ANALYSIS OF THE EXTENT OF READINESS OF GRADE 10 STUDENTS IN TAKING BASIC CALCULUS OF SENIOR HIGH SCHOOL STEM STRAND: A NEXUS WITH CHEMISTRY EDUCATION

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Abstract

This quantitative research study aims to evaluate the level of preparedness of Grade 10 students for Basic Calculus in the Senior High School STEM strand and explore its implications for chemistry education. The study highlights the importance of understanding prerequisite competencies to avoid conflicts in learning and identifies the least mastered topics through data obtained from teacher-respondents and assessment tests. Specifically, Skills in Factoring, Skills in Solving Equations, and Skills in Solving Trigonometric Identities were found to be the students' least mastered skills, along with difficulties in certain topics under Skills in Solving Arithmetic Operations and Solving Problems Involving Functions. These findings have significant implications for chemistry education, as calculus skills are crucial in comprehending quantitative aspects of chemistry. The study suggests bridging programs and collaboration with math teachers to enhance students' mathematical readiness, ensuring a seamless transition to more advanced chemistry topics. Addressing these implications can lead to improved student performance and engagement in chemistry, ultimately fostering a strong foundation for their future studies and careers in STEM-related fields. Additionally, collaborating with math teachers to reinforce these critical mathematical skills can enhance students' readiness for more advanced chemistry topics and create a more seamless transition from Basic Calculus to chemistry concepts. Ultimately, addressing these implications can lead to improved student performance and engagement in chemistry, ensuring a stronger foundation for their future studies and careers in STEM-related fields.

Keywords: Basic Calculus, Readiness, Mathematics, Prerequisite Skills, Chemistry.

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1. Introduction

In today's rapidly advancing world, science, technology, engineering, and mathematics (STEM) education plays a critical role in a nation's progress towards industrialization and innovation. As such, providing students with effective scientific and mathematical education has become a top priority for educational systems worldwide. In response to the growing demand for highly skilled professionals in STEM fields, various countries have implemented reforms to enhance their education systems. One such reform is the introduction of Senior High School (SHS) programs, which aim to equip students with specialized skills and knowledge in their chosen career paths. Within the SHS STEM strand, Basic Calculus holds particular importance, as it forms the foundation for understanding various mathematical concepts vital in scientific disciplines like chemistry. Seeking the level of readiness of Grade 10 students in taking Basic Calculus within the Senior High School STEM strand and explore its convergence with chemistry education. By identifying students' mathematical strengths and weaknesses, educators can tailor teaching strategies to improve their preparedness for the advanced subjects in chemistry, ultimately fostering a well-rounded and capable generation of future scientists, engineers, and innovators. A nation that has educated its people in science and mathematics is progressing toward industrialization. In order to provide citizens with these skills, effective scientific and mathematics education is required, which can be attained by giving a nation's educational system top priority. Republic Act No. 10533 also known as the Enhanced Basic Education Act of 2013 paved the way for the implementation of the K to 12 Education in the Philippines. Senior High School (SHS). This act focuses in upgrading the 10 – year basic education to a 12 – year program. It introduced Senior High School which is from Grade 11 to Grade 12 in the country`s educational system (Lazaro, 2013).

Calculus as a Subject

In Senior High School, Grade 10 students choose their strand that is inclined according to their course of choice and their career path. These strands are under Sports Track, Arts and Design Track, and Academic Track. STEM is under the academic track alongside ABM, HUMSS, and GAS strand. In every strand, Grade 11 students are required to take two math subjects, General Mathematics and Statistics and Probability, as part of their major subjects. Meanwhile, STEM students need to study two more specialized subjects, which are Pre-Calculus and Basic Calculus (Herrera & Dio, 2016).

Calculus is one of the curriculum subjects taught in the Science, Technology, Engineering, and Mathematics (STEM) strand in Senior High School. It is a branch of Mathematics that deals with the analysis of rate changes. All math was stable prior to the advent of Calculus: it could only be used to measure objects that were perfectly still (Russell, 2020). As stated by Berggren (2021), Calculus is a field of Mathematics that deals with the computation of immediate level of alteration, also known as Differential Calculus; and the addition of an unlimited number of minor variables to conclude at a single result, also known as Integral Calculus. In the 1700s, two mathematicians, Isaac Newton of England and Gottfried Wilhelm Leibniz of Germany, were associated with simultaneously developing Calculus.

Calculus as a branch of mathematics was developed in response to the requirement to understand continually changing values. According to Muzangwa and Chifamba (2012), it deals with the infinitely small and infinitely big quantities of a function. The majority of undergraduate degrees in science, technology, and engineering require calculus fundamentals. Calculus ideas that students conceptually understand have an impact on their performance and engagement in various subjects as well as in mathematics. Future scientists, technologists, mathematicians, and engineers need to be produced in this fashion, according to Bressoud et al., (2013), Carlson & Oehrtman (2005), Kinley (2016), Roble (2017), and Sadler & Sonnert (2016). As a result, it is crucial that this subject be grasped in order to produce citizens who can participate in the production and service sectors with advanced academic knowledge and vocational abilities. Calculus serves as a device that enables people to do more than they could in earlier mathematics courses (Kelley, 2006; Roble, 2017; Sadler & Sonnert, 2016).

Research has indicated the importance of calculus knowledge for undergraduate programs in science and technology fields. Unfortunately, one of the main challenges faced by students who join science and technology fields is their knowledge of calculus concepts. The study of Sebsibe (2019) concludes with implications for practice that includes the use of students` errors and misconceptions as an opportunity for progression. Besides, students should be assisted to make sense of concepts through real-life problems, including training teachers in problem-solving approaches and mathematical thinking practice.

Calculus may be a tough subject for certain students; consequently, students who pursue Calculus need to

be ready on the pre-requisite skills in such a way that the difficulties they will encounter will be lessened. Students may therefore encounter difficulty if they are missing the essential expertise for a specific lesson. According to Sampang and Moseros (2005) , revamping diagnostic tests as tools for developmental assessment when they learned that command of prerequisite abilities at a given level, equips the student to handle the higher standards for more challenging concepts and applications in the level after that. In light of this examining the learners of the prerequisites could largely contribute on their own learning. Once these skills are already mastered by the learners, building up the new concepts and skills on the prerequisites and on what they already knew would result to optimal learning.

Chemistry as a Subject

Chemistry is a scientific discipline that explores the composition, structure, properties, and transformations of matter. It is a branch of physical science that plays a fundamental role in understanding the world around us. In chemistry, students study the interactions between atoms, molecules, and ions, as well as the reactions and energy changes that occur during chemical processes. The subject covers a wide range of topics, including chemical bonding, chemical reactions, stoichiometry, thermodynamics, kinetics, and much more.

Chemistry is a central science that connects and overlaps with other scientific fields, such as biology, physics, environmental science, and materials science. It serves as the foundation for various industries and technologies, including pharmaceuticals, agriculture, energy, materials, and environmental management. Moreover, chemistry provides critical insights into the behavior of matter at the molecular and atomic levels, helping to explain natural phenomena and human-made processes.

In educational settings, chemistry is typically taught through a combination of theoretical knowledge and practical laboratory work. Students learn to analyze and interpret experimental data, perform chemical calculations, and understand the underlying principles that govern chemical behavior. Chemistry education emphasizes critical thinking, problem-solving, and the development of scientific skills, preparing students for careers in research, medicine, engineering, and various other fields.

The subjects of Calculus and Chemistry share a significant connection, especially in the context of the Senior High School STEM strand. Calculus provides essential mathematical tools for understanding the rate changes and continuous variations in chemical processes, making it indispensable for students pursuing Chemistry education. However, the challenges students face in mastering Calculus concepts can hinder their readiness for advanced chemistry subjects. To reconcile this, educators should collaborate to reinforce foundational mathematical skills in students and provide real-life problem-solving opportunities, ensuring a seamless transition from Basic Calculus to chemistry concepts. By addressing these concerns, students can be better equipped to excel in both subjects, laying a strong foundation for their future studies and careers in STEM-related fields.

Status of Filipino Mathematical Literacy

Filipino students in almost nationwide are situated at low level of performance in Mathematics. This assertion is corroborated by the nation's high schools' poor performance on the National Achievement Test (NAT), which fell from 50.7% in the school year 2007–2008 to 46.3% in the school year 2011–2012.b of 142 states in the Global Competitiveness Report (Jefferson, 2014). A study by Capuno et al. (2019) shows that the Philippines ranked 79th out of 138 participating countries in the 2016-2017 Global Competitiveness Report in terms of Science and Mathematics education. This corresponds to the Department of Education's results of the National Achievement Test (NAT) concluding that the average percentage score in Math is about 46.63% which is less than the 50 percent requirement of DepEd. This may contribute to the conclusion that for the previous years, students are less likely to be ready for math-related subjects for the STEM strand, especially Basic Calculus. This problem can't be avoided easily as it can be a factor in worse educational development of the country.

Pura (2016) found out in her study on Least Learned Mathematical Skills of Students that the level of proficiency of the students in five mathematical skills, namely describing, performing operations, solving worded problems and illustrating is all at the beginning level. Ereno and Benvidez (2022) in their study about the least learned competencies of the students as revealed by their reflections the selected topics in mathematics were solving problems along permutation, combination, and circles, proving theorems, finding the equation, and plotting of points and graphing of circles. Perante (2022) in his study about the least mastered competencies, results showed that for the Pre-Calculus subject: Analytic Geometry, analyzing conic sections like parabola, circles, and hyperbola are the weaknesses of students, For Series and Mathematical Induction,

Evaluating Summation or Sigma Notation and Proving by Mathematical Induction were the least mastered competencies of the respondents. Additionally, for Trigonometry, Trigonometric Identities, Graphing Sine and Cosine Functions, and Solving Trigonometric Equations were the least mastered competencies.

With the cited results, students do not meet the required prerequisite competencies needed because of time shortage in teaching Mathematics in lower grades, the students do not necessarily acquire the basic knowledge for important topics that are fundamental for their advanced Math subjects. Other schools only introduce the said topics to students and do not elaborate on them further due to a lack of time for them to tackle those topics. This results in the lack of preparation of students in Mathematics, because not all students were able to obtain the prerequisite competencies for their advanced Math subjects.

Some of the skills that must be learned in JHS consist of three main branches of Mathematics which are Algebra which contains Arithmetic Operations, Factoring, Solving Equations, and Solving Problems Involving Functions; Geometry which includes Graphing on Cartesian Plane, Solving Involving Volumes, Areas, and Perimeters; and Trigonometry which circles the topics Solving Using Trigonometry, and Solving Trigonometric Identities as identified by the DepEd's learning competencies.

As reflected in the curriculum guide of the Department of Education, Grade 10 students are expected to have a deeper understanding of the pre-requisite competencies in Basic Calculus such as Algebra, Geometry, and Trigonometry while Grade 12 students are expected to be competent in pre-calculus and basic calculus which provides them with conceptual understanding and computational skills that are crucial for their future STEM courses.

Based on the cited literature and studies, the researcher wants to evaluate the extent of readiness of Grade 10 students in taking advanced mathematics subjects like calculus in taking the STEM strand under the Senior High School Program. This will serve as a guide for both Grade 10 and Basic Calculus teachers to determine what learning competencies they need to focus more on their math instruction in order to enhance the readiness and preparedness of students in taking the subject. If an unmastery of skills is diagnosed in the previous level, interventions such as bridge or review programs must be implemented in order to avoid more learning difficulties and problems in the future.

The findings of this study on the extent of readiness of Grade 10 students in taking advanced mathematics subjects like calculus in the STEM strand have direct implications for chemistry teaching. As calculus plays a crucial role in understanding and solving complex mathematical problems, its proficiency is essential in comprehending various quantitative aspects of chemistry, such as stoichiometry, chemical kinetics, and thermodynamics. However, the identified weaknesses in algebra, geometry, and trigonometry skills can hinder students' ability to handle mathematical aspects of chemistry effectively. Chemistry teachers need to be aware of these specific areas of weakness and design targeted interventions to support students in developing their mathematical abilities for better comprehension and application of chemistry principles. By addressing these implications, educators can create a more conducive learning environment for chemistry students in the Senior High School STEM strand, equipping them with the essential skills to excel in both mathematics and chemistry and fostering a stronger foundation for their future studies and careers in STEM-related fields.

Point of Convergence on Basic Calculus and Chemistry Education

The point of convergence between the analysis of Grade 10 students' readiness in taking Basic Calculus and chemistry education lies in the significance of mathematical skills for success in both subjects. Basic Calculus is a branch of mathematics that deals with the analysis of rate changes and the computation of instantaneous rates of alteration, while chemistry involves various quantitative aspects that often require the application of calculus concepts.

In the Senior High School STEM strand, students who choose chemistry as their focus subject must be prepared to handle mathematical calculations in areas such as stoichiometry, reaction rates, and thermodynamics. Therefore, the extent of students' readiness in Basic Calculus directly impacts their ability to comprehend and solve complex chemistry problems that involve mathematical reasoning.

The identified weaknesses in Grade 10 students' mathematical skills, such as Skills in Factoring, Skills in Solving Equations, and Skills in Solving Trigonometric Identities, are particularly relevant to chemistry education. For instance, factoring plays a crucial role in simplifying chemical equations, solving equations is essential in equilibrium

calculations, and trigonometric identities are used in analyzing wave properties in spectroscopy.

Chemistry teachers need to recognize and address these specific areas of weakness, collaborating with math teachers to reinforce fundamental mathematical concepts that are applicable in chemistry. By providing targeted support and interventions, teachers can enhance students' mathematical readiness, facilitating a seamless transition into chemistry topics that require calculus skills.

The point of convergence emphasizes the importance of a holistic and integrated approach in education, where mathematical concepts are linked to their applications in chemistry. It highlights the need for collaborative efforts between math and chemistry teachers to ensure that students are well-prepared for the challenges of both subjects and equipped with the necessary skills to excel in their STEM education and future careers. By recognizing and addressing the interplay between mathematical readiness and chemistry education, educators can foster a stronger foundation for students' academic and professional growth in the STEM field.

Conceptual Framework

Figure 1 shows the conceptual framework of the study which illustrates the process of assessing students` readiness in taking Basic Calculus considering the prerequisite learning competencies that they need in the field of Algebra, Geometry, and Trigonometry. The input frame consists of students` determined skills required in taking Basic Calculus. The process frame provides assessment of students` readiness in taking the said subject in the lens of their Grade 10 teachers and Basic Calculus teachers. Lastly, the output frame shows the result of evaluation of students. Readiness in taking Basic Calculus.

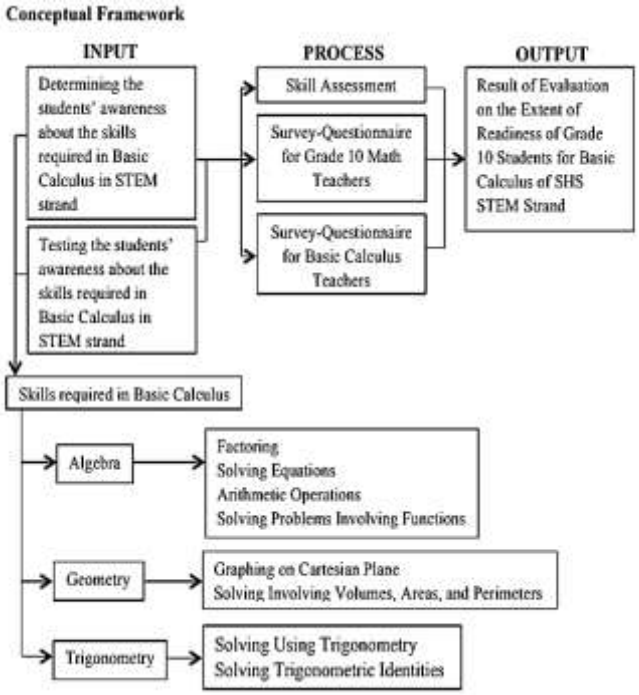

Figure 1. Paradigm of the Study

Objectives of the Study

This study generally aims to determine the extent of readiness of Grade 10 students in Basic Calculus for Senior High School. The following are specific objectives: (1) identify the extent of readiness of the Grade 10 students as assessed by the Grade 10 teacher-respondents, (2) identify the extent of readiness of the Grade 10 students based on their prerequisite competencies as assessed by the Basic Calculus teacher-respondents, (3) determine the extent of readiness of the Grade 10 students in Basic Calculus of SHS relative to the identified pre-requisite competencies, (4) identify the least mastered skills among the identified pre-requisite competencies needed for the Basic Calculus subject, and (5) determine the significant difference between Grade 10 Math teachers and Basic Calculus teachers' assessment on students' readiness in taking Basic Calculus.

2. Methods

Research Design: Quantitative Descriptive Research was utilized in this study. Descriptive research is useful for identifying characteristics, frequencies, trends, and categories accurately and systematically (McCombes, 2020). Quantitative descriptive is the most efficient design to utilize in the study since it deals with acquiring quantifiable data for statistical analysis of a population sample. It will identify the students' least mastered prerequisite skills and their knowledge progress using data collection through surveys. The study aims to determine the readiness of Grade 10 students for the Basic Calculus of STEM strand.

Participants: The respondents of the study consisted of 300 Grade 10 students; the students were selected based on the predetermined criteria that they are planning to take the STEM strand in Senior High School. They were selected through simple random sampling technique since there are many students who really want to take STEM in Senior High School. A simple random sampling technique is one in which every person in the population has an equal probability of being selected as a sample (Thomas, 2020). Further, purposive sampling was utilized in selecting math teacher-respondents. Ten (10) Grade 10 Math teachers, with at least five years of experience teaching the said subject; and other ten (10) Basic Calculus teachers with at least three years of experience in teaching the said subject and are all currently teaching these subjects this academic year. According to Robinson (2014), purposive sampling is a sampling approach in which the researcher chooses members of the population to participate in the study based on their judgment. The researcher decided to survey the Grade 10 students for the reason that they will be the incoming Grade 11 students that will have the opportunity to take Basic Calculus; while the Grade 10 Math teachers and Basic Calculus teachers were also part of the respondents of the study because, through their years of teaching, they can determine the advancement of the students. The responses of both teachers and students served as a crucial foundation for the flow and completion of the study.

3. Materials

The researcher used DepEd's learning competencies as a basis for determining the prerequisite topics which were included in the instrument. The researcher also used a self-made assessment test for students covering all topics relevant to the prerequisite learning competencies in calculus. The instrument passed the validity test having a content validity index (CVI) of 1.00 wherein based on the result all three (3) selected expert validators agreed that all of the items of the instrument are relevant to what the researcher wants to determine. The instrument also passed its reliability with Kuder Richardson rating of 0.811 for the test given to student-respondents and Cronbach alpha of 0.944 and 0.851 for the questionnaires administered for Grade 10 math teachers and Basic Calculus teachers.

Procedure: The researcher sought first permission to conduct the study by securing a formal letter addressed to the DepEd School Superintendent thru the Education Program Supervisor (EPS) of Mathematics. Upon approval, the instruments were administered to the target respondents via Google Forms. Links were provided with the approved letter and purpose of the study to the principals. The researcher explained to the principals that the respondents have the right not to participate in the study. After the collection process, data were collected, tallied, analyzed, and interpreted by the researcher.

4. Results and Discussion

The Grade 10 teacher-respondents assess the extent of readiness of their Grade 10 students in taking Basic Calculus subject in SHS

Table 1 Grade 10 Math Teachers' Assessment of Prerequisite Topics for Grade 10 Students

Prerequisite Topic	M	SD	Verbal Interpretation
Algebra			
I. Pre-requisite Skills of Arithmetic Operations			
Perform Fundamental Operations on Integers	3.60	1.17	High Level
Perform Fundamental Operations on Fractions	2.90	0.99	Moderate Level
Perform Fundamental Operations on Decimals	3.10	0.99	Moderate Level
Evaluating a Given Numerical Expression Following the Order of Operations	3.30	1.25	Moderate Level
II. Pre-requisite Skills of Factoring			
Factor Linear Expressions	3.10	1.29	Moderate Level

Factor Quadratic Expressions	3.20	1.14	Moderate Level
Factor Polynomial Expressions	3.10	0.99	Moderate Level
Factor Sum and Difference of Two Cubes	3.20	1.14	Moderate Level
Factor Difference of Two Squares	3.10	1.10	Moderate Level
III. Pre-requisite Skills of Solving Equations			
Apply Properties of Equality	3.20	1.14	Moderate Level
Add and Subtract Polynomial Expressions	3.70	1.06	High Level
Multiply and Divide Polynomial Expressions	3.30	1.16	Moderate Level
IV. Pre-requisite Skills of Solving Problems Involving Functions			
Graph Functions	3.00	0.67	Moderate Level
Evaluate Functions	3.50	1.08	High Level
Identify the Domain and Range of a Function	3.30	1.25	Moderate Level
Illustrate Functions and Function Notations	3.20	1.14	Moderate Level
Geometry			
I. Pre-requisite Skills of Graphing on Cartesian Plane			
Identify the Parts of Cartesian Plane	4.10	0.88	High Level
Locate Points in Cartesian Plane	4.00	0.82	High Level
Evaluate Algebraic Expressions	3.50	0.97	High Level
II. Pre-requisite Skills of Solving Involving Volumes, Areas, and Perimeters			
Identify the Dimensions of Two-Dimensional and Solid Figures	3.50	0.97	High Level
Convert Measurement from One Unit to Another	3.60	0.97	High Level
Evaluate Algebraic Expressions	3.40	0.84	High Level
Trigonometry			
I. **Pre-requisite Skills of Solving Using Trigonometr**y			
Identify the Parts of a Triangle	4.20	0.79	Very High Level
Apply Pythagorean Theorem	3.70	0.95	High Level
Evaluate Algebraic Expressions	3.50	0.85	High Level
II. Pre-requisite Skills of Solving Trigonometric Identities			
Simplify Trigonometric Expressions Using Identities	2.70	0.82	Moderate Level
Total	**3.38**	**1.02**	**Moderate Level**

Table 1 presents the Grade 10 Math educators' assessed prerequisite topics for Grade 10 students. It can be observed in the table that the respondents have a moderate level of readiness in the majority of the topics. The highest gained mean value among the topics that got the assessment of moderate level of readiness is 3.30 which are Evaluating a Given Numerical Expression Following the Order of Operations (SD = 1.25), Identifying the Domain and Range of a Function (SD = 1.16), and Multiply and Divide Polynomial Expressions (SD = 1.25). The table also shows that the respondents have a high level of readiness receiving 4.10 (SD = 0.88) as the highest mean in the said level of readiness; the topic under this mean value is Identifying the Parts of Cartesian Plane. The last level of readiness is the very high level which received 4.20 (SD = 0.79) that is Identifying the Parts of a Triangle. The lowest mean score was 2.70 (SD = 0.82) in the area of Trigonometry, under the topic of Simplifying Trigonometric Expressions Using Identities, while the highest mean value was 4.20 (SD = 0.79) in the same area but under a different topic, which is Identifying Triangle Parts. The overall mean score of the assessment of Grade 10 Math teachers is 3.38 (SD = 1.02) which indicates that the level of readiness of the Grade 10 students for Basic Calculus is moderate. In the study of Rahman et. al (2017), the student's performance could be improved when they are evaluating numerical expressions following the order of operations. Additionally, it was observed that some students' methods for constructing their work solutions had changed, while other students continued to struggle to perform basic calculations. Results from the study of Carlson et. al. administering the CCR to first semester calculus students at the beginning of the semester revealed severe weaknesses in students' foundational knowledge and reasoning abilities for learning calculus.

The Basic Calculus teacher-respondents assess the extent of readiness of Grade 10 students based on their prerequisite competencies

Table 2 Basic Calculus Teachers' Assessment of Prerequisite Topics for Grade 10 Students

Prerequisite Topic	M	SD	Verbal Interpretation
Algebra			
I. Pre-requisite Skills of Arithmetic Operations			
Perform Fundamental Operations on Integers	4.20	0.79	Very High Level
Perform Fundamental Operations on Fractions	3.00	0.67	Moderate Level
Perform Fundamental Operations on Decimals	3.40	0.52	High Level
Evaluating a Given Numerical Expression Following the Order of Operations	4.00	0.67	High Level
II. Pre-requisite Skills of Factoring			
Factor Linear Expressions	3.40	1.07	High Level
Factor Quadratic Expressions	3.00	0.67	Moderate Level
Factor Polynomial Expressions	3.20	0.79	Moderate Level
Factor Sum and Difference of Two Cubes	3.20	0.79	Moderate Level
Factor Difference of Two Squares	3.00	0.67	Moderate Level
III. Pre-requisite Skills of Solving Equations			
Apply Properties of Equality	3.40	1.26	High Level
Add and Subtract Polynomial Expressions	4.40	0.84	Very High Level
Multiply and Divide Polynomial Expressions	3.60	1.07	High Level
IV. Pre-requisite Skills of Solving Problems Involving Functions			
Graph Functions	3.40	0.52	High Level
Evaluate Functions	4.40	0.84	Very High Level
Identify the Domain and Range of a Function	3.40	1.07	High Level
Illustrate Functions and Function Notations	3.60	0.52	High Level
Geometry			
I. Pre-requisite Skills of Graphing on Cartesian Plane			
Identify the Parts of Cartesian Plane	4.40	0.84	Very High Level
Locate Points in Cartesian Plane	4.60	0.84	Very High Level
Evaluate Algebraic Expressions	4.40	1.26	Very High Level
II. Pre-requisite Skills of Solving Involving Volumes, Areas, and Perimeters			
Identify the Dimensions of Two-Dimensional and Solid Figures	3.40	1.26	High Level
Convert Measurement from One Unit to Another	3.20	1.03	Moderate Level
Evaluate Algebraic Expressions	3.80	1.23	High Level
Trigonometry			
I. Pre-requisite Skills of Solving Using Trigonometry			
Identify the Parts of a Triangle	3.80	0.79	High Level
Apply Pythagorean Theorem	3.60	1.26	High Level
Evaluate Algebraic Expressions	3.40	1.43	High Level
II. Pre-requisite Skills of Solving Trigonometric Identities			
Simplify Trigonometric Expressions Using Identities	2.40	0.52	Low Level
Total	**3.60**	**0.89**	**High Level**

Table 2 shows the assessed prerequisite topics for Grade 10 students by Basic Calculus teachers. It can be observed in the table that the respondents have a high level of readiness in the majority of the topics. The highest gained mean value among the topics that got assessment of high level of readiness (M=4.00, SD = 0.67). The table also shows that the respondents have a very high level of readiness receiving 4.60 mean value (SD = 0.84) as the highest mean value in the said level of readiness; the topic under this mean value is Locating Points in Cartesian Plane. The topics Factoring Polynomial Expressions (SD = 0.79), Factoring Sum and Difference of Two Cubes (SD = 0.79), and Convert Measurement from One Unit to Another (SD = 1.03) are under moderate level of readiness gathering 3.20 as the highest mean value received in this level of readiness; while Simplifying Trigonometric

Expressions Using Identities has a low level of readiness with a mean value of 2.40 (SD = 0.52). The lowest mean value is 2.40 (SD = 0.52) in the field of Trigonometry under the subtopic of Simplifying Trigonometric Expression Using Identities, while the highest mean score obtained was 4.60 (SD = 0.84) in the area of Geometry under the subtopic of Locating Points in a Cartesian Plane. The overall mean score of the Basic Calculus teacher's assessment is 3.60 (SD = 0.89) which pertains to having a high level of readiness which means the Grade 10 students are proficient in taking Basic Calculus subject. As mentioned by Orhun (2015), a study found that students' understanding of trigonometry did not develop as observed and that students have difficulty in completing Trigonometry problems. Some researchers have indicated that students have misunderstandings, errors, and learning challenges when it comes to trigonometry. Students have a poor performance level and have more problems studying Trigonometry, as indicated by the low average score of 21.19 out of 50 for all student participants. Therefore, there's a difficulty for students in learning Trigonometry based on their achievement test (Adhikari & Subedi, 2021).

Grade 10 Students` Extent of Readiness in Senior High School Basic Calculus relative to the identified pre-requisite competencies assessment

Table 3 Level of Readiness of Grade 10 Students in taking Basic Calculus based on their Test Scores

Level of Readiness	N	%	Mean	SD	Verbal Description
Very High (21 – 26)	19	6.33	**13.87**	**6.00**	**Moderate Level**
High (16– 20)	70	23.33			
Moderate (11 – 15)	88	29.33			
Low (6 – 10)	105	35			
Very Low (0 – 5)	18	6			
Total	**300**	**100%**			

Table 3 indicates how prepared Grade 10 students are to take Basic Calculus based on their scores they got in taking the assessment test. Result reveals that the Grade 10 students are moderately ready in taking Basic Calculus in Senior High School (M=13.87, SD = 6.00). Data also reveal that there is a high percentage of students who are situated at low level of readiness in Basic Calculus. This students' level of readiness to learn might be affected by low emotional or physical maturity, as well as challenging personal situations. On the other hand, medium-scoring students may have moderate or high abilities in learning, but for some reason they may require some improvement in learning preparation (Promethean, 2017).

Least Mastered Skills among the Identified Pre-requisite Competencies Needed for Basic Calculus

Table 4 Identifying the Least Mastered Skills of the Students among the Prerequisite Topics Needed for Basic Calculus

Prerequisite Topic	No. of items	Mean	%	Verbal Interpretation
Algebra				
Pre-requisite Skills of Arithmetic Operations	4	2.39	59.75%	Moderate level
Pre-requisite Skills of Factoring	5	2.15	43%	Moderate level
Pre-requisite Skills of Solving Equations	3	1.05	35%	Low Level
Pre-requisite Skills of Solving Problems Involving Functions	4	2.20	55%	Moderate level
Geometry				
Pre-requisite Skills of Graphing on Cartesian Plane	3	1.79	59.67%	Moderate level

Pre-requisite Skills of Solving Involving Volumes, Areas, and Perimeters	3	1.65	55%	Moderate level
Trigonometry				
Pre-requisite Skills of Solving Using Trigonometry	3	2.22	74%	High Level
Pre-requisite Skills of Solving Trigonometric Identities	1	0.40	40%	Low Level

Table 4 presents that according to the student's assessment exam results, a lot of students struggle as they scored less than 50% on some prerequisite topics needed for Basic Calculus such as Prerequisite Skills in Factoring (43%) and Prerequisite Skills in Solving Equations (35%) both under Algebra and Solving Trigonometric Identities (40%) under Trigonometry. In a broader view, the performance of the students based on the score mean percentage in their assessment of every classification of Mathematics shows that the students are struggling most in Algebra scoring 7.79 out of 16 items (48.69%). In addition, their performance in Geometry and Trigonometry scored 3.44 out of six items (57.33%) and 2.62 out of four items (65.50%), respectively. According to Wati et al. (2018), students with high Math performance have no challenges, students with medium Math achievement have factual difficulties, and students with poor Math achievement have factual, conceptual, operational, and principle difficulties, according to the findings. Also, a relevant teaching technique is required to assist students in overcoming their challenges in solving linear equation problems. Students have a very low understanding when it comes to solving problems involving trigonometry, particularly the application of trigonometry. Many of the students struggled to specify variables, let alone correctly articulate mathematical propositions, resulting in mistakes. The majority of students struggled with trigonometric problems, as seen by the number of students (45.6 %) who made errors in their processing skills and were unable to obtain the correct answer (Arhin & Hokor, 2021).

Is there a significant difference between Grade 10 Math teachers and Basic Calculus teachers' assessment on students' readiness in taking Basic Calculus?

Table 5Test of Significant Difference between Grade 10 Math Teachers and Basic Calculus Teachers on Students` Readiness` in taking Basic Calculus Subject

Group	M	SD	t	p-value	Decision
Grade 10 Math Teachers	3.58	0.43	-0.48	0.64	Not Significant
Basic Calculus Teachers	3.69	0.63			

Table 5 presents the analysis of the difference between the assessment of Grade 10 Math teachers and Basic Calculus teachers regarding the readiness of Grade 10 students in taking Basic Calculus subjects when they enter Senior High School. It can be observed on the table that Basic Calculus have slightly higher assessment than Grade 10 Math teachers about the readiness of Grade 10 students who prepare to take the STEM strand for their SHS. The difference is said to be not significant since the computed p-value 0.64 is not lesser than 0.50 level of significance. This only shows that Grade 10 Math teachers and Basic Calculus teachers have the same assessment about the readiness of Grade 10 students relative to the prerequisite topics needed for taking Basic Calculus.

5. Conclusion and Recommendations

Based on the findings of the study, it can be concluded that the least mastered skills of Grade 10 students who are planning to take STEM strand in in Senior High School are factoring and solving equations both under Algebra and solving trigonometric identities under Trigonometry. Moreover, it can be also concluded that Grade 10 mathematics teachers and basic calculus teachers have the same level of assessment on the least mastered skills of their students who will take Basic Calculus subject when they take Science, Technology, Engineering, and Mathematics strand in their Senior High School. Considering the results of the study, it can be recommended that a bridge program may be conducted to enhance the performance of students in taking their calculus

subject. Curriculum planners may also take the result of the study as reference or guide on what topics they need to focus on more and be aware of the problems the students are experiencing so that it could help them make a more effective curriculum guide that would effectively prepare the students for their advanced mathematics subjects. Grade 10 math teachers may enhance the quality and relevance of the instruction particularly in teaching the foundation of mathematics in the JHS level; while Basic Calculus teachers may diagnose the strengths and weaknesses of their students before discussing all of the competencies needed for Basic Calculus. On the other hand, students may watch and subscribe to tutorial online videos particularly on topics that they have a low level of performance. For the future researchers, they may conduct a longitudinal study to validate the results of this study.

Implications in Chemistry Education

The findings of this research study on the extent of psychological readiness of Grade 10 students in taking Basic Calculus have implications for chemistry teaching in the Senior High School STEM strand. The identified least mastered skills, such as Skills in Factoring, Skills in Solving Equations, Skills in Solving Trigonometric Identities, Skills in Solving Arithmetic Operations, and Solving Problems Involving Functions, indicate areas where students may struggle in grasping mathematical concepts, which are often fundamental in understanding advanced chemistry principles. Chemistry is a subject that frequently involves complex mathematical calculations, especially in stoichiometry, chemical equations, and quantitative analysis. Therefore, teachers should take into consideration the identified weaknesses in students' mathematical skills when designing and delivering chemistry lessons. They may incorporate relevant and practical chemistry examples to illustrate the application of these mathematical concepts, helping students understand the significance of their mathematical knowledge in real-world chemical scenarios. Additionally, the concept of bridging programs, as suggested in the study, can be applied in chemistry teaching as well. Before delving into advanced chemical concepts, teachers can provide review sessions or introductory lessons on basic mathematical principles relevant to chemistry. This approach can help refresh students' mathematical skills and build their confidence in applying these skills to chemistry problem-solving. Furthermore, the research highlights the importance of diagnosing students' strengths and weaknesses early on. Chemistry teachers can adopt formative assessment strategies to continuously monitor students' progress and understanding of both chemistry and mathematical concepts. By identifying areas where students are struggling, educators can provide targeted support and interventions, ensuring that students are adequately prepared for more complex chemistry topics that require mathematical proficiency.

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