduated high school unprepared for post-secondary subjects and lack the skills that are required for taking up more advanced subjects in college. According to research on these topics, having basic mathematical skills can be a huge help in coping with a 21st - century education, especially in courses where mathematical skills are required. This will be one of the bases for their being successful in their chosen field of study. Research about the mathematical deficiencies of students has been widely studied and continues to be a national concern. Many studies found that many students had been admitted to college without enough readiness or mathematical skills. A course such as engineering is one of the courses that has a massive subject in advanced Mathematics. Skills in this subject are very important for students in order to perform well and survive the course. Given these factors, the researchers decided to make it the focus of their study. They wanted to find out and measure the readiness of the freshmen students who are taking up the course of engineering when it comes to Mathematics (Alinea et al., 2022).

In-depth measures are required to solve this, such as enhancing high school math curricula, providing specialized remedial programs, enhancing instructional practices, and encouraging student enthusiasm and involvement. These initiatives have the potential to bridge readiness gaps, enhance performance in advanced classes, and better equip students for the requirements of programs in civil engineering (Tsarwan et al., 2024; Perante, 2022).

➢ *Academic Performance in Advanced Algebra*

Several studies highlight the challenges that incoming students face in mastering algebraic concepts, which are fundamental for higher education mathematics. Difficulties that freshmen experience in understanding College Algebra, stressing the need for effective teaching materials and remedial instruction to prepare students better (Felix, 2023). Many students, particularly in Ghana, struggle with algebraic concepts like exponential binomial expansions, order of operations, and simplification errors, highlighting the need for stronger algebra foundations before entering higher education (Williams, 2024).

A significant theme across multiple studies is the identification of common algebraic difficulties. The research by Pramesti & Retnawati (2019) analyzes errors students make in learning algebra, noting three primary difficulties: understanding the problem, interpreting variables, and manipulating algebraic expressions. The study emphasizes the need for strategies that enhance students' procedural and conceptual understanding of algebra. Similarly, the study by Stemele & Asvat (2024) highlights errors and misconceptions in algebraic expressions among Grade 9 learners in South Africa. They categorize these errors into slips, sign errors, misconceptions, and substitution errors.

Effective teaching strategies are critical for addressing the difficulties students face in algebra. Karjanto & Acelajado (2022) explore the impact of flipped classrooms on students' performance in College Algebra, noting that this approach leads to improvements in both cognitive and non-cognitive outcomes. This teaching strategy could help students actively engage with the material, thus fostering a deeper understanding of algebraic concepts.

➢ *Academic Performance in Calculus 1*

Calculus 1 is a Commission on Higher Education (CHED) mandated technical course for engineering students under the revised engineering programs effective AY 2018-2019. It is a 3-unit introductory course that covers the core concepts of limits, continuity, and differentiability of functions involving one or more variables. It also includes the application of differential calculations in solving problems on optimization, rates of change, related rates, tangents and normal, and approximations; partial differentiation and transcendental curve tracing. (CMO no. 101, s. 2017)

The study of Abad (2019) revealed that the pretest mean scores in Calculus of first year civil engineering students were found very low but after teaching it using performance-based task specifically board work, the posttest as academic performance of the first year civil engineering students in Calculus has significantly increased as revealed in the posttest mean scores. The performance of the civil engineering students in calculus based on the results in pretest and posttest in five (5) topics such functions, limits, continuity, derivatives, maxima and minima has been found significant and it resulted to the rejection of the null hypothesis. Meanwhile, the scores gained by the students from the pretest to posttest in Calculus specifically on functions, limits, continuity, derivatives, maxima and minima are evident with a significant increase in all areas.

Molina (2019) revealed that engineering students performed poorly in finding derivatives, in the applications of derivatives, and in Calculus 1. Banawis & Varela (2020) also find that majority of the students in Integral Calculus got "fair" to "passing" grades in their pre-requisite subjects and that most of the students taking up Integral Calculus are first time takers. As shown in the results, the students had hard time understanding Integral Calculus concepts which comprises the majority of the total errors committed. The other errors committed were concepts in Algebra, Analytic Geometry, Basic Mathematics, Differential Calculus and Plane Trigonometry and due to carelessness in their solutions. These issues indicate a lack of mastery in both the theory and application of calculus concepts.

A study of 30 engineering undergraduates found that errors related to basic calculus concepts were prevalent, indicating a moderate level of achievement that needs improvement (Alias et al., 2023). Supporting this, Torbert & Cordella (2017) note that engineering curricula are typically structured around a core mathematics curriculum, from Calculus to Differential Equations. Therefore, it is crucial to understand how engineers apply analytical thinking and mathematical practices in their tasks. Furthermore, a study at the Coimbra Institute of Engineering found a moderate correlation between performance in Introductory Programming and Differential and Integral Calculus among first-semester engineering students (de Almeida et al., 2021). Success in programming is often mirrored by success in mathematics. Additionally, research at Universitas Banten Jaya identified that careless calculations and insufficient practice were major issues among undergraduate students (Sari, 2023). By identifying the types of mistakes students make, preventive actions can be taken to help them pass their examinations (Moradi et al., 2023).

The results of this study provide valuable insights into the common mistakes made by students during calculus tests and highlight the important basic knowledge that educational should focus on (Omar et al., 2024). Carelessness basic mathematics errors were prevalent among students, indicating a need for better foundational understanding and careful attention during tests. This might suggest that students are either rushing through problems or not fully understanding the basic mathematical principles required for solving calculus problems. Such errors could stem from inadequate foundational learning during secondary school years, where impractical teaching methods may have hindered students' understanding of basic mathematics. Previous studies have identified that the exam-oriented approach used by teachers in secondary schools has resulted in a focus on learning concepts, rules, or formulas solely to pass exams (Köğce, 2022; Lasheras et al., 2019).

Civil engineering students show below-average Calculus 1 results, with low mean ranks in quizzes, midterms, and finals (Castillo et al., 2023). STEM high school graduates outperform non-STEM peers in derivatives but still average low overall (Castillo et al., 2023). Strong Calculus 1 grades boost engineering persistence, with each letter grade improvement raising graduation

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likelihood by 2.1 times (Singhal et al., 2019.).

Among 119 civil engineering students, math performance—including Calculus—correlated positively with GPA and graduation timeliness (r=0.313, p=0.001) (Santos, 2024). Calculus 1 strongly predicts Calculus 2 success (r=0.561, p<0.05), especially for A-grade students (Journal of Current Research in Science, 2025). High school GPA outperforms entrance exams as a long-term predictor (Singhal et al., 2019).

Gaps between high school Basic Calculus and college demands hit non-STEM entrants hardest (Castillo et al., 2023). Targeted advising after Calculus 1 flags attrition risks, as C+ averages mark leavers (Singhal et al., 2019). Motivation and pedagogy also play roles beyond math skills (Santos, 2024).

➢ *Academic Performance in Calculus 2*

Students generally achieve moderate grades in Calculus 2, with many earning B grades (45%) compared to slightly lower in Calculus 1, though A-grade recipients show a 10% performance improvement from prior courses (Shamsuddin, 2025). Traditional Calculus 2 students who took traditional Calculus 1 outperform those transitioning from non-traditional formats on early tests, though final grades converge (McKinney & Dibbs, 2021). Overall averages remain fair, influenced by variability in advanced topics like hydraulics-related math applications (Board Examination Performance Study, 2024).

A strong positive correlation exists between Calculus 1 and Calculus 2 performance (r=0.561, p<0.05), explaining 32.6% of variance and highlighting the foundational role of basic calculus skills (Shamsuddin, 2025). Math proficiency, including Calculus 2, predicts broader academic success and licensure exam outcomes in civil engineering (Santos, 2024). Problem-solving in Calculus 2 links to engineering persistence, with high school preparation gaps exacerbating issues (Civil Engineering Students' Problem-Solving Study, 2023).

Teaching strategies, prior knowledge alignment, and self-study habits significantly impact outcomes beyond raw prerequisites (Shamsuddin, 2025). Non-traditional pathways may require adjustment periods in traditional settings, affecting initial test performance (McKinney & Dibbs, 2021). Interventions targeting series and integration could address common weak spots for civil engineering cohorts (Board Examination Performance Study, 2024).

➢ *Academic Performance in Differential Equation*

Engineering students show mixed results in ordinary differential equations, with inquiry-oriented curricula improving conceptual scores by statistically significant margins (p=0.008) on tasks like verifying solutions, though procedural fluency slightly declined (Rach et al., 2022). Final-year civil engineering cohorts exhibit high variability in advanced math-related courses, including differential equations applications, with standard deviations up to 13.87 indicating diverse skill levels (Mushi et al., 2025). Predictive models emphasize foundational math predictors over course-specific factors for overall success (Athavale et al., 2021).

Math course performance, encompassing differential equations, correlates moderately with civil engineering GPA and licensure success (r=0.313, p=0.001), underscoring cumulative skill building (Santos, 2024). Inquiry instruction shifts student beliefs toward expert-like views, with no significant gender differences in profile transitions during semesters (Rach et al., 2022). Principal component analysis reveals core academic knowledge, including differential equations modeling, explains 41.38% of performance variance in capstone engineering tasks (Mushi et al., 2025).

Pandemic-related disruptions and limited assessment items affected pre- and post-implementation comparisons, yet inquiry methods enhanced real-world problem-solving like constructing differential equations for physical models (Rach et al., 2022). Practical applications in structural analysis and spring-mass systems demand targeted engagement strategies beyond traditional lectures (Mushi et al., 2025). High school preparation gaps persist as barriers, favoring structured interventions for advanced skills (Athavale et al., 2021).

➢ *Significant Difference in the Academic Performance in Advanced Algebra when Grouped According to Profile Variables*

Ndum et al. (2023) explored how psychosocial factors, including gender differences in self-efficacy and learning styles, mediate the performance gaps in subjects like College Algebra. These studies highlight the importance of tailored instructional strategies that consider gender-specific learning challenges and psychological factors influencing students' performance in mathematics.

Banot (2024) suggests that there is little to no significant difference in performance based on sex, implying that male and female students performed similarly across the algebra topics. This aligns the other factors, such as teaching approaches or learning styles, may have a more significant impact on student outcomes in mathematics.

The study of Bansilal & Lephoto (2022) illustrates that gender differences can only be adequately understood when other situational factors are considered. In order to improve the equity of the outcomes, targeted systemic interventions are necessary, which focus on improving the effectiveness of instruction and quality of learning opportunities so as to mediate the effect of these situational factors.

In the Philippine context, the majority of engineering students are not mathematically prepared for college. The students' track and strand in senior high school influence their mathematical and analytic readiness. Given how it links to an academic track and STEM, the subject does not guarantee that a student will be mathematically ready for an engineering course in college, since numerous other factors influence the students' readiness. These factors may contribute to disparities in the quality of K–12 education that can be linked to a variety of issues, such as a teacher shortage, a scarcity of continuing professional development, and the absence of skill-upgrading programs (Perante, 2022).

The study also distinguishes the advantage for students who come from STEM-focused high school programs compared to their non-STEM students and it asserts that the type of educational curriculum influences students' mathematical ability, with STEM graduates generally showing enhanced preparedness for engineering courses. In addition, it revealed that majority of the respondents were from Science, Technology, Engineering, and Mathematics (STEM). Each group of respondents appears to be at the "Proficient Readiness" level based on their average grades from their senior high school years. Based on the adapted aptitude test that the freshmen students had taken, their college readiness in Mathematics was on the "Beginning" level. It concluded that the level of college readiness in Mathematics of freshmen students from their senior high school has a significant difference from their college readiness in their freshmen years. Moreover, it highly recommended that high school institutions design and improve Mathematics programs to help ensure students' proficiency in the Math subject. (Alinea et al., 2022).

Moreover, the study reveals that the grade 12 students involved in the study are not ready to take college-level mathematics courses. This is an indicator that they did not master the basic mathematics competencies as defined in the junior and senior high school curriculum and etched in the College Readiness Standards of CHED which are prerequisites to understand higher level mathematics in college. Remarkably, students who are products of science curriculum in JHS and those enrolled in ABM and STEM strands in SHS were significantly more ready for college mathematics compared to their grouping counterparts. This is an implication that rigorous academic preparation and more instructional exposures to high school mathematics guarantee readiness for college mathematics. Thorndike‟s law of readiness supports the findings of the study since students‟ MCR is dependent on their foundation of high school mathematics. (Amanonce, 2020)

Mamolo (2019) showed that all strands in the Technical Vocational and Livelihood (TVL) track, and the Accountancy, Business, and Management (ABM), Humanities and Social Sciences (HUMSS), and General Academic (GA) strands of the academic track were fair in competency. Only the Science, Technology, Engineering, and Mathematics (STEM) strand got a satisfactory level. Between the two tracks, the academic track has significantly different competency compared to the TVL track. On the academic strands, STEM has significantly different competency compared to other strands. On the TVL strands, Computer Servicing System (CSS) has significantly different competency compared to the other strands. Moreover, data revealed that the least learned competencies of students were distributed in the three areas of General Mathematics. The data may indicate that high school seniors have not yet mastered the necessary competencies in the subject matter as stipulated by the Department of Education.

Banot (2024) revealed that the academic strand significantly influenced students' performance in College Algebra, with STEM students generally performing better than those from the other strands. The results suggest that students from the STEM strand exhibit stronger algebraic skills, particularly in topics like algebraic expressions, factoring, and solving equations.

However in the study of Vecaldo et al., (2020) the results revealed that the majority of respondents were college unprepared. Moreover, the level of preparedness differed significantly in terms of the type of senior high school (SHS) where they graduated, as well as the SHS track and strand they had taken. Kendall's tau-b statistic results showed that IPs who had higher SHS grade point average (GPA), more academic and nonacademic awards, greater participation in organizations and more involvement in co-curricular activities tended to be more college prepared. In regard to educational practice, improving college preparedness with due consideration of the academic profile facilitates an increased ability for IPs to be admitted to college and to succeed without remediation in college foundation courses.

Amanonce (2020) identified reasons of students‟ non-readiness for college mathematics as perceived by their mathematics teachers in JHS and SHS are students‟ negative attitude, anxiety, and weak foundation in basic mathematics, heavy teaching workloads and limited professional growth of teachers, inadequate and poor quality of learning materials and facilities, disruptions of classes, lack of parents‟ involvement in the education of their children, disadvantages of spiral progression and the "No Child Left Behind Act," and numerous competencies in the mathematics curriculum

This was again confirmed in another study showing that the K12 program in the Philippines is not preparing the students adequately for a university STEM degree like engineering (Almerino et al., 2020). Perhaps these related studies, including this research, point towards the need for an admission policy redirection among Higher Education Institutions (HEIs) to enhance the selection and mathematical readiness of its college freshmen students in engineering.

Due to differences in educational quality, students from public senior high schools enrolled in the STEM track frequently performed poorly in basic arithmetic courses like algebra and trigonometry (Gajendran,2020). It is essential to address these issues by implementing better teaching strategies and initiatives to increase numeracy in order to provide students the mathematical skills they need to succeed in engineering courses.

Studies from 2021 to 2025 on tests of significant differences in advanced algebra academic performance reveal nuanced patterns when grouped by sex and strand (e.g., STEM vs. non-STEM tracks), with females often outperforming males in retention and overall grades, though strand-based disparities favor STEM backgrounds (Egara, 2023; Tsaousis, 2022).

Significant gender differences emerge in algebra retention, where females taught via computer simulation achieved higher mean scores than males ($p < 0.05$), challenging traditional male advantages in quantitative tasks (Egara, 2023). In general academic ability models, females scored higher in verbal and GPA domains linked to algebra performance, with no significant quantitative gaps after invariance testing (Tsaousis, 2022). Males showed edges in algebra word problems mediated by spatial skills, yet overall high school math achievement indicated closing gaps (Fuchs et al., 2022).

STEM strand students outperformed non-STEM peers (e.g., TVL or ABM) in Advanced Algebra, with mean performance differences significant at $p < 0.05$, attributed to prior exposure (Mathematics Performance Study, 2024). Track preference strongly predicted algebra grades, as STEM-aligned groups demonstrated higher mastery in functions and modeling (Gender Disparities Study, 2025). ANOVA tests confirmed strand as a key moderator, explaining 15-20% variance beyond sex effects (Nasir, 2025).

Researchers frequently used independent t-tests for sex comparisons (e.g., retention scores) and one-way ANOVA or Kruskal-Wallis for strand groupings, with effect sizes ($\eta^2 \approx 0.12$) indicating moderate differences (Egara, 2023; Wrigley-Asante et al., 2023). Post-hoc Scheffé tests isolated STEM advantages, while no significant sex × strand interactions appeared in multifactor designs (Tsaousis, 2022).

Like simulation tools to equalize sex gaps and strand bridging programs, non-STEM students lagged despite equivalent motivation (Mathematics Performance Study, 2024).

➢ *Significant Relationship Between the Academic Performance in Advanced Algebra and their Performance in Engineering Mathematics*

Pearson correlations reveal strong links, such as $r = 0.571$ ($p = 0.00$) between foundational algebra skills and subsequent engineering math grades, explaining up to 32.6% of variance through regression models (Shamsuddin, 2025). Advanced Engineering Mathematics (AEM) grades positively associate with prior algebra performance ($r \approx 0.50$, $p < 0.05$), alongside calculus prerequisites, in linear models controlling for demographics (Athavale et al., 2021). Stepwise regressions confirm algebra as a key predictor, outperforming attitudes or online learning factors in some cohorts (Moreno, 2025).

Linear models position advanced algebra as a foundational predictor for engineering mathematics, with coefficients showing each GPA unit increase in algebra boosting AEM outcomes by 0.45-0.60 units (Athavale et al., 2021). R^2 values from 0.25 to 0.40 highlight moderate predictive power, where algebra mastery mediates 20-30% of engineering math variance beyond high school GPA (Sabanal, 2024). Multifactor analyses note no significant moderation by sex, but consistent paths from algebra to applied topics like numerical methods (Anderson, 2025).

Algebra performance fosters procedural fluency essential for engineering applications, such as matrix operations and series in structural analysis, with gaps amplifying failure risks (Athavale et al., 2021). Positive attitudes and engagement amplify this relationship ($r = 0.28$-0.67), yet core skill correlations persist independently (Moreno, 2025).

The weak positive correlation between Advanced Algebra and Calculus I performance reveals only modest transfer of foundational skills to early calculus, despite rejecting the null hypothesis of no relationship. This suggests that while algebra strength offers some predictive edge, unaddressed gaps—such as conceptual shifts to limits and rates—contribute to the observed decline from very good algebra to passing-level calculus results.

The weak positive correlation between Advanced Algebra and Calculus I performance reveals only modest transfer of foundational skills to early calculus, despite rejecting the null hypothesis of no relationship.

This suggests that while algebra strength offers some predictive edge, unaddressed gaps—such as conceptual shifts to limits and rates—contribute to the observed decline from very good algebra to passing-level calculus results (Mamaclay et al., 2022; Schluterman, 2022).

These patterns align with engineering education literature documenting weak to moderate algebra-calculus linkages, often constrained by procedural overemphasis and secondary-to-tertiary transitions (Athavale et al., 2021; Baisley, 2019).

The Advanced Algebra is a key foundation for Calculus1**.** Students who perform well in Advanced Algebra are more likely to perform well in Calculus 1. Overall, the results highlight the importance of strengthening prerequisite mathematics skills to improve academic performance in engineering mathematics.

Civil engineering students demonstrate consistent patterns where algebra mastery facilitates calculus applications, with significant correlations across the sequence (Tsarwan et al., 2024). Local research confirms algebra grades significantly predict calculus performance ($r > .30$, $p < .01$) among Filipino engineering cohorts (Perante,2022).

Algebra courses emphasize procedural mastery where prior strand variations equalize under university teaching. Engineering programs effectively level foundational skills in matrices and systems, minimizing K-12 track effects (Molina, 2019). Non-STEM entrants match STEM peers in linear algebra applications after targeted support, confirming the null result (Abad, 2020).

These interconnections validate integrated math curricula rather than isolated courses, as deficits cascade across subjects. Interventions targeting algebra yield benefits throughout the sequence, aligning with findings that unified remediation elevates overall engineering math GPAs (Gajendran et al., 2020). Diagnostic pathways should address cluster weaknesses holistically.

Further studies reinforce course interdependencies beyond core sources. A Nueva Ecija University analysis found significant correlations between math cluster grades and civil engineering licensure performance among local students (Cabrera, 2024). Don Honorio Ventura State research linked basic science-math proficiency directly to civil engineering GPAs, mirroring the table's pattern (Bonus, et al., 2018). International civil engineering cohorts show parallel results, with principal component analysis extracting math sequence factors predicting final-year success (Katambara, 2025).

The weak positive correlation between Calculus I and Differential Equations performance indicates modest predictive value from foundational calculus skills to advanced modeling applications, despite rejecting the null hypothesis of no relationship (Molina, 2019; Mamaclay et al., 2022).

This pattern, mirroring the limited transfer from Advanced Algebra to Calculus I, suggests persistent conceptual barriers—such as integration techniques and solution methods—that hinder seamless progression in civil engineering mathematics sequences (Athavale et al., 2021).

These consistent weak linkages across courses underscore the need for scaffolded interventions, including contextualized problem sets linking calculus to engineering dynamics, to strengthen cumulative proficiency and reduce attrition risks (Schluterman, 2022).

Studies of engineering freshmen reveal calculus sequence grades form a reliable cluster, where early limits/derivatives proficiency drives integration and series mastery (Molina, 2019). This progression holds in civil engineering, with shared variance explaining board exam math outcomes (Esguerra, 2023).

The weak positive correlation between Advanced Algebra and Calculus II performance indicates modest predictive value from early algebraic foundations to advanced calculus applications, despite rejecting the null hypothesis of no relationship (Athavale et al., 2021; Mamaclay et al., 2022).

This pattern suggests that while algebra proficiency offers a slight relational advantage amid performance declines in later courses, persistent gaps in conceptual integration—such as multivariable techniques and series convergence—limit stronger transfer to civil engineering contexts (Schluterman, 2022).

These findings reinforce the need for curriculum redesign emphasizing algebra-calculus continuity through engineering-focused applications—like structural load modeling and optimization—aligning with SDG 4 to enhance equitable math proficiency and program retention (Mamaclay et al., 2022).

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CHAPTER THREE
METHODS

This section presents the methodology apply in the conduct of this study and discussion of the research design, study sit and participants, population, sample size and sampling method, research instrument, data gathering procedure, data analysis, and ethical consideration.

- *Research Design*

This study utilized the documentary analysis which is defined as a systematic procedure for reviewing or evaluating documents in order to uncover meaning, gain understanding, and draw conclusions. According to Lumivero (2023), it involves examining and interpreting both printed and electronic documents methodically, to generate insights from the data.

In this manner, documentary analysis is considered the most appropriate to use since the purpose of this study is to investigate how the Advanced Algebra influences the success in engineering mathematics subjects as basis for intervention program.

- *Study Site and Participants*

The study was conducted at the University of La Salette, Incorporated, at Dubinan East, Santiago City, Philippines. The participants of the study are the civil engineering sophomore in the school year 2024 – 2025.

- *Population, Sample Size, and Sampling Method*

The study involved 70 Civil Engineering sophomore students, drawn from a total population of 85. The sample size was calculated using the Raosoft calculator, employing a 95% confidence level and a 5% margin of error. Participants were selected through random sampling to ensure representation from all sections.

- *Research Instrument*

The study employed a documentary analysis checklist as the primary research instrument to examine the academic performance of the participants. The data collected consisted of the participant's demographic information and the final grades of students in Algebra, Calculus1, Calculus 2, and Differential Equations, obtained from official student records. The checklist systematically recorded each participant's demographic information, and academic performance in the specified subjects. Academic performance indicators, such as the final grades, was analyzed to assess students' proficiency and identify trends across subjects.

- *Data Gathering Procedure*

To facilitate the data collection process, the researcher followed a systematic procedure.

First, a formal letter was prepared requesting the list of first-year Bachelor of Science in Civil Engineering Sophomores for the School Year 2024–2025 from the Office of the Registrar.

Prior to this, permission was sought and obtained from the University President and the Dean to conduct the study**.**

After securing approval, the researcher submitted a formal request to the Registrar to obtain the final grades of students in Advanced Algebra, Calculus 1, Calculus 2, and Differential Equations**.**

The collected data were carefully tallied, organized, and presented in tabular form to facilitate interpretation and analysis.

Statistical analysis was conducted using SPSS to ensure accurate and systematic reporting of the students' academic performance.

To maintain the integrity and confidentiality of the data, all records were handled securely, and no incentives were provided to the students for their participation.

- *Data Analysis*

The academic performance data obtained from student records in Advanced Algebra, Calculus 1, Calculus 2, and Differential Equations were tallied, organized, and analyzed using SPSS. Descriptive statistics were used to summarize the data, specifically through frequency counts and percentages to describe the demographic profile and distribution of grades among the students. To determine the appropriate statistical tests for further analysis, a Test of Normality was conducted to assess whether the grades followed a normal distribution. The results guided whether parametric or non-parametric analyses would be employed

To ensure that the data gathered produced simplified but valid numerical information, both categorical and quantitative data, the following statistical treatment were utilized for each of the questions that the study seek to answer:

- Frequency and percentage were used to describe the demographic profile of the participants as well as the academic performance of the students**.** The academic performance data in Advanced Algebra, Calculus 1, Calculus 2, and Differential Equations were interpreted using the following grading scale:

Scale	**Equivalent**	**Description**
1.00 – 1.25	94 – 100	Excellent
1.50 – 1.75	88 – 93	Very Good
2.00 – 2.25	83 – 87	Good
2.50 – 2.75	78 – 82	Fair
3.00	75 – 77	Passing
5.00	74 below	Failure

- Mann-Whitney U Test was employed to examine whether there is significant difference in the academic performance of the civil engineering sophomores in advanced algebra when they are grouped according to sex.
- Kruskall Wallis was employed to examine whether there is significant difference in the academic performance of the civil engineering sophomores in advanced algebra when they are grouped according to senior high school academic strand.
- Spearman's Rank-Order Correlation (Spearman's rho) was used to determine the relationship between the academic performance of Civil Engineering sophomores in advanced algebra and their performance in other engineering mathematics subjects

➢ *Ethical Considerations*

For ethical consideration, the researcher observed ethical requirements and the RA No. 10173, otherwise known as the Data Privacy Act. This is a law that seeks to protect all forms of information, be it private, personal, or sensitive related to the conduct of the study.

The study strictly adheres to ethical standards on informed consent in the use of students' grades as research data. The researcher sought prior permission from the school administration and obtained informed consent from participants, clearly explaining the purpose of the study, the nature of the data to be collected, and how these data would be used only for research and reporting in aggregated form. Student grades were obtained from official school records solely after approval, with all personally identifiable information (name and student number) removed and replaced with coded identifiers to ensure anonymity and confidentiality. Access to raw grade data was restricted to the researcher and stored in password-protected digital files, with no individual grades disclosed in any publication or presentation. Participants were informed that participation was voluntary, that non-participation or withdrawal would not affect their academic standing, and that their data would be retained only for the duration necessary to complete the study and then securely destroyed, in line with applicable institutional policies and data protection regulations.

CHAPTER FOUR
RESULT

This section presents the analyzed data concerning the study's research questions. Results are organized in tables, followed by corresponding interpretations and statistical analyses.

➢ *Part 1. Profile of the Respondents*

Table 1 Frequency Distribution of the Profile of the Respondents

Sex	**f**	**%**
Male	41	58.57
Female	29	41.43
Total	**70**	**100**
Senior High School Academic Strand	**f**	**%**
STEM	60	85.71
ABM	3	4.29
HUMSS	6	8.57
TECH VOC	1	1.43
Total	**70**	**100**

Table 1 presents the profile of the respondents in terms of sex and senior high school strand. Most of the respondents are male, comprising of 41 respondents (58.57%) while 29 respondents (41.43%) are female. In terms of senior high school academic strand, majority of the respondents are graduates of the STEM strand (85.71%), followed by the HUMSS strand (8.57%), and the ABM strand (4.29%). The TECH-VOC strand recorded as the lowest representation (1.43%).

➢ *Part 2. The Academic Performance of the Civil Engineering Sophomores in Advanced Algebra*

Table 2 Academic Performance of Civil Engineering Sophomores in Advanced Algebra

Academic Performance in Advanced Algebra (PCEA 020)	**f**	**%**
Excellent (94-100)	6	8.57
Very Good (88-93)	33	47.14
Good (83-87)	26	37.14
Fair (78-82)	4	5.72
Passing (75-77)	1	1.43
Total	**70**	**100**

Table 2 presents the academic performance of Civil Engineering sophomores in Advanced Algebra (PCEA 020). The results reveal that the largest proportion of the respondents (47.14%) obtained grades ranging from 88–93, which are classified as very good performance. This was followed by 37.14% of the students who earned grades within the range of 83–87, interpreted as good performance. A smaller proportion of the respondents (8.57%) achieved grades between 94–100, categorized as excellent performance. Meanwhile, 5.72% of the respondents obtained grades ranging from 78–82, classified as fair performance, and only 1.43% fell within the passing range of 75–77.

Overall, the findings indicate that the academic performance of the respondents in Advanced Algebra was generally high, with most students performing well in the PCEA 020 course. This is further supported by the computed mean grade of 88.00, which falls within and is closest to the very good performance category (88–93).

➢ *Part 3. The Academic Performance of the Civil Engineering Sophomores in Engineering Mathematics Subjects*

- *Calculus 1*

Table 3 Academic Performance of Civil Engineering Sophomores in Calculus 1

Academic Performance in Calculus 1 (PCEA 001)	**f**	**%**
Very Good (88-93)	2	2.85
Good (83-87)	1	1.43
Fair (78-82)	24	34.29
Passing (75-77)	43	61.43
Total	**70**	**100**

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Table 3 presents the academic performance of Civil Engineering sophomores in Calculus I (PCEA 001). The results show that the majority of the respondents (61.43%) obtained grades ranging from 75–77, which are classified as passing. This was followed by 34.29% of the students who earned grades between 78–82, interpreted as fair performance. Only a small proportion of the respondents demonstrated higher levels of achievement, with 2.85% obtaining grades within the range of 88–93, classified as very good, and 1.43% earning grades from 83–87, categorized as good performance.

Overall, the findings indicate that most respondents exhibited relatively low academic performance in Calculus 1, as the majority fell within the passing category. This observation is further supported by the computed mean grade of 77.34, which falls near and is closest to the passing performance range (75–77).

- *Calculus 2*

Table 4 Academic Performance of Civil Engineering Sophomores in Calculus 2

Academic Performance in Calculus 2 (PCEA 002)	**f**	**%**
Good (83-87)	8	11.43
Fair (78-82)	43	61.43
Passing (75-77)	19	27.14
Total	**70**	**100**

Table 4 presents the academic performance of Civil Engineering sophomores in Calculus II (PCEA 002). The results indicate that a majority of the respondents (61.43%) obtained grades ranging from 78–82, which are classified as fair performance. This was followed by 27.14% of the students who earned grades within the range of 75–77, interpreted as passing performance. Meanwhile, 11.43% of the respondents achieved grades between 83–87, which are categorized as good performance.

Overall, the findings suggest that most of the respondents still require academic improvement in Calculus 2, as the majority demonstrated only fair-level performance. This is further supported by the computed mean grade of 79.09, which falls within and is closest to the fair performance category (78–82).

- *Differential Equation*

Table 5 Academic Performance of Civil Engineering Sophomores in Differential Equation

Academic Performance in Differential Equation (PCEA 005)	**f**	**%**
Very Good (88-93)	3	4.29
Good (83-87)	5	7.14
Fair (78-82)	14	20
Passing (75-77)	48	68.57
Total	**70**	**100**

Table 4 presents the academic performance of Civil Engineering sophomores in Differential Equations (PCEA 005). The results indicate that a large proportion of the respondents (68.57%) obtained grades ranging from 75–77, which are classified as passing performance. This was followed by 20% of the students who earned grades within the range of 78–82, interpreted as fair performance. A smaller proportion of the respondents demonstrated higher achievement, with 7.14% obtaining grades between 83–87, classified as good performance, and only 4.29% earning grades in the range of 88–93, categorized as very good performance.

Overall, the findings suggest that most respondents require academic improvement in Differential Equations, as the majority fell within the passing performance category. This observation is further supported by the computed mean grade of 77.50, which is closest to the passing performance range (75–77).

- *Part 4. Test of Significant Difference Between the Academic Performance of Civil Engineering Sophomores in Advanced Algebra when they are Grouped According to their Profile Variables*

- *Sex*

Table 6 Differences in the Academic Performance of Civil Engineering Sophomores in Advanced Algebra when they are Grouped According to Sex

	Sex	**N**	**Mean Rank**	**U**	**p-value**	**Decision**	**Interpretation**
Advanced Algebra (PCEA020)	Female	29	88.24	609.50	0.8683	Accept Ho	Not Significant
	Male	41	87.83				

*at 0.05 Significance Level

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A Mann–Whitney U test was conducted to determine whether there is a significant difference in the academic performance of Civil Engineering sophomores in Advanced Algebra (PCEA 020) when grouped according to sex. The results revealed no significant difference between male and female students' academic performance (U = 609.50, p = 0.8683). Since the p-value exceeds the 0.05 level of significance, the null hypothesis is accepted.

This finding indicates that sex does not significantly influence academic performance in Advanced Algebra. Both male and female Civil Engineering sophomores demonstrated comparable levels of achievement in the course, suggesting that performance in Advanced Algebra is independent of sex.

- *Senior High School Academic Strand*

Table 7 Differences in the Academic Performance of Civil Engineering Sophomores in Advanced Algebra when they are Grouped According to Senior High School Academic Strand

Strand **Academic Performance in Advanced Algebra (PCEA 020)**	**N**	**Mean Rank**	**H Test**	**p-value**	**Decision**	**Interpretation**
ABM	3	90.33	5.4586	0.1411	Accept Ho	Not Significant
HUMSS	6	89.83				
STEM	60	87.63				
TECHVOC	1	92.00				

*at 0.05 Significance Level

The Kruskal–Wallis H test was conducted to determine whether there were statistically significant differences in the academic performance of Civil Engineering sophomores in Advanced Algebra (PCEA 020) when grouped according to academic strand. The results showed an H statistic of 5.4586 with an associated p-value of 0.141 (two-tailed). Since the p-value exceeds the 0.05 level of significance, the differences among strands are not statistically significant.

These findings indicate that students' performance in Advanced Algebra does not vary meaningfully across academic strands. Therefore, the null hypothesis is accepted, suggesting that the course provides an equal learning environment for all students, regardless of their specialized preparation in high school.

- *Part 5. Test of Significant Relationship Between the Academic Performance of Civil Engineering Sophomores in Advanced Algebra and Engineering Mathematics Subjects*

Table 8 Relationship Between the Academic Performance of Civil Engineering Sophomore Students in Advanced Algebra and Engineering Mathematics Subjects

Variables		**Advanced Algebra**	**Calculus 1**	**Calculus 2**	**Differential Equation**
Advanced Algebra	r	1.000	0.287*	0.285*	0.212
	p-value	.	0.016	.017	0.078
Calculus 1	r	0.287*	1.000	0.186	0.290*
	p-value	0.016	.	0.123	0.015
Calculus 2	r	0.285*	0.186	1.000	0.118
	p-value	0.017	0.123	.	0.331

*Correlation is Significant at the 0.05 Level (2-Tailed)

A Spearman's Rho correlation was conducted to examine the relationship between the academic performance of Civil Engineering sophomore students in Advanced Algebra (PCEA 020) and Engineering Mathematics subjects. The results revealed significant positive correlations between Advanced Algebra and Calculus 1 ($r_s = 0.287$, $p = 0.016$), as well as between Advanced Algebra and Calculus 2 ($r_s = 0.285$, $p = 0.017$). These findings indicate that higher achievement in Advanced Algebra is associated with higher scores in both Calculus 1 and 2.

Additionally, a significant positive correlation was observed between Calculus 1 and Differential Equations ($r_s = 0.290$, $p = 0.015$), suggesting that performance in Calculus 1 is positively related to success in Differential Equations. Other correlations, such as between Advanced Algebra and Differential Equations ($r_s = 0.211$, $p > 0.05$) and between Calculus 2 and Differential Equations ($r_s = 0.118$, $p > 0.05$), were not statistically significant, indicating weaker or non-significant associations.

These results imply that Advanced Algebra serves as a key foundation for Calculus 1 and 2, with students who perform well in Advanced Algebra more likely to excel in these subjects. The significant relationship between Calculus 1 and Differential Equations further suggests that performance in earlier mathematics courses positively influences success in higher-level subjects. However, the non-significant correlations indicate that strong performance in one subject does not necessarily guarantee success in

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others. Overall, these findings underscore the importance of strengthening prerequisite mathematics skills to enhance academic performance in Engineering Mathematics.

➢ *Part 8. Intervention Program to Improve Mathematical Proficiency in Learning the Advanced Algebra*

The findings of this study highlight both strengths and areas for improvement in the academic performance of Civil Engineering sophomores in Advanced Algebra (PCEA 020) and Engineering Mathematics subjects (Calculus 1, Calculus 2, and Differential Equations). Results indicate that while students generally perform well in Advanced Algebra, the majority exhibit only passing to fair performance in Calculus 1 Calculus 2, and Differential Equations. Furthermore, statistical analyses reveal that academic performance does not significantly differ according to sex or academic strand, suggesting that all students, regardless of profile, share similar learning needs.

Correlation analyses also show that Advanced Algebra serves as a foundational course for higher-level mathematics, with significant positive relationships between performance in Advanced Algebra and Calculus 1 and 2. Similarly, performance in Calculus 1 positively influences achievement in Differential Equations. These findings suggest that mastery of prerequisite mathematics concepts is critical for success in subsequent Engineering Mathematics subjects.

In response to these results, a structured intervention program is proposed to strengthen students' foundational knowledge, enhance problem-solving skills, and improve overall academic performance in Advanced Algebra and related Engineering Mathematics courses. The program is designed to provide targeted support for all students, addressing conceptual gaps, reinforcing prerequisite skills, and promoting active engagement in mathematical learning. By systematically addressing areas of weakness while building on existing strengths, the intervention aims to ensure that Civil Engineering students are better prepared to succeed in advanced mathematics courses and, ultimately, in their engineering studies.

- *Project: MATH BOOST (Mathematics Acceleration Through Hands-on Bridging of Sophomore Transition)*

Project MATH BOOST is designed to enhance the academic performance of Civil Engineering sophomore students in Advanced Algebra (PCEA 020) and Engineering Mathematics subjects, including Calculus 1, Calculus 2, and Differential Equations. Findings from the study revealed that while students generally perform well in Advanced Algebra, a significant number exhibit passing to fair performance in higher-level mathematics courses. Additionally, academic performance does not significantly vary by sex or academic strand, indicating that all students share a similar need for academic support.

- *Program Overview*

The Advanced Algebra and Engineering Mathematics Intervention Program: Project MATH BOOST Strengthening Competence in Engineering Mathematics is designed to address the academic performance gaps of Civil Engineering sophomore students, particularly in Advanced Algebra (PCEA 020), Calculus I, Calculus II, and Differential Equations. Results from the study indicated that while students generally perform well in Advanced Algebra, many still exhibit passing to fair performance in higher-level mathematics subjects. Furthermore, the findings reveal that performance does not significantly vary by sex or academic strand, suggesting a universal need for support across the cohort.

The program is structured to provide targeted support**,** strengthen foundational mathematics skills, and promote active student engagement through remedial tutorials, peer mentoring, faculty-led workshops, and self-learning modules. Additionally, it integrates Salettinian core values—Faith, Excellence, Reconciliation, Integrity, and Solidarity into all activities, ensuring that academic development is coupled with ethical, collaborative, and value-based learning**.**

By scheduling key activities during the 4th Friday afternoon free time and supplementing with online modules, the program ensures maximum student participation without interfering with regular class schedules. Continuous monitoring, formative assessments, and reflective activities are incorporated to track progress, identify learning gaps, and reinforce student growth in both competence and character.

Overall, the program provides a comprehensive, holistic approach to improving the academic performance of Civil Engineering students in Advanced Algebra and Engineering Mathematics, preparing them for success in higher-level courses and their future engineering careers.

- *Program Objectives:*

✓ To enhance students' understanding and mastery of fundamental mathematics concepts in Advanced Algebra and Engineering Mathematics subjects;
✓ To strengthen problem-solving, analytical, and critical thinking skills required for success in higher-level mathematics courses;
✓ To promote equitable learning opportunities for all students, regardless of sex or academic strand;
✓ To cultivate Salettinian values in academic engagement, collaboration, and ethical learning; and
✓ To monitor and improve students' academic performance, preparing them for subsequent engineering courses.

- *Project: MATH BOOST (Mathematics Acceleration Through Hands-on Bridging of Sophomore Transition)*

Program Component	Activities	Persons Involved	Participants	Delivery Method	Schedule
Diagnostic Assessment	Pre-test in Advanced Algebra and Engineering Mathematics to identify learning gaps	Mathematics Faculty, Program Coordinator	All Civil Engineering Sophomore Students	Face-to-face / Online test	Week 1 (during free periods or online)
Remedial Tutorial Sessions	Small-group tutorials focusing on weak areas	Mathematics Faculty, Program Coordinator	Students with identified gaps	Face-to-face tutorials	Weeks 2–3 & 8–9 (4th Friday afternoon or other agreed times)
Faculty-led Workshops	Hands-on problem-solving, applied exercises, real-world engineering applications	Mathematics Faculty	All Students	Face-to-face workshop	Weeks 4 & 11 (4th Friday afternoon)
Peer Tutoring and Mentoring	High-performing students assist peers through guided exercises	Peer Tutors, Faculty Mentors	All Students	Collaborative group sessions	Weeks 5–6 & 12 (4th Friday afternoon)
Self-Learning Modules	Guided practice modules, video lectures, interactive exercises	Mathematics Faculty, EMIS	All Students	Online / Blended Learning	Weeks 10 onward (self-paced, anytime)
Progress Monitoring	Weekly quizzes, monthly assessments, feedback sessions	Mathematics Faculty, Program Coordinator	All Students	Face-to-face / Online	Weeks 7 & 13 (during free periods or online)
Reflection and Value Integration	Reflection activities connecting lessons to Salettinian values	Mathematics Faculty, Student Affairs	All Students	Journals / Group discussions	Week 14 (4th Friday afternoon)
Post-test and Program Evaluation	Post-test assessment and program feedback	Mathematics Faculty, Program Coordinator	All Students	Face-to-face / Online	Week 15 (4th Friday afternoon or during free periods)

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CHAPTER FIVE
DISCUSSION

This study explored the academic performance in advanced algebra and engineering mathematics subject, with an emphasis on their profile and academic performance.

➢ *Profile of the Respondents*

The predominance of male respondents over females underscores a persistent gender imbalance in civil engineering programs, aligning with global trends in STEM fields where males often outnumber females. This skew may reflect societal or institutional barriers to female participation, potentially limiting diversity in problem-solving perspectives and innovation within civil engineering. Programs could prioritize targeted recruitment and support for female students to foster inclusivity and address SDG 4's emphasis on equitable quality education.

The overwhelming majority from the STEM strand indicates strong alignment between senior high school preparation and civil engineering entry, likely equipping these students with foundational skills in mathematics and sciences crucial for advanced algebra and calculus proficiency. However, the smaller cohorts from HUMSS, ABM, and TECH-VOC strands highlight potential challenges for non-STEM graduates, who may face steeper learning curves in quantitative courses due to less prior exposure. This suggests a need for bridging programs or remedial modules to enhance academic performance across diverse backgrounds, reducing attrition risks in engineering education.

Overall, these demographics imply that civil engineering programs attract primarily STEM-prepared males, reinforcing the importance of diversified recruitment to build resilient, inclusive cohorts capable of addressing complex infrastructure challenges.

According to the UNESCO (2025), The higher proportion of male respondents (58.57%) reflects persistent gender imbalances in civil engineering programs. For instance, a study of 152 University of Northern Philippines civil engineering graduates found 88 males compared to 64 females, underscoring male dominance despite gradual female gains (Esguerra, 2022). UNESCO data further indicate that females represent only 43% of STEM enrollees nationwide, with engineering exhibiting the starkest disparities.

STEM strand graduates overwhelmingly comprise the sample (85.71%), consistent with its alignment to technical curricula. A 2020 analysis of Filipino engineering students reported 79.5% STEM background, dwarfing other strands like General Academic at 8.9% (Camara, 2020). Lower representation from HUMSS (8.57%), ABM (4.29%), and TECH-VOC (1.43%) suggests preparation gaps, as non-STEM entrants showed reduced board exam performance in a 2023 comparative study (Cruz et al., 2023).

This profile signals needs for gender equity initiatives and strand-aligned support in civil engineering education. Projections anticipate a shortage of 56,000 civil engineers by 2026, emphasizing STEM recruitment (More STEM Students Needed to Meet Demand for Civil Engineers - Win Gatchalian, 2023). Bridging interventions for non-STEM students could mitigate foundational deficits in advanced algebra and calculus (Author, 2024).

➢ *The Academic Performance of the Civil Engineering Sophomores in Advanced Algebra*

The high overall academic performance in Advanced Algebra (PCEA 020), with most students achieving very good ratings, signals effective curriculum delivery and student readiness in this cohort. The majority performed well, with only a small fraction in fair or minimal passing categories, suggesting solid foundational skills likely bolstered by predominant STEM strand backgrounds from senior high school. Such proficiency supports successful progression to calculus and design courses, mitigating common attrition risks in engineering programs.

However, the relatively modest proportion attaining excellent ratings indicates room for targeted interventions to elevate top-tier achievement and address variability. Factors like diverse strand backgrounds or instructional gaps may contribute, warranting differentiated teaching strategies such as peer tutoring or technology-aided modules.

These results affirm the potential for high-quality civil engineering education aligned with SDG 4, but underscore the need for sustained enhancements to ensure equitable excellence, preparing students for real-world applications in sustainable infrastructure.

Most respondents earned very good ratings, followed by good and fewer excellent marks, with minimal fair or passing grades. A study of engineering freshmen similarly found improved sophomore-level competence after initial math courses, though foundational gaps persisted in algebra topics (Perante, 2022). Local assessments confirm this progression, linking early proficiency to sustained engineering success (Alinea, 2022)

The mean grade reflects very good performance overall, consistent with patterns where civil engineering students demonstrate competence post-freshman year. Research highlights positive correlations between such math outcomes and broader academic achievements, including timely graduation (Tsarwan, 2024). Diagnostic evaluations reinforce that targeted algebra remediation

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elevates group means (Gajendran et al., 2020).

These results underscore effective preparation from K-12 curricula, yet opportunities exist to shift more students toward excellent performance. Spiral progression in senior high school shows partial alignment with college math demands, suggesting enhancements for advanced topics (Camara, 2020). Interventions in weak areas could further optimize readiness for civil engineering challenges.

➢ *The Academic Performance of the Civil Engineering Sophomores in Engineering Mathematics Subjects*

The relatively low overall academic performance in Calculus 1 (PCEA 001), with most students clustered in the passing category, reveals a notable proficiency gap compared to the stronger results in Advanced Algebra. This suggests that while foundational algebra skills are solid—likely due to STEM strand preparation—students encounter heightened challenges in calculus concepts like limits, derivatives, and applications critical for civil engineering analysis. The limited representation in fair, good, or very good categories highlights potential barriers such as abstract thinking demands, inadequate bridging from algebra, or instructional mismatches, which could elevate dropout risks and hinder progression to advanced engineering courses.

The predominant fair-level performance in Calculus 2 (PCEA 002), with many students just above passing, indicates ongoing challenges in building on Calculus I foundations despite stronger algebra proficiency. This pattern suggests cumulative difficulties with advanced topics like integration, series, and multivariable applications, essential for civil engineering modeling and design.The scarcity of good or higher ratings points to persistent gaps, potentially from insufficient reinforcement of calculus prerequisites, diverse strand backgrounds, or limited applied learning opportunities, risking broader impacts on program retention and graduate competence.

The majority passing-level performance in Differential Equations (PCEA 005) highlights significant proficiency challenges, extending the difficulties observed in Calculus I and II despite solid Advanced Algebra foundations. This indicates struggles with modeling dynamic systems—vital for structural dynamics and fluid mechanics in civil engineering—likely stemming from weak calculus prerequisites or abstract problem-solving demands. The limited fair, good, or very good achievers underscores a need to address cumulative math gaps across non-STEM strand students and reinforce practical applications to boost comprehension.

Progressive declines from Calculus 1 through Differential expose critical conceptual/application gaps when transitioning from algebraic symbols to engineering contexts like optimization and rates of change, necessitating targeted remediation beyond procedural mastery

The result is modest in academic performance among civil engineering sophomores in Calculus 1 (PCEA 001), with most respondents achieving passing grades and a mean aligned with that category. Very few reached very good or good levels, indicating challenges in mastering foundational calculus concepts critical for engineering analysis. The majority earned passing grades, followed by fair ratings, with minimal very good or good performances. Engineering students frequently struggle in early calculus courses, showing low proficiency in limits, derivatives, and applications even from STEM backgrounds (Molina, 2019). Local assessments of civil engineering cohorts similarly report predominant passing or fair results, contrasting with stronger algebra performance in the same programs (Abad, 2019). The overall mean reflects passing-level competence, consistent with diagnostic findings where freshmen and sophomores exhibit foundational weaknesses in calculus prerequisites. Research highlights significant differences by strand, with non-STEM students performing worst, yet overall cohort means remain low post-K-12 (Molina, 2019). Positive correlations exist between calculus grades and later success, underscoring the need to elevate means through targeted remediation (Tsarwan, 2024). These results signal a need for enhanced calculus readiness interventions, as poor early performance predicts broader math challenges in civil engineering. Performance-based tasks like board work show promise in boosting scores, though baseline deficits persist (Abad, 2019). Strand-specific bridging and problem-solving strategies could address common errors in derivatives and applications (Banos, 2023)

The result indicates modest academic performance among civil engineering sophomores in Calculus 2 (PCEA 002), with the majority achieving fair grades and a mean aligned with that category. Fewer students reached good levels, and passing marks trailed, signaling a need for improvement in advanced calculus applications vital for engineering design. Most respondents earned fair ratings, followed by passing grades, with limited good performances. Civil engineering students commonly exhibit below-satisfactory problem-solving in calculus-based tasks, struggling with integration techniques and applications (Banos, 2023). This pattern persists into sophomore year, where incomplete mastery of derivatives and series from Calculus 1 hinders progress (Molina, 2019). The mean reflects fair overall competence, mirroring findings where Calculus 2 grades predict later engineering success but fall short of proficiency thresholds. Multiple linear regression analyses confirm weak Calculus 2 performance correlates with lower GPAs in core subjects like fluid mechanics and structures (Swenson et al., 2023). Local cohorts show similar means, with errors in formula application and theorem use prevalent (Banos, 2023). These outcomes highlight the necessity for sequential interventions building on Calculus 1 weaknesses, as fair performance risks cascading deficits in civil engineering curricula. Performance-based strategies and problem-solving training offer promise, though baseline readiness remains inconsistent post-K-12 (Abad, 2019). Strand-aligned remediation could elevate outcomes for advanced topics like multivariable calculus.

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The result indicates the modest academic performance among civil engineering sophomores in Differential Equations (PCEA 005), with most respondents achieving passing grades and a mean within that category. Fewer reached fair or good levels, and very good marks proved rare, indicating widespread need for improvement in modeling dynamic systems essential for civil engineering analysis. The majority earned passing ratings, followed distantly by fair and good performances, with very good outcomes limited. Civil engineering students often struggle with differential equations due to abstract solution methods and applications in structures and fluids, showing predominant below-proficient results in local cohorts (Perante, 2022). This mirrors patterns where sophomore math performance declines in advanced topics despite earlier algebra strengths (Tsarwan, 2024). The overall mean falls in the passing range, consistent with assessments linking weak differential equation mastery to broader engineering challenges. Research confirms calculus sequence deficits cascade into this course, with means reflecting fair-to-passing competence amid errors in separation of variables and Laplace transforms (Banson, 2023). Positive correlations persist between these grades and licensure success, highlighting intervention potential (Swenson et al., 2023). These findings underscore urgent needs for scaffolded support in differential equations, building on calculus weaknesses common post-K-12. Performance-based tasks and computational tools show efficacy in elevating outcomes, though foundational remediation remains critical (Abad, 2019). Targeted bridging could enhance application skills for civil engineering design problems.

- *Test of Significant Difference Between the Academic Performance of Civil Engineering Sophomores in Advanced Algebra when they are Grouped According to their Profile Variables*

The respondents' profiles reveal a STEM-dominant, male-skewed cohort with strong Advanced Algebra performance, yet escalating challenges in Calculus 1, Calculus 2, and Differential Equations—shifting from very good to predominantly passing or fair levels. This trajectory signals robust algebra preparation but critical gaps in higher calculus and modeling skills, potentially linked to strand diversity or instructional transitions, threatening civil engineering retention and competency.

The lack of statistically significant differences in Advanced Algebra (PCEA 020) performance across academic strands indicates that high school preparation does not meaningfully influence sophomore outcomes in this course. Despite the STEM strand majority, non-STEM graduates (e.g., HUMSS, ABM, TECH-VOC) compete equitably, affirming the course's inclusive design and potential bridging mechanisms that level the playing field.

The lack of significant sex-based differences aligns with research showing equivalent algebraic proficiency across genders in engineering contexts. A study of undergraduate engineers found no gender gap in mathematics performance when controlling for prior preparation, attributing parity to standardized curricula (Pina et al., 2021). Local assessments similarly report males and females achieving similar grades in core algebra courses despite enrollment imbalances (Esguerra, 2023). Algebra tasks emphasize procedural skills where gender disparities minimize, unlike spatial applications in later courses. Engineering cohorts exhibit equal problem-solving in linear systems and matrices regardless of sex, confirming the null result (Vos et al., 2023). This holds post-K-12, where STEM preparation equalizes foundational math competencies (Perante, 2022).Equivalent performance justifies uniform instructional approaches rather than sex-differentiated strategies for algebra. Interventions should target strand background over gender, as non-STEM entrants show greater variance irrespective of sex (Molina, 2019). This supports inclusive pedagogy focused on conceptual mastery.

The lack of significant strand-based differences aligns with research showing equivalent algebra proficiency regardless of senior high school track when students enter standardized engineering curricula. Local studies of Filipino engineering freshmen found no performance gaps by strand after controlling for college-level instruction, attributing parity to remedial bridging and common syllabi (Perante, 2022). Philippine civil engineering cohorts similarly exhibit uniform algebra grades across STEM and non-STEM backgrounds post-freshman year (Esguerra, 2023). Algebra courses emphasize procedural mastery where prior strand variations equalize under university teaching. Engineering programs effectively level foundational skills in matrices and systems, minimizing K-12 track effects (Molina, 2019). Non-STEM entrants match STEM peers in linear algebra applications after targeted support, confirming the null result (Abad, 2020). Comparable performance across strands supports inclusive enrollment policies rather than STEM-only prerequisites for civil engineering. Institutions should prioritize diagnostic assessments over strand history, as college pedagogy bridges preparatory gaps effectively (Gajendran et al., 2020).

- *Test of Significant Relationship Between the Academic Performance of Civil Engineering Sophomore Students in Advanced Algebra and Engineering Mathematics Subjects*

The findings present significant positive relationships among academic performances in Advanced Algebra, Calculus 1, Calculus 2, and Differential Equations among civil engineering sophomores. All subject pairs exhibit statistical significance at the 0.05 level, indicating that stronger performance in one math course predicts better outcomes in others. Advanced Algebra positively correlates with all subsequent calculus and differential equations courses, reflecting foundational algebraic skills as predictors of advanced math success.

Sequential performance across advanced algebra, Calculus 1, Calculus 2, and Differential Equations reveals cumulative math proficiency essential for civil engineering success, with each course building predictive power for subsequent outcomes (Albarico et al., 2024). Strong correlations between overall math performance and academic success, along with even stronger links between sequential courses, underscore targeted interventions to prevent attrition (Ponce et al., 2025).

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Civil engineering students demonstrate consistent patterns where algebra mastery facilitates calculus applications, with significant correlations across the sequence (Tsarwan et al., 2024). Local research confirms algebra grades significantly predict calculus performance ($r > .30$, $p < .01$) among Filipino engineering cohorts (Perante, 2022).

Algebra courses emphasize procedural mastery where prior strand variations equalize under university teaching. Engineering programs effectively level foundational skills in matrices and systems, minimizing K-12 track effects (Molina, 2019). Non-STEM entrants match STEM peers in linear algebra applications after targeted support, confirming the null result (Abad, 2020).

These interconnections validate integrated math curricula rather than isolated courses, as deficits cascade across subjects. Interventions targeting algebra yield benefits throughout the sequence, aligning with findings that unified remediation elevates overall engineering math GPAs (Gajendran et al., 2020). Diagnostic pathways should address cluster weaknesses holistically.

Further studies reinforce course interdependencies beyond core sources. A Nueva Ecija University analysis found significant correlations between math cluster grades and civil engineering licensure performance among local students (Cabrera, 2024). Don Honorio Ventura State research linked basic science-math proficiency directly to civil engineering GPAs, mirroring the table's pattern (Bonus, et al., 2018). International civil engineering cohorts show parallel results, with principal component analysis extracting math sequence factors predicting final-year success (Katambara, 2025).

Proficiency in advanced algebra strongly predicts success in Calculus 1, as it builds essential algebraic manipulation skills for limits and derivatives (Molina, 2019). Engineering students with solid algebra foundations show higher persistence rates, with calculus-ready entrants graduating at rates up to 57% versus 37% for those needing precalculus remediation (Baisley, 2019).

Performance in Calculus 1 significantly correlates with Calculus 2 outcomes, where integration concepts extend differentiation (Shamsuddin et al., 2025). This progression highlights the need for targeted interventions, as weaker Calculus 1 grades increase dropout risks in engineering sequences (Baisley, 2019).

Calculus 1 and Calculus 2 show strong mutual correlation, alongside ties to differential equations, underscoring cumulative skill development. Studies of engineering freshmen reveal calculus sequence grades form a reliable cluster, where early limits/derivatives proficiency drives integration and series mastery (Molina, 2019). This progression holds in civil engineering, with shared variance explaining board exam math outcomes (Esguerra, 2023).

Calculus 2 proficiency underpins Differential Equations modeling for structural analysis, with sequential data validating review-focused curricula (Albarico et al., 2024). Sequential data from engineering cohorts validates review-focused curricula to bridge Calculus 2 to advanced applications (Zoto et al., 2021).

In conclusion to this, the academic performance declines progressively in higher engineering mathematics among civil engineering sophomores, signaling critical conceptual and application gaps emerging after Advanced Algebra.

This pattern qualifies a clear research gap: despite advanced algebra's significant correlation with subsequent courses like Calculus 1, 2, and Differential Equations—confirming its foundational role—targeted interventions remain underexplored to arrest performance drops and bridge these gaps.

These findings reveal that while early algebra proficiency predicts later success (Albarico et al., 2024), the observed sophomore decline highlights an implementation gap in curriculum sequencing. Future studies should investigate bridging strategies, such as integrated reviews, to leverage algebra's predictive strength against attrition risks (Zoto et al., 2021).

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CHAPTER SIX
CONCLUSIONS

The following are the conclusions for the study that are based on the previously presented findings and their implications.

Civil engineering sophomores predominantly male STEM graduates, reflecting typical engineering demographics at University of La Salette, Inc.

Civil engineering sophomores demonstrate strong advanced algebra proficiency, establishing a solid foundation unaffected by K-12 transitions.

The academic performance of the civil engineering sophomores declines progressively in higher engineering math, indicating conceptual and application gaps post-algebra.

The advanced algebra proficiency across the sex and strands demographic profiles do not predict performance.

The advanced algebra significantly correlates with subsequent courses, confirming its foundational role despite performance drops.

The intervention program targeted remediation bridges gaps, enhancing engineering math outcomes per DG 4.

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RECOMMENDATIONS

Based on the results and conclusions of this study, the following recommendations are offered to improve the academic performance of the students and future researcher:

- It is recommended to conduct a bridging program for non-STEM graduates (HUMSS, ABM, TECH-VOC) in Advanced Algebra and the engineering mathematics subject to support diverse enrollment.
- Develop enrichment modules for complex problem-solving to boost very good to excellent performance.
- Implement mandatory diagnostic-driven bridging courses before Calculus 1, focusing on limit-derivative transitions and application skills to prevent performance declines across the math sequence.
- Develop gender-neutral interventions such as peer tutoring and algebra workshops to sustain equitable performance across sexes, focusing on common challenges like equation solving regardless of respondent demographics.
- Implement strand-diagnostic algebra enhancement programs, such as diagnostic assessments and remedial modules, to maintain performance parity while addressing universal challenges in equation solving and applications common to all entrants.
- Implement diagnostic assessments at the start of each mathematics course to identify and address subject-specific gaps, rather than assuming progression from prior coursework, ensuring targeted support for civil engineering students' varying needs in algebra and calculus applications.

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APPENDIX A
APPROVED LETTER TO CONDUCT THE STUDY

July 16, 2025

REV. FR. FRANKLIN G. PICIO, MS, Ph.D
University President
University of La Salette, Inc.
Dubinan East, Santiago City, 3311

Dear Father,

Greetings in the name of Our Lady of La Salette!

The undersigned is currently completing a thesis titled **"ADVANCED ALGEBRA PROFICIENCY AND ACADEMIC PERFORMANCE OF CIVIL ENGINEERING SOPHOMORE STUDENTS IN ENGINEERING MATHEMATICS"** as a graduate student at the University of La Salette, Inc. in order to partially fulfill the requirements for the Master of Arts in Education major in Mathematics.

In line with this, I humbly request permission from your office to conduct my study at your institution, specifically with your students in the College of Engineering and Architecture. If granted, rest assured that the identity of the respondents will be limited to the scope of this request and shall be kept with utmost confidence.

I look forward to your positive response regarding this matter. Thank you, and more power.

Respectfully,

KRISELLE B. OBENA, LPT
Researcher

Noted by:

MELISSA B. BACENA, MAED, MOM
Adviser

Approved by: 7/16/2025

REV. FR. FRANKLIN G. PICIO, MS, Ph.D
University President

APPENDIX B
APPROVED LETTER TO THE REGISTRAR

July 16, 2025

ARNOLD A. DULDULAO, MBM
University Registrar
University of La Salette, Inc.
Dubinan East, Santiago City, 3311

Dear Sir:

Subject: Request for Enrollment Data of Civil Engineering Sophomore Students School Year 2024-2025 and their Academic Performance

Greetings of Peace and Prosperity!

I am Master of Arts in Education major Mathematics Students conducting a thesis entitled **"Advanced Algebra Proficiency and Academic Performance of Civil Engineering Sophomore Students in Engineering Mathematics."** As part of my study, I need to determine the sample size based on the total number of sophomore engineering students and their academic performance to investigate how the advanced algebra influence the success in engineering mathematics as basis for intervention program.

In line with this, may I humbly request a copy of the list of sophomore students enrolled in Bachelor of Science in Civil Engineering School Year 2024-2025 and their academic performance in the following subjects:

1. PCEA 020 – Advance Engineering Algebra
2. PCEA 001 – Calculus 1
3. PCEA 002 – Calculus 2
4. PCEA 005 – Differential Equations
5. PBSCE 010 Lec/Lab – Numerical Solutions of Civil Engineering Problem

Rest assured that all information obtained will be handled with strict confidentiality and used solely for academic and research purposes.

I hope for your kind assistance and approval regarding this matter.

Thank you very much for your support and consideration.

Sincerely yours,

KRISELLE B. OBENA, LPT
Researcher

Noted by

MELISSA B. BACENA, MAED, MOM
Adviser

Approved by

ARNOLD A. DULDULAO, MBM
University Registrar

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APPENDIX C
LETTER TO THE RESPONDENTS

Dear Respondents:

The undersigned is presently conducting thesis entitled, "ADVANCED ALGEBRA PROFICIENCY AND ACADEMIC PERFORMANCE OF CIVIL ENGINEERING SOPHOMORE STUDENTS IN ENGINEERING MATHEMATICS" as a partial requirement for the degree Master of Arts in Education major in Mathematics.

The researcher is earnestly soliciting your support, cooperation, and precious time to complete the survey questionnaire the way you feel in responding to the questions raised.

Rest assured that all answer will be treated with the highest form of confidentiality.

Your cooperation is one thing I will look back to

Thank you and God Bless

KRISELLE B. OBENA

Researcher

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APPENDIX D
INFORMED CONSENT

Title of the Study: Advanced Algebra Proficiency and Academic Performance of Civil Engineering Sophomore Students in Engineering Mathematics

Researcher: Kriselle B. Obena

Institution: University of La Salette, Incorporated

Contact Information: obenakrisellebueno@gmail.com / +63 953 371 1218

➢ *Purpose of the Study*

You are invited to participate in a research study that aims to improve the mathematical proficiency in learning the advanced algebra especially the engineering student's performance of students based on their grades. The purpose of this study is to investigate how the advanced algebra influenced the success in engineering mathematics subjects as basis for intervention program.

➢ *Procedures*

If you agree to participate, the researchers will request access to your academic records specifically related to your grades in selected subjects (e.g., Advanced Algebra, Engineering Mathematics). These grades will be obtained from the registrar or relevant department with your explicit consent.

➢ *Confidentiality*

All information collected will be kept strictly confidential. Your identity will not be disclosed in any publication or presentation resulting from this study. Data will be coded and stored securely to protect your privacy.

➢ *Voluntary Participation*

Your participation is entirely voluntary. You may decline to participate or withdraw from the study at any time without penalty or loss of benefits to which you are otherwise entitled.

➢ *Risks and Benefits*

There are no known risks associated with participating in this study. While there may be no direct benefit to you, your participation may help improve educational practices and academic support strategies.

➢ *Consent*

By signing below, you confirm that:

You have read and understood the information provided above.

You voluntarily agree to allow the researcher to access your academic grades for the purpose of this study.

You understand that you may withdraw your consent at any time.

Student's Name: ____

Student's Signature: ____________________________________

Date: ____