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Research Article

Optimizing Lecture Hour Allocation Based on Perceived Topic Difficulty in an Intervention for Calculus Course

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Abstract

This study explores the perceived difficulty of topics in an Intervention for Calculus course among STEM and non-STEM graduates and proposes an instructional hour allocation model based on these perceptions. Grounded in Cognitive Load Theory, the study responds to observed disparities in level of difficulty of each topic in Intervention for Calculus course between student groups. A quantitative-descriptive comparative design was employed using a researcher-developed questionnaire administered to 245 STEM and non-STEM graduates. Results revealed that non-STEM students consistently rated more topics as difficult, with statistically significant differences in overall perceived difficulty ($p < 0.05$). Topics involving geometry and trigonometry were found to be the most challenging for both groups. Using the average topic difficulty scores, instructional hours were computed thru exponential scaling to highlight and address small differences. This approach yielded a more differentiated and equitable distribution of instructional time across topics compared to linear scaling. The study highlights the importance of tailoring instruction based on learner background and perceived difficulty to avoid cognitive overload and improve educational outcomes, particularly for underprepared learners. The proposed model ensures that instructional design aligns with student needs, contributing to more effective delivery of foundational concepts in calculus.

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1. Introduction

Instructional hours, that is, the scheduled lecture or contact time allocated to each topic within a college course are a critical component of course design and student learning outcomes. These hours are typically specified in the course syllabus and are often determined based on faculty judgment or convention rather than empirical evidence (Fang, 2013). Despite the central role of instructional time, there is a notable lack of systematic strategies or techniques guiding how instructional hours are distributed across topics in higher education curricula.

Research highlights that time on task both in terms of duration and engagement is directly correlated with student performance (Baker et al., 2004). However, mere instructional hours are not sufficient; their quality and relevance to learner needs are crucial for effective learning (Lightweis, 2013). Yet, academic literature rarely investigates formal models for allocating instructional hours based on topic difficulty or student comprehension levels.

This gap is particularly notable in remedial or support courses, such as Intervention for Calculus, where aligning time allocation with student readiness and topic complexity is essential. Despite the high stakes of facilitating conceptual understanding for underprepared students, there is no established framework guiding the distribution of hours based on difficulty.

Theories of desirable difficulties (Bjork & Bjork, 2020) suggest that appropriately challenging tasks, though uncomfortable in the short term, enhance long-term learning. These include strategies such as spaced practice, interleaving, and retrieval-based activities, which deepen encoding and retention. Despite theoretical support, implementation of differentiated instruction often faces challenges: insufficient training, high teacher workload, and lack of institutional support (Chamberlin & Powers, 2010) . Similarly, faculty tend to rely on tradition rather than structured frameworks when designing syllabi and allocating instructional time.

Before the implementation of the K-12 curriculum in the Philippines, engineering programs spanned five years, with first-year students taking basic engineering mathematics courses, including Algebra, Trigonometry, Analytic Geometry, and Solid Mensuration. However, with the transition to the K-12 system, engineering progra. ms were reduced to four years, based on the assumption that these foundational mathematics subjects had already been covered in High School.

Despite the additional two years of education under the K-12 system, studies suggest that SHS graduates, even those from the STEM strand, struggle with engineering programs. Gamboa (2023) reported in the Philippine Star that the additional years of SHS have not significantly improved students' aptitude in college-level academic programs, including engineering. Similarly, Fernando et al. (2019) found that STEM graduates who took an assessment test covering essential engineering prerequisites were only "somewhat prepared" for their baccalaureate engineering courses.

Further research highlights the need for additional mathematical training for freshman engineering students. Alinea et al. (2022) concluded that first-year engineering students require more engagement in mathematical activities to enhance their proficiency and readiness for higher-level engineering subjects. Perante (2022) also emphasized that many Filipino engineering students are not adequately prepared for college-level mathematics. Several factors contribute to this issue, including disparities in K-12 education quality, a shortage of qualified teachers, limited professional development opportunities, and the lack of skill-upgrading programs.

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Given these concerns, several studies have suggested that SHS graduates, regardless of their strand, may not be sufficiently prepared for engineering programs. Recognizing that this might be the case for the many of the SHS graduates, CHED issued a memorandum in November 2020 recommending that Higher Education Institutions (HEIs) offer bridging courses or programs to ensure college readiness. In response, some HEIs have implemented intervention programs. For example, the National University-Clark (NU-Clark) offers an Intervention for Calculus course that includes basic engineering mathematics subjects, such as Algebra, Trigonometry, Analytic Geometry, and Solid Mensuration, to help first-year engineering students build a stronger mathematical foundation before tackling more advanced courses.

In an online technical article by Boschen (2025), differentiated instruction, which adapted teaching strategies based on students' backgrounds and needs, had been widely recognized as an effective approach to address diverse learning profiles. Within inclusive education research, differentiated instruction is promoted as a model to create more inclusive classrooms by addressing individual learning needs and maximizing learning opportunities (Gheyssens, 2023). In the context of the Intervention for Calculus course, allocating more instructional hours to topics that were more difficult to grasp, thereby providing targeted support where it was most needed.
This study also supported Sustainable Development Goal (SDG) 4: Quality Education, which aimed to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. By identifying disparities in high school mathematics preparation and addressing them through data-driven instructional planning, this research contributed to reducing educational inequities and enhancing access to STEM education (UNICEF, 2023).

This study addresses these gaps by proposing a data-driven model for allocating instructional hours in Intervention for Calculus based on student perceptions of topic difficulty. It examines potential differences between STEM and non-STEM graduates and leverages these insights to construct a transparent, replicable allocation strategy that better aligns instructional time with topic complexity and learner readiness.

This study aimed to develop a data-driven approach for allocating instructional hours in the Intervention for Calculus course by analyzing the perceived level of difficulty of each topic and proposing a corresponding time distribution model. Specifically, it seeks to address the following objectives: (1) To assess the perceived level of difficulty for each topic in the Intervention for Calculus course, (2) To examine whether a significant difference exists in perceived topic difficulty between STEM and non-STEM senior high school graduates, and (3) To propose an instructional hour allocation model that adjusts the distribution of lecture hours based on the perceived difficulty of each topic.

2. Materials and Methods

2.1. Research Design

This study utilized a descriptive-comparative quantitative research design to examine how students perceive the level of difficulty across topics in the Intervention for Calculus course and to determine whether significant differences exist between students from STEM and non-STEM senior high school strands. This design was chosen because it allows the researcher to systematically describe observed phenomena using numerical data and statistically compare the responses of two or more distinct groups without manipulating any variables.

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According to Bhandari (2023), descriptive research is used to describe characteristics of a population or phenomenon, and when combined with comparative analysis, it becomes a powerful tool for identifying group differences. McCombes (2022) also emphasized that descriptive designs are ideal for understanding educational contexts without manipulating variables, making them suitable for curriculum evaluation. These sources support the use of this design in educational settings where the goal is to generate actionable insights from existing conditions.

2.2. Respondents and Sampling Procedure

The study was carried out in National University – Clark engineering students during the third term academic year 2024-2025. National University (NU) Clark, located in Mabalacat, Pampanga, is the 10th campus of the National University system and the second in Central Luzon. Officially inaugurated on September 22, 2023, the campus is situated within the Clark Tech Hub 8, part of the SM City Clark Expansion.

The National University – Clark offers two engineering programs: the Bachelor of Science in Civil Engineering and the Bachelor of Science in Computer Engineering.

There were 245 respondents, 178 from STEM strand and 67 from non-STEM strands. The participants were engineering students who had previously taken the course Intervention for Calculus. All students graduated under the latest Basic Education Curriculum (BEC) implemented by the Department of Education (DepEd) and came from various Senior High School (SHS) strands.

2.3. Research Instruments

A structured questionnaire was developed as the primary research instrument to gather quantitative data aligned with the objectives of the study. Specifically, the questionnaire was designed to assess students' perceived level of difficulty for each topic in the *Intervention for Calculus* course and to determine whether significant differences exist between STEM and non-STEM graduates in their perception of these topics.

To ensure the reliability and validity of the questionnaire, a two-step process was followed. First, the instrument underwent content validation by experts in engineering education and educational measurement, who reviewed the items for content validity, clarity and language, and relevance and comprehensiveness.

Second, to establish the reliability of the questionnaire, a test–retest reliability procedure was conducted. The instrument was administered to a pilot group of students on two occasions, separated by a two-week interval. The correlation between the two sets of responses was calculated, yielding a coefficient of $r = 0.89$ which indicates high validity of the instrument. Test–retest reliability is a widely recognized method in psychometrics, particularly for assessing the stability of survey and educational instruments over time (Cohen, Swerdlik, & Sturman, 2013). In the context of educational research, this approach ensures that the questionnaire yields dependable results when measuring perceived topic difficulty, rather than being influenced by temporary factors such as mood or situational context (Heale & Twycross, 2015; Taherdoost, 2016).

2.4. Data Collection and Analysis

The data for this study was collected following a structured procedure to ensure the reliability and validity of the findings. Initially, a formal request for approval was submitted to the Campus Executive Director, detailing the study's objectives, methodology, and research

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instrument. Upon approval, the researcher proceeded with the development of the questionnaire, which was done using Microsoft Forms. The questionnaire was carefully structured to align with the research objectives. Prior to administering the survey, informed consent was obtained from all participants, emphasizing the voluntary nature of participation and the confidentiality of their responses.

The questionnaire was then distributed electronically via university communication channels, allowing students to access and complete the survey at their convenience.

The collected data were analyzed using appropriate statistical treatments aligned with the research objectives using Microsoft Excel program.

Perceived Level of Difficulty for Each Topic in the Intervention for Calculus Course

Descriptive statistics, particularly mean, was used to analyze students' perceptions of difficulty for each topic. The Likert scale responses were interpreted to identify which topics students find the most and least difficult. This approach is suitable as it quantifies subjective perceptions into measurable data.

Responses were collected using a 5-point Likert scale, where 1 represents "Very easy" and **5** represents "Very difficult." The interpretation of mean scores followed this classification:

Mean Score Range	**Perceived Level of Difficulty**
4.50 – 5.00	Very difficult
3.50 – 4.49	Difficult
2.50 – 3.49	Moderate
1.50 – 2.49	Easy
1.00 – 1.49	Very easy

A high mean score (close to 5) suggests that students found the topic highly challenging, whereas a low mean score (close to 1) indicates that the topic was relatively easy for them.

Comparison of STEM and Non-STEM Graduates on Perceived Difficulty of Each Topic in Intervention for Calculus

Independent samples t-tests was used to compare STEM and non-STEM graduates on each topic in terms perceived difficulty. The analysis was done in Microsoft Excel using the Data Analysis Toolpak. For each topic, the mean scores of the two groups was compared, and a p-value of less than 0.05 will indicate a significant difference.

Allocation of Instructional Hours for Each Topic in the Intervention for Calculus Course Based on Perceived Difficulty

One of the central aims of this study was to propose a data-informed strategy for allocating instructional hours in the *Intervention for Calculus* course based on the perceived difficulty of each topic. Currently, the distribution of lecture hours in many mathematics syllabi is often determined through faculty consensus or tradition, without a clear analytical basis tied to student learning needs. As observed in curriculum planning practices, there is a tendency to distribute instructional hours evenly or arbitrarily, relying largely on the experience and subjective judgment of instructors (Wieman & Gilbert, 2014). While this may work in some contexts, such approaches can fail to address the differing levels of preparedness students bring into a

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course, especially for bridging or intervention subjects such as calculus.

To address this gap, the present study collected students' ratings on topic difficulty and applied an exponential scaling method to proportionally allocate instructional hours. Exponential scaling is particularly suitable in this context because it emphasizes differences in topic difficulty ratings, thus providing more instructional time to the most challenging topics and less to the easier ones. In contrast, linear scaling, where time is distributed proportionally to raw difficulty scores—results in only minor differences between topic allocations. This tends to produce almost equal instructional hours across all topics, even when some topics clearly demand more instructional support.

As highlighted in a web article by Statsig (2025), assuming linear growth in contexts where the need or impact increases rapidly (such as knowledge gaps or learning difficulties) can underestimate the necessary response or intervention effort. In instructional design, this could mean failing to provide sufficient time to address topics students struggle with the most. Linear models are limited in that they treat all incremental changes in input (difficulty) as equally significant in output (instructional time), which flattens the range of support offered and weakens differentiation (Statsig, 2025; McKee, 2025).

To overcome this, the study adopted the exponential weighting function:

$$w_i = e^{m_i} \tag{1}$$

Notation:
Let **T** be the total number of instructional hours (T = 88 hours).
Let **n** be the total number of topics (n = 15).
Let $\mathbf{m_i}$ be the mean level of difficulty score for topic **i**.
Let $\mathbf{w_i}$ be the weight for topic **i**.
Let $\mathbf{h_i}$ be the number of hours allocated to topic **i**.

Total Weight:

$$W = \sum_{i=1}^{n} w_i \tag{2}$$

Allocated Hours:
Each topic’s allocated hours should be proportional to its weight:

$$h_i = T \times \frac{w_i}{W} = T \times \frac{e^{m_i}}{\sum_{j=1}^{n} e^{m_i}} \tag{3}$$

The computed hours for each topic shall be adjusted and rounded to the nearest whole number or half-hour, based on the researchers’ judgment.

The rationale for using the exponential function, specifically Euler’s number (e ≈ 2.71828), lies in its ability to model continuous growth or decay, concepts that mirror how instructional needs rise sharply as topic difficulty increases (McKee, 2025). Instructional needs often increase nonlinearly as topic difficulty rises – similar to compounding effects in growth models – thus e provides a principled basis for representing these

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sharp increases. Using *e* rather than another base avoids arbitrary scaling, since other bases (e.g., 2 or 10) would produce results dependent on convention rather than grounded in the inherent calculus-based properties of *e*, which underpins exponential and logarithmic functions used widely in modeling cognitive and learning processes.

By exaggerating differences in difficulty, this method ensures that topics with lower perceived readiness receive more focused instructional time, thereby maximizing learning equity and efficiency.

This strategy is also grounded in Cognitive Load Theory, which posits that unfamiliar or difficult content increases intrinsic cognitive load, reducing students' capacity to process new information (Sweller, 1988, as cited in de Jong, 2010). Allocating more hours to these topics helps alleviate overload, promotes deeper understanding, and enhances long-term retention. Additionally, this approach promotes data-driven, differentiated instruction aligned with international goals such as Sustainable Development Goal 4, which advocates for inclusive and equitable quality education (United Nations, 2015).

Exponential scaling provides a pedagogically sound, learner-centered framework for allocating instructional time. By accentuating differences in perceived difficulty, it enables course designers to align instructional resources more precisely with student learning needs, whereas linear allocation methods are comparatively less effective in capturing such variations.

2.6. Ethical Considerations

Confidentiality and anonymity was rigorously upheld throughout the research process. All collected data was securely stored and accessible only to the researcher and authorized personnel, ensuring the protection of personal information. In reporting the findings, all identifying details was removed to safeguard participant anonymity further.

The study adhered to ethical academic standards by presenting results honestly and accurately, ensuring integrity in data interpretation. Additionally, the principles of "do no harm" and respect for persons was strictly followed, minimizing any potential harm, discomfort, or coercion to participants.

Participation in the study was entirely voluntary, and respondents were informed that they may withdraw at any time without penalty or the need to provide a reason. The study involved the completion of a short questionnaire, which is expected to take approximately five minutes. Participants were assured that their responses will be kept confidential and used solely for research purposes.

To protect participants' privacy, all collected data was anonymized through a coding system, ensuring that no identifying information is linked to their responses. Furthermore, all data was securely stored in encrypted digital formats, with access restricted to the researchers directly involved in the study. No hard copies of personal data were created. Data files were stored on a password-protected cloud storage system and a secure external drive to prevent unauthorized access. The data will be retained for a period of one year after the completion of the study, after which it will be permanently deleted to ensure privacy and compliance with ethical research standards.

This study was conducted with integrity and in accordance with ethical guidelines. The research team ensured that all participants have the opportunity to ask questions regarding their involvement and obtain clarification when necessary. Additionally, participants were provided with contact information should they have any concerns or inquiries regarding the study.

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2.7. Limitations

While the study offers important insights into students' perceived levels of difficulty in the Intervention for Calculus course and demonstrates the utility of exponential scaling for instructional time allocation, several limitations should be acknowledged.

The study relied on self-reported perceptions of difficulty rather than objective performance metrics such as test scores or retention data. Although perceptions provide valuable information about learners' confidence and readiness, they may not always align perfectly with actual mastery or achievement. Future studies may benefit from triangulating perception data with objective performance measures to provide a more comprehensive evaluation of students' learning needs.

The study was also conducted within a single institution, which may limit the generalizability of the findings. The academic preparation, curriculum emphasis, and student demographics of this institution may not fully represent other contexts. Replicating the study across multiple institutions, including both public and private universities, would provide a more representative basis for generalizing the findings.

The research design was cross-sectional in nature and did not include longitudinal follow-up to assess the long-term impact of the proposed instructional hour allocation. As such, while the exponential scaling framework is promising, its actual effect on student performance, retention, and progression remains untested. Longitudinal studies that track student outcomes after implementation would be necessary to establish causal links and evaluate the sustained benefits of this approach.

3. Discussion

3.1. Perceived Level of Difficulty for Each Topic in the Intervention for Calculus Course

Table 1. Perceived Level of Difficulty for Each Topic in Intervention for Calculus

No.	Topic	STEM		Non-STEM	
		Mean Score	Interpretation	Mean Score	Interpretation
1	The Real Number Systems, Integer Exponents, and Polynomials	2.742	Moderate	3.209	Moderate
2	Factoring Polynomials and Rational Expressions	2.882	Moderate	3.254	Moderate
3	Rational Exponents, Radicals, and Complex Numbers	3.000	Moderate	3.388	Moderate
4	Inequalities	3.067	Moderate	3.522	Difficult
5	Equations in One Variable	3.006	Moderate	3.448	Moderate
6	Systems of Equations	3.045	Moderate	3.507	Difficult
7	Functions	2.764	Moderate	3.388	Moderate
8	Fundamentals of Trigonometry	3.360	Moderate	3.672	Difficult
9	Analytic Trigonometry	3.483	Moderate	3.731	Difficult
10	Applications of Trigonometry	3.444	Moderate	3.761	Difficult
11	Plane Geometry	3.461	Moderate	3.657	Difficult
12	Solid Geometry: Polyhedrons	3.556	Difficult	3.731	Difficult
13	Solid Geometry: Non-Polyhedrons	3.584	Difficult	3.672	Difficult
14	Lines and Planes	3.208	Moderate	3.687	Difficult
15	Conic Sections	3.354	Moderate	3.657	Difficult

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Table 1 presents the perceived level of difficulty of topics in the Intervention for Calculus course, comparing STEM and non-STEM students. Across nearly all topics, non-STEM students consistently reported higher difficulty ratings than their STEM counterparts. While STEM students rated all but two topics ("Solid eometry: Polyhedrons" and "Non-Polyhedrons") as “moderately difficult,” non-STEM students classified 9 out of 15 topics as “difficult,” especially in areas related to geometry, trigonometry, and inequalities. The most challenging topics for both groups were: Solid Geometry: Non-Polyhedrons (STEM: 3.584 | Non-STEM: 3.672), Applications of Trigonometry (STEM: 3.444 | Non-STEM: 3.761), and Analytic Trigonometry (STEM: 3.483 | Non-STEM: 3.731).

This pattern aligns with Cognitive Load Theory (Sweller, 1988), which explains that learners can become overwhelmed when new material is cognitively demanding and not well-supported by prior knowledge. Since non-STEM students had reported less exposure to these topics in high school, it is likely that their cognitive load was higher when encountering these subjects in college.

Topics related to solid geometry and trigonometry were consistently ranked among the most difficult for both groups. Instructional design should recognize the mismatch between high school preparation and college expectations, particularly for non-STEM learners.

A closer examination suggests that the higher difficulty ratings among non-STEM students may be attributable not only to curricular gaps but also to socio-academic factors. Many non-STEM senior high school strands (e.g., HUMSS, ABM) allocate fewer hours to mathematics, creating a preparedness gap compared to STEM tracks where these subjects are taught more extensively and with greater depth. This gap likely translates into reduced fluency with symbolic manipulation, geometric visualization, and problem-solving strategies, all of which are heavily demanded in calculus-related courses.

Beyond curricular exposure, affective factors such as math anxiety may also play a role. Research indicates that students with limited prior success in mathematics often develop heightened anxiety, which negatively impacts working memory and problem-solving performance (Ashcraft & Krause, 2007). Thus, non-STEM students’ higher perceptions of difficulty could partly stem from an emotional-cognitive cycle: lower preparedness leading to anxiety, which in turn amplifies perceptions of difficulty.

Socio-academic influences must also be considered. Non-STEM students may internalize beliefs that mathematics is primarily a “STEM domain,” reinforcing stereotypes that they are less capable in math-intensive tasks. This self-perception can reduce confidence and persistence when tackling challenging material, thereby magnifying the perceived difficulty (Beilock & Maloney, 2015). Conversely, STEM students—socialized within a track that emphasizes mathematical rigor—may approach the same tasks with greater confidence and expectation of success, even when difficulty is objectively high.

Taken together, these findings suggest that differences in difficulty perception are not merely cognitive but are shaped by curricular design, affective responses, and broader academic identity factors. Addressing these issues requires not only adjusting instructional time allocations but also implementing strategies that reduce math anxiety and promote positive mathematical self-concepts among non-STEM learners.

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3.2. Comparison of STEM and Non-STEM Graduates on Perceived Difficulty of Each Topic in Intervention for Calculus

Table 2. Comparison of STEM and Non-STEM Graduates on Perceived Difficulty of Each Topic in Intervention for Calculus

	Grand Mean		p-value	Interpretation
	STEM	Non-STEM		
Perceived Difficulty of Each Topic in Intervention for Calculus	3.20	3.55	1.24019E-07	Significant

Table 2 presents the comparison of the perceived difficulty of topics in the Intervention for Calculus course between STEM and non-STEM graduates. The grand mean of the perceived difficulty ratings was 3.20 for STEM graduates and 3.55 for non-STEM graduates, with a highly significant p-value of 1.24×10^{-7}. This indicates that non-STEM students generally perceived the topics in the course as more difficult compared to their STEM counterparts. The difference is statistically significant, suggesting that students' academic backgrounds play a substantial role in how they experience and interpret mathematical content.

This finding is consistent with previous studies highlighting disparities in calculus readiness between STEM and non-STEM students. Molina (2019) observed that STEM graduates often outperform non-STEM peers in calculus-related subjects due to stronger foundational skills acquired during senior high school. Similarly, Tan and Dejoras (2019) found that STEM students generally exhibit greater confidence and competence in mathematical problem-solving than non-STEM entrants. These performance differences are also influenced by variations in prior knowledge, which affect how students perceive the difficulty of advanced mathematics topics. As Furner and Berman (2003) explain, students with limited math exposure often develop math anxiety and low self-efficacy, which contribute to higher difficulty ratings. This view is reinforced by St Laurent et al. (2014), who emphasized the role of pedagogical support in helping less-prepared students persist in calculus courses. Their findings show that students with weaker preparation benefit from instructional strategies that incorporate scaffolding, multiple examples, and structured problem-solving activities.

The results of this study underscore the need for differentiated instructional planning, especially in courses like Intervention for Calculus that cater to mixed student populations. Since non-STEM students perceive the material as more difficult, they may require more instructional time, targeted review sessions, or specialized teaching strategies to close learning gaps. Tailoring instructional hour allocation based on perceived difficulty can help ensure equitable learning opportunities and improved outcomes for all students, regardless of academic background.

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3.3. Allocation of Instructional Hours for Each Topic in the Intervention for Calculus Course Based on Perceived Difficulty

Table 3. Allocation of Instructional Hours for Each Topic in the Intervention for Calculus Course Based on Perceived Difficulty

No.	Topic	Average Topic Difficulty (STEM and Non-STEM)	Transformed Ratings, e^{m_i} (w_i)	Computed Instructional Hours (h_i)	Proposed Instructional Hours
1	The Real Number Systems, Integer Exponents, and Polynomials	2.87	17.637	3.731	4
2	Factoring Polynomials and Rational Expressions	2.98	19.688	4.165	4
3	Rational Exponents, Radicals, and Complex Numbers	3.11	22.421	4.743	5
4	Inequalities	3.19	24.288	5.138	5
5	Equations in One Variable	3.13	22.874	4.839	5
6	Systems of Equations	3.17	23.807	5.036	5
7	Functions	2.93	18.728	3.962	4
8	Fundamentals of Trigonometry	3.44	31.187	6.597	6.5
9	Analytic Trigonometry	3.55	34.813	7.365	7.5
10	Applications of Trigonometry	3.53	34.124	7.219	7
11	Plane Geometry	3.51	33.448	7.076	7
12	Solid Geometry: Polyhedrons	3.6	36.598	7.742	7.5
13	Solid Geometry: Non-Polyhedrons	3.61	36.966	7.820	8
14	Lines and Planes	3.34	28.219	5.970	6
15	Conic Sections	3.44	31.187	6.597	6.5
		Total	415.986	88.000	88

Table 3 presents the allocation of instructional hours for each topic in the Intervention for Calculus course based on the perceived difficulty ratings of students from both STEM and non-STEM strands. The average difficulty ratings were transformed using an exponential scaling function to generate weight values that emphasize the nonlinear relationship between perceived difficulty and the need for instructional time. This transformation assigns greater importance to topics rated as more difficult, allowing small differences in perceived difficulty to result in significant variations in computed instructional hours. For instance, topics such as "Solid Geometry: Non-Polyhedrons" and "Analytic Trigonometry," which received some of the highest difficulty ratings (3.61 and 3.55, respectively), were assigned the most time, with computed hours of 7.82 and 7.37, and proposed instructional hours of 8 and 7.5. In contrast, topics with lower difficulty ratings such as "The Real Number Systems, Integer Exponents, and Polynomials" (2.87) and "Factoring Polynomials and Rational Expressions" (2.98) were allotted only around 4 hours. The computed instructional hours were proportionally scaled to fit a total of 88 hours, and the proposed instructional hours were rounded to practical values while preserving this total. Overall, this data-driven approach ensures a student-centered allocation of instructional time, providing more support for challenging topics and optimizing the effectiveness of the intervention program.

The use of exponential weighting allows small differences in topic difficulty to translate into meaningful differences in instructional hours. This stands in contrast to linear scaling, which would yield minor hour variations and result in nearly uniform time distribution across topics—failing to address disparities in readiness. As argued by Statsig (2025), exponential growth models are more effective in contexts where inputs (e.g., prior knowledge scores) must yield amplified outputs (e.g., hour allocation) to support decision-making. This technique is particularly appropriate in

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educational settings where differentiated instruction is essential to bridge learning gaps. Further, Cognitive Load Theory (Sweller, 1988; de Jong, 2010) supports allocating more time to complex or unfamiliar content to avoid cognitive overload and support long-term learning.

This data-driven model also promotes equitable instructional practices, ensuring that students, particularly those from non-STEM backgrounds with less preparation in abstract mathematics (Molina, 2019), are given appropriate learning opportunities. The total proposed instructional time was capped at 88 hours, consistent with typical semester course limits, and yet the exponential model allowed for the strategic distribution of these hours. By grounding instructional hour allocation in students' actual learning needs, this model helps advance quality education outcomes in alignment with global education standards (UNESCO, 2015).

4. Conclusions and Recommendations

The findings revealed that non-STEM students consistently perceived higher levels of difficulty across nearly all topics in the Intervention for Calculus course compared to STEM students, particularly in geometry and trigonometry. These findings point to a misalignment between high school preparation and college-level expectations, underscoring the importance of tailoring instructional approaches to support students with varying academic backgrounds.

The statistically significant difference in perceived difficulty between STEM and non-STEM students highlights the influence of academic background on calculus readiness. This indicates the need for differentiated instruction, with additional support structures for non-STEM students, to ensure equitable access to learning and improved mathematical outcomes.

The data-driven allocation of instructional hours using exponential scaling effectively translates students' perceived difficulty into a practical instructional framework. By assigning more time to topics identified as more challenging, the proposed schedule ensures that instructional efforts are focused where they are most needed. This approach not only promotes a more equitable learning experience but also enhances the potential effectiveness of the Intervention for Calculus course by aligning teaching time with actual student needs.

To address the observed gaps, it is recommended that supplementary review and bridging modules be integrated into the Intervention for Calculus course, particularly for non-STEM students who may lack adequate exposure to prerequisite skills in algebra, geometry, and trigonometry. These modules can be offered prior to or alongside the course to provide students with a stronger foundation for tackling higher-level topics.

In addition, flexible pedagogical approaches such as flipped classrooms and blended learning may be employed for the most challenging topics. By shifting basic content delivery to pre-class activities, class time can instead be used for guided problem-solving, collaborative exercises, and immediate feedback, thereby maximizing active learning opportunities. Instruction should also incorporate scaffolding strategies, including the use of step-by-step worked examples and the gradual removal of supports, as well as peer tutoring initiatives that can help reduce math anxiety and build confidence among less-prepared learners.

At an institutional level, embedding differentiated instruction through tiered problem sets, adaptive learning technologies, and formative assessments would allow instruction to dynamically respond to varying readiness levels and promote more equitable outcomes. Finally, the exponential scaling framework proposed in this study demonstrates scalability

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beyond calculus, as it can be adapted to other disciplines where topic difficulty is unevenly distributed, such as physics, engineering, and even business education. By combining data-driven time allocation with evidence-based instructional practices, educators can more effectively bridge preparation gaps, mitigate affective barriers such as math anxiety, and ensure more inclusive and equitable learning across diverse academic contexts.

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