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Analyzing the Errors of Senior High School STEM Students in Solving Basic Calculus Problems

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ABSTRACT

Students often make errors in solving mathematical problems, particularly in Basic Calculus. This study aimed to identify the types of errors encountered by STEM students in solving Basic Calculus problems at a Senior High School in a university in Northern Philippines. A descriptive qualitative design was used, and error analysis was conducted based on a ten-item researcher-made problem-solving test validated by experts. The errors were categorized as careless errors, conceptual errors, encoding errors, and unfamiliarity errors, with conceptual errors—particularly violations of the Power Rule—being the most frequent. Thematic analysis revealed that these errors stemmed from confusion about concepts, processes, and formulas, difficulty in memorization and application, poor understanding, and the complexity of problem-solving steps. To address these issues, the study recommends developing a Strategic Intervention Material (SIM) with step-by-step explanations, visual aids, and interactive resources to enhance conceptual understanding. A blended learning approach, combining face-to-face discussions and digital modules, is suggested to improve engagement. Additionally, remedial sessions should support students struggling with problem-solving. Future research should evaluate the effectiveness of such interventions and explore other factors influencing errors in Calculus.

RESUMO

Los estudiantes a menudo cometen errores al resolver problemas matemáticos, especialmente en Cálculo Básico. Este estudio tuvo como objetivo identificar los tipos de errores que enfrentan los estudiantes de STEM al resolver problemas de Cálculo Básico en una escuela secundaria de una universidad en el norte de Filipinas. Se utilizó un diseño cualitativo descriptivo, y se realizó un análisis de errores basado en una prueba de resolución de problemas de diez ítems, elaborada por el investigador y validada por expertos. Los errores se categorizaron en errores por descuido, errores conceptuales, errores de codificación y errores por falta de familiaridad, siendo los errores conceptuales—especialmente las violaciones de la Regla de la Potencia—los más frecuentes. El análisis temático reveló que estos errores se debían a la confusión sobre conceptos, procesos y fórmulas, dificultad en la memorización y aplicación, falta de comprensión y la complejidad de los pasos en la resolución de problemas. Para abordar estos problemas, el estudio recomienda desarrollar un Material de Intervención Estratégica (SIM) con explicaciones paso a paso, recursos visuales e interactivos para mejorar la comprensión conceptual. Se sugiere un enfoque de aprendizaje combinado, que incluya discusiones presenciales y módulos digitales, para mejorar la participación de los estudiantes. Además, se deben ofrecer sesiones de refuerzo para los estudiantes con dificultades en la resolución de problemas. Las futuras investigaciones deberían evaluar la efectividad de estas intervenciones y explorar otros factores que influyen en los errores en Cálculo.

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Introduction

Mathematics is an important subject in the school curriculum. In Senior High School, one of the specialized courses in the Science, Technology, Engineering, and Mathematics (STEM) strand is Basic Calculus. This course covers key topics such as limits of functions, derivatives, and integrals of algebraic, exponential, logarithmic, and trigonometric functions of a single variable. It also includes problem-solving in areas like continuity, extreme values, related rates, population models, and areas of plane regions (Anton et al., 2021; Thompson & Harel, 2021).

Many students find Calculus difficult, especially when learning limits and derivatives. Studies show that students often struggle with the rules for calculating these concepts, particularly when identifying maximum and minimum values of functions (Siti Fatimah & Yerizon, 2019; Desfitri, 2016). For those who find the subject challenging, these difficulties can prevent them from fully understanding more advanced topics.

Calculus plays a big role in solving problems in different fields such as Physics, Engineering, Astronomy, Geology, Chemistry, Biology, and the Social Sciences. Learning how to apply its concepts helps students develop problem-solving and critical thinking skills, which are useful both in academics and in real life. However, despite the availability of learning materials (Galangco et al., 2024), students still face challenges in understanding and applying problem-solving techniques in Mathematics. According to Peter (2012) and Domondon et al. (2024), some of these challenges include lack of proper training, limited resources, pre-existing biases, and time constraints. Research also shows that students in different fields struggle with problem-solving in Mathematics, proving that these difficulties are common across various courses.

Despite its importance, many students dislike Calculus because of its complexity. This often leads to errors, especially when working with integrals (Domondon et al., 2022). According to Abdullah, Abidin, and Ali (2015), students tend to misunderstand problems because they do not fully absorb the given information. Other studies have also pointed out that students often get confused when identifying given variables, forming mathematical patterns, and choosing the right solution strategies. Common reasons for these mistakes include lack of practice, weak foundational knowledge, and carelessness in writing formulas or presenting solutions (B. Collins et al., 2019; Gutmann, 2019; Rini et al., 2024).

Rohmah and Sutiarso (2017) also found that students make mistakes in solving math problems due to incomplete understanding, lack of focus, and not being careful in their work. Similarly, Zakariyya, Beji, and Itodo (2018) suggested that poor performance in Mathematics is often linked to repeated errors and misconceptions.

Although previous studies have identified common mistakes in Calculus, there is still a need for more in-depth analysis of how and why these errors occur, especially among Senior High School students. Most existing research focuses on college-level learners, leaving a gap in understanding the challenges faced by students at the Senior High School level, where Basic Calculus is introduced. Understanding the specific difficulties of STEM students in Senior High School can help improve teaching strategies and develop more effective learning materials tailored to their needs.

Since errors in Mathematics, especially in Calculus, are unavoidable, it is important to study and understand them. Domondon et al. (2022) recommended a qualitative analysis of students' errors in Basic Calculus to identify common mistakes and the challenges that cause them. This study aims to explore the errors made by Senior High School STEM students in solving Basic Calculus problems and to understand the difficulties they face in order to improve learning strategies and teaching methods. The findings of this study will contribute to the development of targeted interventions that can help students improve their problem-solving skills and overall performance in Calculus.

Objectives

This study aimed to determine the errors encountered in solving problems on Basic Calculus by STEM students of Senior High School in a university in the Northern Philippines. Specifically, it sought to look into (1) the common errors encountered by the students in solving problems on Basic Calculus; and (2) the difficulties lead to the errors of students in problem-solving.

Methodology

This portion presented the research design, population and sample, research instrument, data gathering procedure, ethical consideration and statistical treatment of data.

Research Design

This study used the descriptive qualitative design of research. The errors committed were further analyzed and a focus group discussion was done to determine the difficulties of students that lead in committing errors in problem-solving.

Participants of the Study

The participants of the study were the 46 Grade 11 STEM students of Senior High School in a university in Northern Philippines. The selection of 46 students allowed for a detailed examination of common mistakes in Basic Calculus while keeping the data manageable. This sample size was enough to identify patterns and themes in students' errors, ensuring meaningful insights without overwhelming the analysis.

In addition, there was one group composed of 7 low-scorer students of the whole class who were selected purposively based on their problem-solving skills and were interviewed through focus group discussion (FGD). The participants of the FGD should have something in common or homogenous and the ideal size of the group is five to eight participants. Nyumba, Wilson, Derrick, and Mukherjee (2018) said that the number of participants in a focus group ranged from 3-21.

Research Instrument

A 20-item problem-solving pilot test composing limits and derivatives of algebraic functions was first made by the researcher based from K-12 books. The test questionnaire was validated by three Mathematics teachers and experts. The questionnaire was found to be very much valid and later piloted to one section at a public national high school. Using Cronbach's Alpha, its reliability index was 0.703 which was acceptable for a classroom test.

The test item was soon finalized into a ten-item problem-solving test with 0.735 reliability index which was already the instrument of the study. A point was given to each item with complete and correct solution. It was used to gather the data needed for the study.

Data Gathering Procedure

The researcher subjected a twenty-item test to validation and with the approval from the Division Superintendent and the Principal of a public national high school, a pilot testing was done to senior high school students at that national high school. After pilot testing, the researcher got the reliability index of the instrument and finalized a ten-item test as an instrument for the study.

The researcher asked permission from the principal of the Senior High School in a university in Northern Philippines through proper consent. Upon approval, the researcher administered the ten-item test to the informed and consented respondents. They were given one hour to answer the test.

The papers were checked. A point was given to each item with complete and correct solution. If there was any error on the solution, no point was given, items without solutions were marked "no solutions" and the items with incomplete solutions were marked "incomplete."

Errors were determined through an analysis of the answers and solutions of the students. The errors encountered were based on the errors committed in solving Basic Calculus problems. The errors were soon categorized.

The researcher, with the participants' approval, interviewed 7 low scorers of the whole class through a focus group discussion on their difficulties that contributed to their errors in solving Basic Calculus problems. The data from the FGD were analyzed qualitatively using thematic analysis.

Data Analysis

The study utilized the thematic analysis by Caulfield (2019) to analyze qualitative data from the focus group discussion. The thematic analysis followed six-step process:

familiarization, coding, generating themes, reviewing themes, defining and naming themes, and writing up. In addition, inter-rater reliability checks were also considered along the process.

Ethical Considerations

Ethical considerations were strictly considered. The respondents were recruited through proper and full consent. The respondents were not subjected to harm, discrimination or any form of violence. Their participation was voluntary.

The data collected were strictly for the purpose of the study. Any records were kept safely and confidentially. The records would be destroyed once the research has been published and presented. Any type of communication was done with honesty and transparency.

Results and Discussions

This study aimed to determine the errors encountered by STEM Senior High School students in solving problems on Basic Calculus.

Common Errors Encountered by Students in Solving Basic Calculus Problems

The test given to the students consists of ten items on limits, derivatives and higher derivatives of functions.

The common errors identified from the students' solutions in solving problems in Basic Calculus are categorized as follows: careless errors, conceptual errors, encoding errors, and unfamiliarity errors.

<u>On Careless Errors</u>

The first category of error identified was the "Careless Errors". These are done by the negligence of students in writing symbols or solving problems. Errors are presented in the table and exhibits below.

Table 1.
Careless Errors Committed by the Students

Category	Specific Errors	f	Rank
Careless Errors	• Failure to write appropriate symbol/s	16	1
	• Failure to write the exponent	2	2
	• failure to use grouping symbols	1	3
	Total	19	

Table 1 reveals that students committed a total of 19 careless errors, with "failure to write appropriate symbol/s" being the most frequent. This indicates that while students may understand the mathematical concepts, lapses in attention to detail affect their accuracy. Such errors, though minor, can lead to incorrect answers and should be addressed through strategies that promote careful verification, such as encouraging students to double-check their work and reinforcing the importance of mathematical notation.

Careless errors are random slips in declarative or procedural knowledge that do not reflect misconceptions or conceptual issues (Priyani & Ekawati, 2018). They occur when students fail to pay attention or work too quickly (Cicekci & Sadik, 2019).

Students become careless every now and then which results in their errors. Examples of solutions of students committing careless errors are presented below:

Item 6: Give the fourth derivative of $y = x^5 - 2x^4 + 3x^3 + 4x^2 - 5x + 6$.

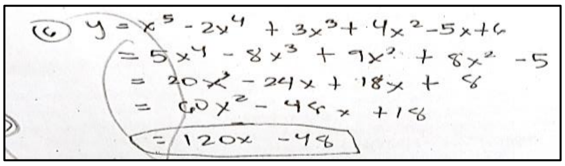

Exhibit 1. *Failure to write appropriate symbol in Item 6*

The student's derivation process was correct, but they failed to include the appropriate symbols in derivatives. While they understood the procedure, the omission of symbols—an essential component of mathematical communication—led to an incomplete solution. Symbols serve as a concise and precise way to convey calculations, eliminating the need for lengthy explanations. Their absence can lead to misinterpretation and errors. Carelessness and lack of attention to detail, as noted by Bowling (2016) and Veloo et al. (2015), often contribute to such mistakes, highlighting the need for students to develop meticulous problem-solving habits.

Item 4: Give the derivative of $y = 6x^4 + 5x^2 - 2x$.

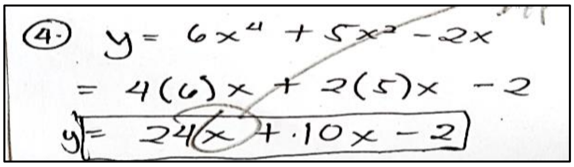

Exhibit 2. *Failure to write the exponent in Item 4 by another student*

Another student made an error in item 4 by failing to include the exponent in her answer, a mistake attributed to carelessness. Siti Fatimah and Yerizon (2019) noted that students often exhibit a lack of carefulness when solving problems. Applerouth (2011) emphasized that careless errors follow patterns and are not random but repetitive, suggesting that these systematic mistakes can be addressed by identifying gaps in students' mental processes through repetition. Similarly, Peterson (2018) highlighted that careless errors can stem from various factors, and students must be aware of their tendencies and develop strategies to minimize such mistakes.

Item 2: Given $f(x) = (4x - 3)(x^2 + 4)$*, find* $\lim_{x \to 3} f(x)$.

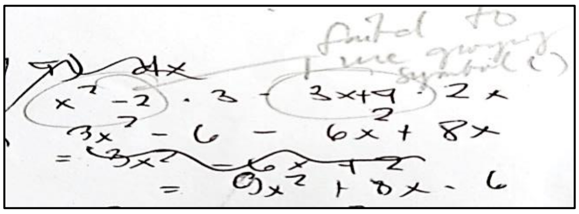

Exhibit 3. *Failure to use grouping symbols in Item 2*

A student failed to use grouping symbols, specifically parentheses, when multiplying given terms by a number. Without proper grouping symbols, the intended operations were misinterpreted, leading to an incorrect result. This highlights the critical role of notation in mathematical accuracy. Bowling et al. (2016) and Veloo et al. (2015) emphasized that carelessness and lack of attention to detail can significantly impact problem-solving accuracy. Proper use of symbols is essential to prevent miscalculations and ensure clarity in mathematical expressions.

On Conceptual Errors

The second category identified was the “Conceptual Errors”. Conceptual errors are mistakes committed in the application of different mathematical concepts.

Table 2.
Conceptual Errors Committed by the Students

Category	Specific Errors	f	Rank
Conceptual Errors	• substituted 0 to all "x"	2	5
	• Failure to perform operations	31	2
	• derived the factors instead of expanding it first	7	4
	• directly derived the radicand	18	3
	• violation of Power Rule	70	1
	Total	128	

The table indicates that the most common conceptual error among students is the violation of the Power Rule (f=70), followed by failure to perform operations (f=31). This suggests a fundamental gap in students' understanding of exponentiation rules and algebraic operations, which can hinder their problem-solving abilities. Addressing these misconceptions through targeted instruction, step-by-step problem breakdowns, and conceptual reinforcement can enhance students’ comprehension and application of mathematical principles. Priyani and Ekawati (2018) emphasized that conceptual errors arise when students struggle to apply mathematical concepts effectively, highlighting the need for deeper conceptual engagement in learning.

Below are sample solutions for students with conceptual errors.

Item 6: Give the fourth derivative of $y = x^5 - 2x^4 + 3x^3 + 4x^2 - 5x + 6$.

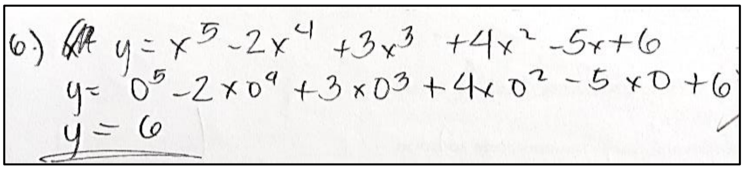

Exhibit 4. *Substituted 0 to all "x" in Item 6*

A student mistakenly substituted 0 for all values of x instead of deriving the function, indicating confusion about the concept of derivatives. This error suggests a lack of conceptual understanding in differentiation, leading to misapplication of procedures. Hashemi et al. (2014) emphasized that derivation is a fundamental mathematical concept, yet many students struggle with it due to their focus on symbolic manipulation rather than conceptual understanding. Difficulties often stem from an inability to establish logical connections between different representations and a weakness in handling generalized problems, highlighting the need for deeper conceptual instruction in calculus.

Item 2: Given $f(x) = (4x - 3)(x^2 + 4)$, *find* $\lim_{x \to 3} f(x)$.

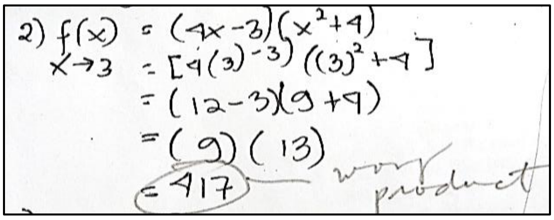

Exhibit 5. *Failure to perform operations in Item 2 by other student*

The student correctly applied the process of solving the limit in item 2 but arrived at an incorrect answer due to a multiplication error—miswriting 117 as 417. This suggests a lapse in attention or miscopying rather than a misunderstanding of the limit concept. Siti Fatimah and Yerizon (2019) noted that students often struggle with basic mathematical operations due to insufficient mastery of prerequisites. Brandt, Bassoi, and Baccon (2016) emphasized that errors in operations stem from a weak understanding of the decimal numbering system and the organization of representation registers. OCadiz (2017) highlighted that incomplete mastery of number facts is a common issue, as these fundamental skills are essential for grasping more complex mathematical concepts. Priyani and Ekawati (2018) further explained that operational errors occur when students fail to accurately compute numerical values, reinforcing the importance of strengthening basic arithmetic skills.

Item 5: Evaluate $y = (x^2 - 2)(3x + 4)dx$.

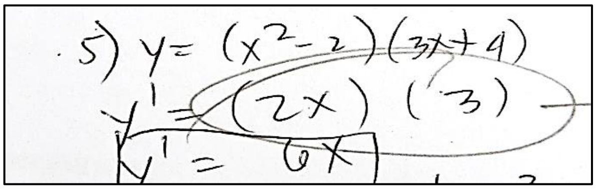

Exhibit 6. *Derived the factors instead of expanding in Item 5*

The student demonstrated an understanding of derivatives but applied an incorrect process by differentiating the expression directly instead of expanding it first, leading to an incorrect answer. Additionally, the student could have used an alternative method but failed to do so. Tan Sisman and Aksu (2016) revealed that such errors and misconceptions often result from a lack of both conceptual and procedural understanding. This underscores the importance of reinforcing multiple solution approaches and strengthening students' grasp of procedural steps to minimize errors in differentiation.

Item 9: Give the second derivative of $y = \sqrt{x-2}$.

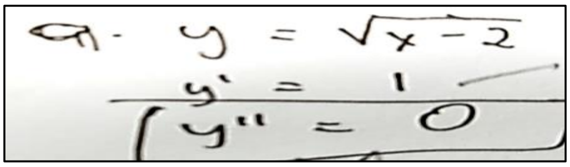

Exhibit 7. *Directly derived the radicand in Item 9 by student C*

Another student incorrectly applied differentiation by directly deriving the radicand, resulting in a first derivative of 1 and a second derivative of 0. This error indicates a lack of knowledge and understanding of the derivative of radical functions. Makgakga and Maknakwa (2016) emphasized that prioritizing procedural understanding over conceptual comprehension contributes to students' difficulties in solving calculus problems. This highlights the need for instructional strategies that reinforce both conceptual and procedural aspects of differentiation, particularly for radical functions.

Item 7: Find the fifth derivative of $y = x^7 - 4x^5 + x^2 + 8x$.

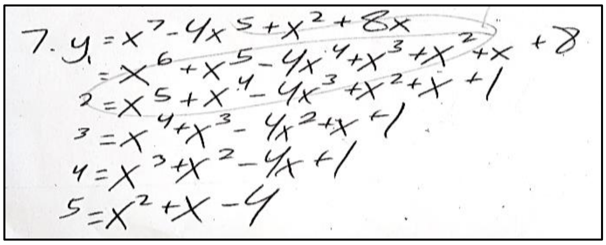

Exhibit 8. *Violation of Power Rule in Item 7*

A student correctly subtracted 1 from the exponent but failed to multiply the exponent by the numerical coefficient, violating the Power Rule. This suggests a lack of full comprehension of the differentiation process, particularly in applying the rule correctly. Since the Power Rule is one of the most commonly used rules in derivatives (Sun et al., 2018), gaps in understanding it can significantly impact students' problem-solving abilities. Reinforcing this rule through targeted practice and step-by-step explanations can help address this misconception.

On Encoding Errors

Encoding errors are mistakes in copying given numbers and symbols.

Errors in encoding are hereby presented below.

Table 3.
Encoding Errors Committed by the Students

Category	Specific Errors	f	Rank
Encoding Errors	• Miscopied entry based on the given	3	3
	• excess term in the answer	5	1.5
	• Wrong operation	5	1.5
	Total	13	

The table shows that "excess terms in the answer" and "wrong operation" are the most frequently committed encoding errors, tying in rank. This indicates that students struggle with accurately translating their solutions into final expressions, possibly due to lapses in attention, misapplication of rules, or procedural confusion. Addressing these errors through structured practice, error analysis, and reinforcement of proper encoding techniques can enhance students' accuracy and problem-solving efficiency.

Different encoding errors are exhibited below.

Item 1: Find the limit of $x^2 - 4x + 5$ *as x approaches 2.*

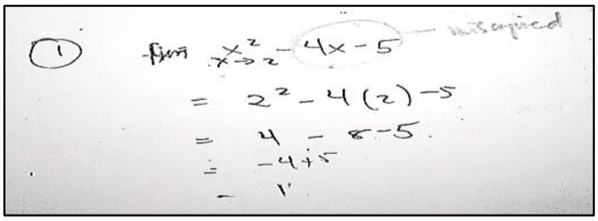

Exhibit 9. *Miscopied entry based on the given in Item 1*

The student committed an error by miscopying an operation from the given information without realizing that it was incorrect. This mistake resulted from a lack of presence of mind. Sekaryanti et al. (2022) emphasized that writing clearly is just as important a mathematical skill as solving equations. Similarly, Cayabyab (2016) found that miscopying entries from a previous solution is one of the most common errors in mathematical problem-solving.

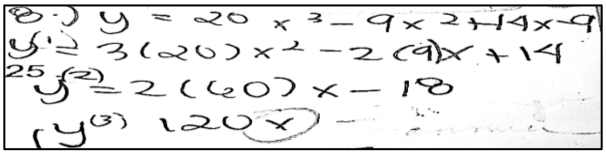

Exhibit 10. *Excess variable in the answer in Item 8*

The student's answer contained an extra variable, but he was unaware of this mistake. Although he understood the process and the correct solution, he wrote the final answer incorrectly.

Item 2: Given $f(x) = (4x-3)(x^2+4)$, *find* $\lim_{x \to 3} f(x)$.

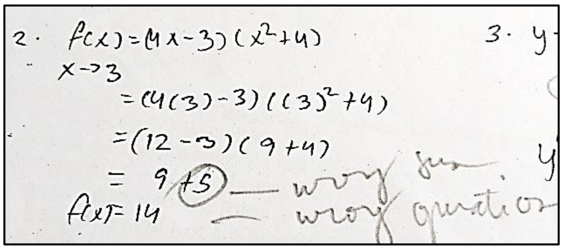

Exhibit 11. *Wrong operation in Item 2 by other student*

In addition to incorrectly summing 9 and 4, the student also mistakenly placed a plus symbol between 9 and the incorrect sum (5) instead of using a multiplication symbol or parentheses. This resulted in a double error in item 2.

<u>On Unfamiliarity Errors</u>

Unfamiliarity errors are mistakes committed resulting to unfinished and no solutions. Due to the unfamiliarity of concepts, students failed to finish or write any solutions on the problems. Committed errors along unfamiliarity of concepts are included below.

Table 4.
Unfamiliarity Errors Committed by the Students

Category	Specific Errors	f	Rank
Unfamiliarity Errors	• Unfinished solution	28	2
	• no solution	44	1
	Total	72	

Table 4 reveals that the most frequent unfamiliarity error among students is "no solution" (f = 44). This suggests that many students struggle with identifying appropriate solution strategies or lack confidence in applying their knowledge. Such errors may stem from limited exposure to similar problem types or inadequate reinforcement of problem-solving techniques. Addressing this issue through targeted practice, step-by-step guidance, and real-world problem applications can help students develop familiarity and confidence in tackling unfamiliar mathematical problems.

Exhibits on unfamiliarity errors are presented below.

.Item 3: Solve for the derivative of $y = 4x^2 - 7x$.

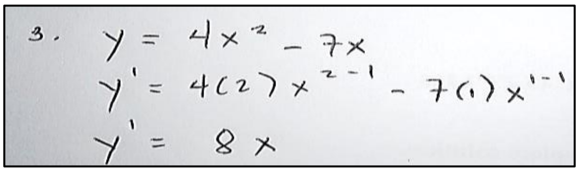

Exhibit 12. *Unfinished Solution in Item 3*

The student did not complete the solution, failing to include '-7' in the final answer because he mistakenly believed he had already finished. This error stemmed from his unfamiliarity with the fact that x raised to 0 equals 1, not 0. Believing it to be 0, he did not continue the solution. According to Cayabyab (2016), incomplete values in the final answer are a common error among students.

Item 7: Find the fifth derivative of $y = x^7 - 4x^5 + x^2 + 8x$.

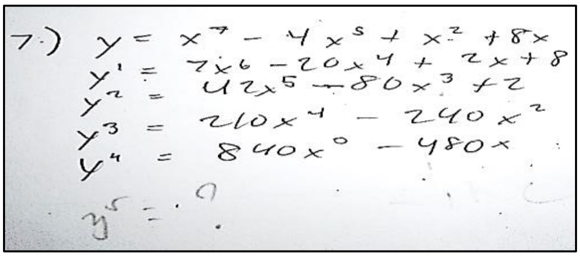

Exhibit 13. *Unfinished solution in Item 7*

The student failed to complete the required higher derivative of the function, stopping at the 4th derivative instead of solving for the 5th as specified in the problem. This may have resulted from a lack of attentiveness to the given instructions. Kohen and Nitzan-Tamar (2022) found that many students struggle to precisely solve contextual mathematics problems, often stopping prematurely when they believe they have completed the mathematical steps, even though the solution does not fully address the problem's requirements.

Item 10: Find the fourth derivative of $y = x^8 + 2x^6 - 5x^4 - x^3 + 2x^2 + 10x - 25$.

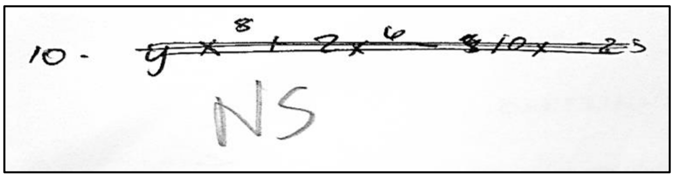

Exhibit 14. *No Solution in Item 10*

In item 10, the student initially wrote something, presumably the given information, but later erased it, leaving the solution blank. This may indicate uncertainty about how to proceed or unfamiliarity with the solving process. Desfitri (2016) emphasized that understanding derivatives requires mastery of interconnected foundational concepts such as functions, limits, slope, continuity, and rate of change. Additionally, Mulwa (2015) found that errors often stem from students' inadequate grasp of mathematical language, leading to either incorrect or blank responses.

Summary of Error Categories

The summarized error categories committed by students is presented on the table below.

Table 5.
Summary of Error Categories Committed by the Students

Category	f	Rank
Careless Errors	19	3
Conceptual Errors	128	1
Encoding Errors	13	4
Unfamiliarity Errors	72	2

Table 5 shows that conceptual errors (f = 128) are the most prevalent, followed by unfamiliarity errors (f = 72). This indicates a fundamental gap in students' understanding, which can hinder problem-solving proficiency and long-term learning. Conceptual errors, being difficult to recognize and correct, require targeted interventions such as deeper conceptual discussions and diagnostic assessments.

Kingsdorf and Krawec (2014) emphasized that conceptual and procedural errors weaken students' understanding, while Kurudirek et al. (2025) noted that these errors stem from misunderstandings of underlying concepts or incorrect logic. Egodawatte et al. (2015) further supported that such misconceptions often lead to incorrect problem-solving approaches. The presence of unfamiliarity errors suggests that students struggle with applying knowledge in new contexts, highlighting the need for varied problem types and real-world applications. Addressing these issues through explicit instruction and metacognitive strategies can enhance students' mathematical proficiency and adaptability.

Difficulties that Lead to the Errors of Students in Problem-solving

Seven low-scoring students were interviewed to identify the difficulties that led to errors in problem-solving. From the responses, nine themes emerged, highlighting the challenges students faced. Six of these themes were directly related to the subject matter:

confusion about concepts, processes, and formulas; forgetting concepts; difficulty in memorization; poor application; lack of understanding; and the complexity of the process. The remaining three themes reflected broader difficulties: a negative mindset toward math ('not good in math' thinking), a habitual tendency to make mistakes, and inattentiveness.

Confusion about Concepts, Processes and Formulas

One major difficulty that leads to student errors is confusion about concepts, processes, and formulas. Five out of seven students explicitly mentioned feeling 'confused,' as illustrated by Participant A’s statement: *'I was confused about the positive and negative signs.'* Many students struggle with different mathematical concepts, particularly foundational topics such as integer operations. Additionally, some students experience confusion regarding formulas and problem-solving processes, which contributes to their errors.

This difficulty results in conceptual errors. As Domondon et al. (2024) stated, students who lack mastery or understanding of mathematical concepts are more likely to commit this type of error.

Forgetting Concepts

Another difficulty that led to student errors was forgetfulness of mathematical concepts. Participant B stated, *'I already forgot the process on how to solve it and even the formulas, which is why I was not able to answer everything correctly.'* This lack of recall resulted in incorrect solutions due to missing formulas and steps.

Similarly, Participant C admitted, *'I forgot to multiply the exponent, and I forgot to write the symbol.'* This indicates a failure to apply the correct rules in solving Basic Calculus problems. Additionally, some students forgot to include necessary symbols in their solutions, leading to incorrect answers.

As a result, these errors can be categorized as careless errors, conceptual errors, and unfamiliarity errors. Students were either unable to complete their solutions or solve the problem correctly. Abdullah, Abidin, and Ali (2015) highlighted two key factors that prevent students from producing correct answers: difficulties in language fluency and conceptual understanding, as well as challenges in mathematical process skills, including understanding, transformation errors, procedural execution, and writing answers correctly.

Habitual Tendency to Make Mistakes

Another significant difficulty contributing to student errors was their habitual tendency to make mistakes when solving mathematics problems.

Participant D admitted, *'I didn't write the symbol because it was what I habitually do before.'* This suggests that the student had developed a repetitive habit of omitting symbols, making such errors feel normal. Even after being corrected in the past, the student continued making the same mistake.

Many students claimed they simply followed what they were accustomed to doing. It had become a habit for them to write down any solution they knew, even if it was incorrect.

This habitual approach led to encoding errors and conceptual errors. Wang et al. (2018) emphasized that poor habits contribute to mistakes in accuracy. Similarly, Frontiers for Young Minds (2015) explained that students often repeat the same mistakes not due to a lack of knowledge but because they fail to suppress an incorrect yet seemingly logical response.

<u>Negative Mindset Toward Math ('Not Good in Math' Thinking)</u>

A student stated, *'I am not good in Math... That's the reason I experience difficulty in Math.'* This belief led him to struggle with solving problems in Basic Calculus, as he perceived anything related to mathematics as a personal weakness.

Similarly, another student shared*, 'Ever since, problem-solving was my weakness, and I did not improve as I grew up. Maybe that is why I struggle with Math.'* This student acknowledged a long-standing difficulty with problem-solving and believed that this weakness had persisted over time, affecting his overall performance in mathematics.

This kind of mindset often results in unfamiliarity errors, where students either leave problems unsolved or fail to complete their solutions simply because they believe they are not good at Mathematics.

Students with a fixed mindset create a self-fulfilling prophecy—since they believe they lack mathematical ability, they tend to give up quickly when faced with challenging problems (Particle, 2017). According to Rabanal and Domondon (2023), students either appreciate or criticize Math. Those who criticize it and frequently claim they are 'not good at Math' or experience anxiety over math tests may suffer from math trauma, a mental shutdown triggered by negative past experiences, such as a strict teacher, embarrassment, or other distressing events (Ruef, 2018).

<u>Difficulty in Memorization</u>

Memorization was identified as one of the key difficulties leading to student errors.

Participant E stated, *'My weakness is the formula itself. There are many formulas. I can't memorize all of them, and I struggle to apply them to problems.'* This student expressed difficulty in recalling multiple formulas and applying them correctly in problem-solving.

Due to poor memorization, students often commit encoding errors, conceptual errors, and unfamiliarity errors. They tended to write or copy incorrect formulas, which frequently resulted in incomplete or incorrect solutions.

According to Pia (2015), many students dislike Mathematics because it requires extensive memorization and involves making frequent mistakes as part of the learning process.

<u>Poor Application</u>

Poor application of concepts was identified as a difficulty in students' problem-solving.

Participant F shared, *'Whenever the teacher is explaining, I can comprehend. But when I try to do it on my own, it becomes more difficult for me.'* This suggests that comprehension was not the student's main challenge, but rather the ability to apply learned concepts independently.

Difficulties in applying concepts often resulted in conceptual errors and unfamiliarity errors. According to Harr (2015), students struggle to apply acquired knowledge because they have not practiced the skills of integration and synthesis, or they are unable to effectively draw upon them.

<u>Inattentiveness</u>

Another difficulty that contributed to student errors was inattentiveness.

One student admitted, *'I was not paying attention to classroom discussions before.'* This lack of engagement led to difficulties in Basic Calculus, particularly in problem-solving, as the student missed essential explanations and concepts.

Inattentiveness resulted in various errors, including careless, conceptual, encoding, and unfamiliarity errors. Galangco (2023) emphasized that a negative attitude toward Math, such as poor attention, affects student achievement. Similarly, studies by Lai (2012) and Metcalfe (2017) identified poor attention as a possible cause of student errors.

Moreover, inattentiveness often occurs during lessons requiring prolonged listening. Hakala (2015) explained that students' attention constantly shifts between external and internal experiences, making them vulnerable to distractions (Mak, 2018).

Several factors contribute to student inattentiveness, including poor understanding of the material, lack of challenge, external distractions, low motivation, mismatched learning styles, improper nutrition, disorganized problems, school anxiety, and learning difficulties (Oxford Learning, 2019).

Lack of Understanding

Similar to confusion on concepts, poor understanding was also identified as a significant difficulty that led to student errors.

One student admitted, *'I just didn't understand the equation.'* This lack of understanding prevented the student from solving the problem correctly, resulting in conceptual and unfamiliarity errors.

Lai (2012) emphasized that a lack of conceptual knowledge hinders students' ability to process information at the instructional pace and respond effectively. Ristiyani and Bahriah (2016), as cited by Siti Fatimah and Yerizon (2019), explained that learning difficulties often arise when students have not mastered prerequisite skills—those essential for understanding more advanced concepts.

Similarly, Desfitri (2016) noted that students who struggle with Calculus often lack mastery of foundational topics, leading to difficulties in comprehension. Kashefi et al. (2011) and Hashemi et al. (2015) further highlighted that common student challenges include a lack of conceptual understanding and insufficient prior knowledge, which significantly impact their mathematical performance.

Complexity of the Process

The complexity of the process was identified as a difficulty that led students to commit errors.

One student expressed, *'There are so many processes, which is why I got confused about what to do.'* The student perceived Basic Calculus problems as complex due to the numerous steps involved, leading to confusion and errors.

Conceptual and unfamiliarity errors were common mistakes resulting from the intricate nature of problem-solving. Waswa and Al-Kassab (2023) explained that subject difficulties arise from the complexity of mathematical symbols and computations. Mathematics is particularly challenging because each concept builds upon prior knowledge, making mastery of foundational topics essential for problem-solving success.

Conclusions

Based on the study's findings, the researcher concludes that the most frequent errors made by students were conceptual errors related to limits and derivatives, primarily driven by difficulties in understanding the subject matter. To address these challenges, teachers can use the findings to enhance instruction by focusing on common misconceptions, providing targeted interventions, and using error analysis to guide lesson planning. It is recommended that a Strategic Intervention Material (SIM) be developed, validated, and tested, specifically designed to address conceptual errors in limits and derivatives. The SIM should include step-by-step explanations, visual representations, real-life applications, and guided practice exercises to strengthen students' conceptual understanding. Additionally, it should incorporate interactive digital resources, video tutorials, and self-paced assessments to cater to different learning styles. A blended delivery mode, combining face-to-face discussions, online modules, and hands-on problem-solving activities, is suggested to maximize engagement and comprehension. Furthermore, remedial or tutorial classes should be provided for students with below-satisfactory problem-solving skills, allowing for personalized support.

Future researchers are encouraged to explore the effectiveness of the proposed SIM and other instructional interventions in improving students' problem-solving skills in Basic Calculus. Experimental or quasi-experimental studies may be conducted to measure the impact of these interventions on student performance, conceptual understanding, and error reduction. Additionally, further research can investigate other factors contributing to students' errors, such as cognitive load, anxiety, and motivation, to develop more comprehensive strategies for enhancing mathematics instruction.

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