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From Definition to Need: Redefining the Selected Topics in Mathematics Education Course Through Students' Mastery Profiles

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Abstract

This study aims to analyze mathematics education students' mastery of high school mathematical content and their readiness to teach it, as a basis for redefining the design of the *Selected Topics in Mathematics Education* (*Kapita Selekta*)course. A quantitative descriptive survey design was employed involving 14 mathematics education students at Universitas Kristen Indonesia who were enrolled in the *Kapita Selekta II* course. Data were collected using a questionnaire that assessed students' mastery and willingness to learn and teach 32 high school mathematics topics. Descriptive statistics were used to determine the percentage of mastery and non-mastery for each topic. The findings reveal that only 40.13% of topics were mastered, while 59.87% showed a lack of mastery. Students demonstrated stronger understanding in algebraic and symbolic topics such as sequences, exponents, relations, and matrices, but weaker performance in geometry, trigonometry, and calculus-related topics. Despite these gaps, all respondents expressed a willingness to improve their mastery of mathematical content, with 42.9% being very willing and 57.1% willing to do so. These results suggest that the *Kapita Selekta* course should not be limited to topic selection based on theoretical definitions. Instead, it should be redesigned to respond to students' actual mastery profiles and learning needs. By aligning course content with diagnostic data, the program can strengthen students' mathematical competence and pedagogical readiness to teach effectively at the high school level.

Keywords: mathematical mastery, teaching readiness, mathematics education, *Kapita Selekta*

1. Introduction

Teacher quality has long been recognized as one of the most significant factors influencing students' academic success (Hine & Thai, 2019). In mathematics education, the teacher's role becomes even more critical since mathematics demands deep conceptual understanding, reasoning, and problem-solving skills (Peter, 2012) (Chapman, 2015) (Siagian, Purba, & Simbolon, 2023). Pre-service mathematics teachers, therefore, must be adequately prepared in both pedagogical and content domains to ensure effective classroom instruction (Novikasari, 2020).

Readiness to teach encompasses various components, including professional competence, pedagogical skills, attitudes, and mastery of subject matter (Manasia, Ianos, & Chicioreanu, 2020) (Jacob, John, & Gwany, 2020). Among these, mastery of mathematical content is particularly essential because it forms the foundation upon which teaching competence is built (Novikasari & Dede, 2024). Teachers who possess strong content mastery are more capable of explaining abstract concepts, anticipating students' misconceptions, and applying mathematics to real-world problems (Jeyabal, Vasuki, & Kumar, 2016) (An & Wu , 2012). Conversely, insufficient content mastery may hinder teachers' ability to implement meaningful learning, affecting students' understanding and motivation (Zubaedi , et al., 2021).

In many developing countries, including Indonesia, studies have shown that pre-service mathematics teachers often face challenges in mastering advanced mathematical concepts and applying them pedagogically (Merliza, Loviana, & Winata, 2020). The transition from learning mathematics to teaching mathematics requires a higher level of abstraction and pedagogical flexibility (Lee, Na, & Song, 2020). Senior high school students encounter complex topics such as calculus, trigonometry, and statistics, which demand teachers with deep mathematical understanding and high readiness to teach (Brahier, 2020) (Ditasona, et al., 2025).

Moreover, the implementation of Indonesia's *Kurikulum Merdeka* (Independent Curriculum) emphasizes competency-based and student-centered learning (Simarmata & Wahyuni, 2023), requiring teachers to adapt their teaching approaches, integrate digital tools, and design contextual learning experiences (Kasemsukpipat, 2016). This educational reform poses new demands for teacher readiness, especially among mathematics education students who are preparing to enter the profession. Therefore, assessing their readiness to teach mathematics based on their mastery of mathematical content becomes an important step toward improving teacher education programs (Wang, Utemov, Krivonozhkina, Liu, & Galushki, 2018) (Podkhodova, Snegurova, Stefanova, Triapitsyna, & Pisa, 2020).

The results of this research are expected to provide insights into how well mathematics education programs prepare students to teach mathematics in senior high schools. The study may also inform curriculum development and teaching strategies within teacher education institutions, ensuring alignment between theoretical preparation and the practical demands of teaching.

This study is expected to contribute both theoretically and practically. Theoretically, it enriches the body of knowledge concerning the relationship between mathematical content mastery and teaching readiness in mathematics education. Practically, it provides valuable information for university mathematics education programs to evaluate and enhance their curriculum design, teaching strategies, and assessment systems. Policymakers and educators can also use the findings to design interventions that strengthen pre-service teachers' readiness, ensuring that future

mathematics teachers are competent and confident to meet the demands of senior high school teaching (Agyei, 2012).

The quality of mathematics education in higher education institutions depends largely on how well students master both mathematical content and its pedagogical applications. For mathematics education students, a deep and comprehensive understanding of various mathematical topics is essential not only for academic success but also for future teaching practice (Benken, Ramirez, Li, & Wetendorf, 2015). One of the courses that reflects this integrative goal is the *Selected Topics in Mathematics Education* (often called *Kapita Selekta*). This course allows lecturers to explore a range of mathematical concepts considered essential or emerging in the field of mathematics education. However, the effectiveness of this course greatly depends on students' level of mastery across different mathematical areas. Identifying which topics students have mastered and which they have not is therefore critical to improving the design and implementation of the course.

In many teacher education programs, students enter the *Selected Topics* course after completing a series of fundamental mathematics subjects such as algebra, geometry, calculus, trigonometry, and statistics. Ideally, they should possess adequate mastery of these foundational topics before exploring more advanced or applied mathematical ideas. Nevertheless, research and classroom observations have shown that not all students demonstrate consistent levels of understanding across mathematical domains (Schlesinger & Jentsch, 2016). Some may exhibit strong proficiency in algebraic reasoning but struggle with spatial visualization in geometry, while others may understand calculus concepts but find difficulty applying them in teaching contexts. These discrepancies indicate the need for a systematic evaluation of students' mastery of mathematics topics before and during their engagement in the *Selected Topics* course. However, limited mastery of core mathematical concepts can hinder the development of this pedagogical competence (Abrantes, 2001). For this reason, lecturers need to identify which mathematical materials are already well mastered by students and which require further reinforcement. This process helps ensure that the content selected for the *Selected Topics* course is relevant, attainable, and supportive of students' professional growth as future mathematics teachers.

The significance of this study lies in its contribution to evidence-based curriculum planning. By identifying patterns of mastery and non-mastery, mathematics education programs can make informed decisions about which topics should be prioritized or revisited in *Selected Topics* courses. Furthermore, this information can help lecturers design remedial or enrichment activities that cater to diverse student needs. In a broader context, the findings can also support institutional efforts to align course objectives with national standards for mathematics teacher education, ensuring that graduates are both mathematically competent and pedagogically skilled. Determining which mathematical topics are mastered or not mastered by mathematics education students provides essential input for improving the relevance and effectiveness of the *Selected Topics in Mathematics Education* course. The descriptive survey approach allows educators to obtain a clear picture of students' strengths and weaknesses across various mathematical areas. By doing so, this study contributes not only to the enhancement of the *Selected Topics* curriculum but also to the overall quality of mathematics teacher education programs.

2. Methods

This study employed a quantitative descriptive survey design (Sugiyono, 2015). The purpose of this method was to describe and analyze the level of readiness of mathematics education students to teach mathematics in senior high schools based on their mastery of mathematical content. According to (Creswell & Creswell, 2018), a descriptive survey design is appropriate for studies aiming to collect data from a population or sample to describe characteristics, opinions, or behaviors as they naturally occur. In this research, no treatment or manipulation was conducted; the researcher simply observed and reported the current condition of students' readiness and content mastery for mathematics senior high school level in Indonesia.

The population of this study consisted of all mathematics education students enrolled in the Faculty of Teacher Training and Education at Universitas Kristen Indonesia. The population was chosen by students in Mathematics Education Study program who will teach mathematics in senior high level in the future. The sample was determined using a purposive sampling technique, focusing on students who were currently in the fifth semester of their study. This ensured that participants possessed sufficient exposure to mathematical theory and teaching preparation. The total number of participants was approximately 14 students who take the course of *Kapita Selekta II*. This course is to prepare students to master the mathematical content in senior high school, and preparing students to do the internship program for the next year of their study.

3. Result and Discussion

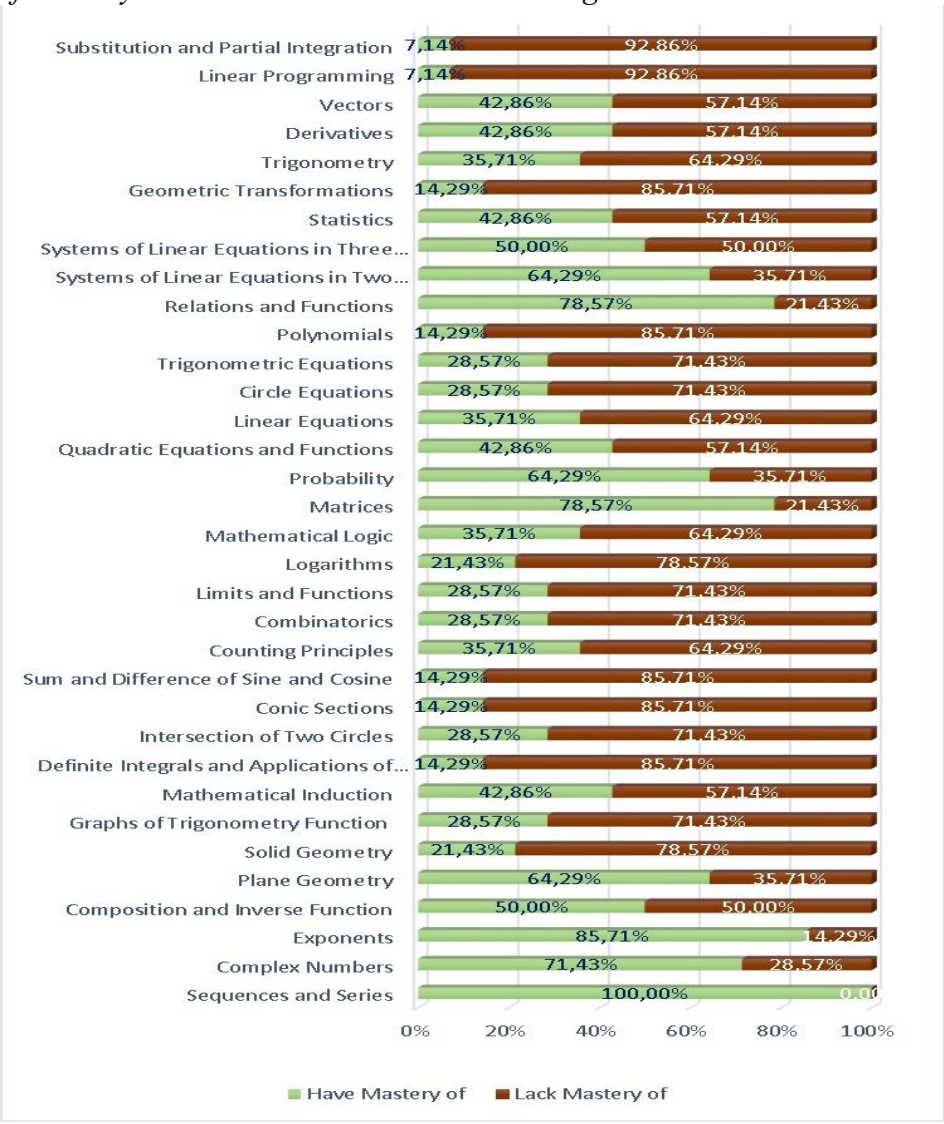
The findings of this study present an overview of mathematics education students' mastery of mathematical content typically taught at the high school level. The data were obtained through a survey in which students indicated whether they had mastered or not mastered a list of major mathematical topics. Figure 1 illustrates the percentage distribution of mastery (Have Mastery of) and non-mastery (Lack Mastery of) across 32 mathematical topics.

Overall, the results reveal a considerable variation in students' mastery levels across different content areas. Only a few topics were found to be highly mastered by most students, while a majority of topics displayed relatively low levels of mastery.

3.1. High-Mastery Topics

The topic with the highest mastery rate was Sequences and Series, with 100% of students indicating mastery. This suggests that students are highly familiar with this topic, likely because it is commonly emphasized in both high school and early university mathematics curricula. Similarly, Exponents (85.71%), Complex Numbers (71.43%), Relations and Functions (78.57%), and Matrices (78.57%) also showed high mastery levels. These results indicate that students generally have strong procedural and conceptual understanding of topics that involve algebraic manipulation and symbolic reasoning.

Figure 1.
Percentage of Mastery Mathematics Content in Senior High School Level



Other topics with moderate to high mastery include Systems of Linear Equations in Two Variables (64.29%)**,** Plane Geometry (64.29%), and Probability (64.29%)**.** These findings imply that students tend to perform well in topics that are more structured and procedural, as opposed to those requiring higher-level conceptual or spatial reasoning.

3.2. Moderate Mastery Topics

A group of topics showed moderate levels of mastery, ranging from 35% to 50% of students reporting understanding. These include Vectors (42.86%), Derivatives (42.86%), Statistics (42.86%), Quadratic Equations and Functions (42.86%), Mathematical Induction (42.86%), Systems of Linear Equations in Three Variables (50%), and Composition and Inverse Functions (50%). The fact that about half or fewer of the students mastered these topics indicates that while the concepts are familiar, many still face difficulties in applying them, especially in complex problem-solving or teaching contexts. For instance, derivatives and vectors are abstract topics that often require strong conceptual visualization, which could explain the relatively moderate level of mastery.

3.3. Low-Mastery Topics

A substantial number of topics exhibited low mastery levels, meaning fewer than 30% of students reported mastering them. These include Linear Programming (7.14%), Substitution and Partial Integration (7.14%), Geometric Transformations (14.29%), Polynomials (14.29%), Sum and Difference of Sine and Cosine (14.29%), Conic Sections (14.29%), and Definite Integrals and Applications of Integrals (14.29%).

This finding suggests that students face the greatest challenges in topics that require advanced reasoning, multi-step processes, or strong geometric and calculus-based understanding. The particularly low mastery in integration and linear programming indicates that these areas may not have been sufficiently reinforced in prior learning experiences or are conceptually more demanding.

Another notable observation is the relatively low mastery in Trigonometry (35.71%), Trigonometric Equations (28.57%), Graphs of Trigonometric Functions (28.57%), and Intersection of Two Circles (28.57%). These topics involve spatial visualization and functional understanding, which are often difficult for students to internalize. Similarly, Solid Geometry (21.43%) and Geometric Transformations (14.29%) showed very low mastery, reinforcing the idea that three-dimensional and transformational thinking pose persistent difficulties among mathematics education students.

From a broader perspective, the findings indicate that students tend to have stronger mastery in algebraic and symbolic topics (e.g., sequences, exponents, relations, matrices) compared to geometric, trigonometric, and calculus-related topics, where mastery rates are significantly lower. This imbalance highlights the need for the Selected Topics in Mathematics Education course to provide targeted reinforcement on areas that are conceptually challenging and less mastered.

The descriptive data suggest that future mathematics teachers may need additional support in strengthening their understanding of advanced topics—particularly those that integrate multiple representations, such as geometry, trigonometry, and calculus. These domains are essential for developing comprehensive pedagogical content knowledge, which enables future teachers to explain abstract concepts effectively to their students.

The survey also explored mathematics education students' willingness to teach mathematics at the high school level. As presented in Table1, the majority of students indicated a positive

attitude toward teaching in senior high schools, although the level of enthusiasm varied among respondents.

Table 1.
Percentage of Willingness of Students Teach High School Level

	Percentage
Very Willing to Teach High School Level	7,1%
Willing to teach High School Level	78,6%
Not Willing to Teach High School Level	14,3%

The data show that 78.6% of students reported being willing to teach at the high school level, while 7.1% stated that they were very willing to teach. This means that a total of 85.7% of respondents demonstrated readiness and interest in pursuing teaching roles at the high school level. Conversely, 14.3% of students reported that they were not willing to teach at that level.

These findings indicate that most mathematics education students possess a strong inclination toward becoming high school mathematics teachers. The high percentage of willingness suggests that students recognize the importance of teaching mathematics at the secondary level and perceive it as a meaningful professional pathway. It also reflects their confidence in handling mathematical content and engaging with adolescent learners, which aligns with the goals of mathematics education programs to prepare competent and motivated future educators.

However, the presence of a small proportion of students is 14.3% who expressed reluctance to teach high school students deserves further attention. This unwillingness may stem from several possible factors, such as limited confidence in mastering complex mathematical topics, anxiety about classroom management at the secondary level, or a preference for other educational or non-teaching careers.

Moreover, the survey also examined the level of willingness among mathematics education students to master mathematical content typically taught in senior high schools. The findings, presented in Table 2, indicate that all respondents expressed a positive attitude toward developing mastery of high school mathematics content, although with varying levels of enthusiasm.

Table 2.
Percentage of Willingness To Mastery Mathematics Content on High School Level

	Percentage
Very Willing to Mastery Mathematics Content on High School Level	42,9%
Willing to Mastery Mathematics Content on High School Level	57,1%

According to the data, 42.9% of students reported being very willing to master high school-level mathematical content, while 57.1% indicated that they were willing to do so. This result

shows that 100% of the respondents demonstrated a willingness to enhance their understanding and mastery of mathematical concepts required for teaching at the secondary level.

Furthermore, the relatively high percentage of students 42.9% who are very willing shows a strong motivation among nearly half of the participants to strengthen their mastery beyond the minimum requirement. This could be attributed to their aspiration to become confident and effective mathematics teachers capable of delivering complex mathematical concepts in a comprehensible way to students.

However, the slightly higher proportion of students who are merely willing rather than very willing (57.1%) may indicate that some students still perceive mastering high school mathematics content as challenging. This might be due to gaps in their prior understanding of advanced mathematical topics

The implications of these findings are twofold. First, curriculum developers should consider using diagnostic assessments such as this survey to identify content gaps before students begin the Selected Topics course. This ensures that the course content can be tailored to address specific weaknesses. Second, mathematics education lecturers should incorporate remedial and enrichment strategies to bridge conceptual gaps, especially in topics requiring spatial reasoning and calculus-based applications.

Overall, the descriptive data reveal that all respondents have a positive disposition toward mastering mathematical content, demonstrating readiness to build the knowledge base essential for teaching mathematics at the secondary level. This strong willingness forms a solid foundation for developing their teaching readiness and professional competence as future mathematics educators.

The findings of this study highlight that mathematics education students show a high level of willingness both to master mathematical content and to teach at the high school level. However, the data also indicate that not all areas of mathematics are equally well mastered. Several topics, such as integration, linear programming, and conic sections, remain challenging for many students. This disparity suggests that there is a need for teacher education programs to adapt their curriculum design to address students' actual learning needs rather than relying solely on traditional course definitions.

In this regard, the *Kapita Selekta* course plays a crucial role as a bridge between theoretical mathematical knowledge and its pedagogical application. The results imply that the content of this course should not be determined merely by its formal description or textbook structure. Instead, it should be developed based on diagnostic information regarding students' mastery levels of mathematical content less than 50% mastery of students, around 24 topics such as substitution and partial part, linear programming, vectors, derivatives, trigonometry, geometric transformations, statistics, polynomials, trigonometric functions, circle equations, linear equations, quadratic equations, mathematical logic, logarithms, limit and functions, Combinatorics, Counting principal, sum and differences of sine and cosine, conic sections, intersection of two circle, definite integral, mathematical induction, graph of trigonometry, and solid geometry. By doing so, the course can serve as a platform for reinforcing areas where students show limited understanding, thereby enhancing their readiness to teach mathematics effectively.

4. Conclusion

The findings of this study show that among 32 mathematical topics, only 40.13% were mastered by students, while 59.87% indicated a lack of mastery at the high school level. Students demonstrated stronger understanding in algebraic and symbolic topics such as sequences, exponents, relations, and matrices, whereas their mastery of geometry, trigonometry, and calculus-related concepts was relatively weak. This imbalance reveals the need for targeted reinforcement in more complex and conceptually demanding areas of mathematics.

Despite these variations in content mastery, mathematics education students exhibited a generally positive attitude toward both mastering mathematical content and teaching at the high school level. All respondents showed motivation to strengthen their mastery, with 42.9% being very willing and 57.1% being willing to do so.

Overall, the results indicate that while students possess strong motivation to become competent mathematics teachers, their understanding across mathematical domains remains uneven. Therefore, the Selected Topics in Mathematics Education (*Kapita Selekta*) course should not be limited to choosing a few theoretical topics based on its formal definition. Instead, it must be designed to respond to students' actual learning needs by facilitating the mastery of challenging mathematical concepts. Through this approach, the course can better prepare future teachers with the confidence, competence, and pedagogical readiness required to teach mathematics effectively at the high school level.

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