From Mathematics Achievement to Inclusive Mathematics Teacher Readiness: Developing an Evidence-Based Framework for Pre-service Mathematics Teachers

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ABSTRACT:
Preparing pre-service mathematics teachers for inclusive classrooms requires both mathematical competence and pedagogical readiness. This study examined mathematics achievement as an indicator of inclusive mathematics teacher readiness and developed an evidence-based Inclusive Mathematics Teacher Readiness Framework (IMTRF). An explanatory sequential mixed-methods design was employed involving 161 pre-service mathematics teachers from nine Teacher Education Institutions in the Philippines. Quantitative data were collected using a researcher-developed Mathematics Achievement Test (MAT), while qualitative data were obtained through open-ended questionnaires from 27 purposively selected participants. Descriptive statistics, thematic analysis, and triangulation were used to integrate the findings. Results revealed satisfactory mathematics achievement, with strengths in Numbers and Number Sense and Patterns and Algebra, but learning gaps in Measurement, Geometry, Statistics and Probability, and higher-order problem-solving. Four themes influencing teacher readiness emerged: personal learning factors, quality of teacher preparation, challenges in learning mathematics, and recommendations for strengthening teacher education. Based on these findings, the Inclusive Mathematics Teacher Readiness Framework (IMTRF) was developed, positioning mathematics achievement as a diagnostic indicator for identifying competency needs and guiding targeted interventions. The framework provides teacher education institutions with an evidence-based approach for preparing competent, reflective, and inclusive mathematics teachers capable of addressing diverse learner needs.

Keywords: inclusive teacher education, mathematics achievement, mathematics teacher readiness, pre-service mathematics teachers, teacher preparation

1. Introduction

Background of the Study

Preparing mathematically competent teachers has become increasingly important as classrooms become more diverse and inclusive. Teacher education institutions are therefore expected to develop pre-service mathematics teachers who possess not only strong mathematical knowledge but also the pedagogical competence, professional dispositions, instructional adaptability, and self-efficacy needed to support equitable learning for diverse learners (Scherer & Bertram, 2024).

While mathematics achievement has traditionally been viewed as an indicator of academic performance, it is increasingly recognized as an important source of evidence of mathematics teacher readiness. Teacher readiness is a multidimensional construct that includes mathematical content knowledge, pedagogical competence, instructional confidence, and professional judgment. Research indicates that teacher education experiences strengthen readiness for inclusive mathematics instruction by enhancing pre-service teachers' beliefs, competence, and teaching self-efficacy (Scherer & Bertram, 2024). Consequently, mathematics achievement can serve not only as a measure of competence but also as a diagnostic tool for identifying strengths, learning gaps, and areas requiring targeted support.

The preparation of competent mathematics teachers remains a global educational priority because teacher quality significantly influences students' mathematical learning. Mathematics education requires teachers who can integrate strong content knowledge with responsive and inclusive instructional practices (Ashkenazi & Velner, 2023). Likewise, Abu Talib et al. (2025) emphasized that mathematics teachers should be prepared through the development of mathematical competence, pedagogical expertise, and professional readiness, while Frischemeier et al. (2025) highlighted instructional adaptation as essential for meeting the needs of diverse learners.

Recent studies further demonstrate that mathematics teacher readiness develops through authentic learning experiences and continuous professional preparation. Strengthening mathematical content knowledge, pedagogical content knowledge, and classroom experiences enhances readiness for teaching (Yılmaz, 2022; Dwirahayu et al., 2024; Njiku, 2025). Furthermore, equitable mathematics instruction is promoted through differentiated teaching, culturally responsive pedagogy, and learner-centered instructional strategies (Lee & Herner-Patnode, 2025). Collectively, these studies suggest that mathematics teacher readiness extends beyond content mastery to include the competencies needed for inclusive and effective mathematics instruction.

Analysis of the Problem

Mathematics Achievement Tests are widely used to assess the mathematical competence of pre-service teachers, yet their results are often interpreted only as measures of academic performance. Limited attention has been given to how achievement data, competency profiles across mathematics content strands, and pre-service teachers' learning experiences collectively inform mathematics teacher readiness. Consequently, teacher education institutions have limited empirical evidence to guide interventions that strengthen both mathematical competence and pedagogical readiness for inclusive teaching.

To address this gap, the present study examines the Mathematics Achievement Test performance of pre-service mathematics teachers from selected Teacher Education Institutions in one province in the Philippines. By integrating quantitative evidence of mathematical competence with qualitative insights into the factors influencing readiness for teaching, the study develops an evidence-based Inclusive Mathematics Teacher Readiness Framework (IMTRF). The framework is intended to assist teacher education institutions in diagnosing readiness, identifying competency priorities, designing targeted interventions, and

strengthening the preparation of future mathematics teachers for diverse and inclusive classrooms.

Specifically, the study aims to: (1) determine the Mathematics Achievement Test performance of pre-service mathematics teachers; (2) identify their strengths and learning gaps across mathematics content strands; (3) explore their perceptions regarding the factors influencing their mathematical competence and readiness for teaching; and (4) develop an evidence-based Inclusive Mathematics Teacher Readiness Framework (IMTRF).

2. Methodology

Research Instruments

Two research instruments were used. The first was a researcher-developed Mathematics Achievement Test (MAT) consisting of multiple-choice items covering the major mathematics content strands in the Bachelor of Secondary Education major in Mathematics curriculum. The test was developed from the program outcomes and curriculum competencies, validated by mathematics education experts, pilot-tested, and subjected to item analysis and reliability testing. Participants' proficiency levels were interpreted using the classification of Pacis (2018) with modifications appropriate to the study.

The second instrument was an open-ended questionnaire administered to selected participants to explore their perceptions of the factors influencing their mathematics achievement. The guide questions focused on learning experiences, instructional practices, study habits, motivation, self-regulation, learning resources, and other factors affecting mathematical learning.

Data Gathering Procedure

Approval to conduct the study was obtained from the participating Teacher Education Institutions (TEIs). Program Chairpersons identified three pre-service mathematics teachers from each institution representing relatively high-, average-, and low-performing students based on their overall academic standing for participation in the qualitative phase.

The researcher administered the Mathematics Achievement Test (MAT) to 161 pre-service mathematics teachers under standardized conditions. After the test, the purposively selected participants completed the open-ended questionnaire. Quantitative data were scored and analyzed to determine mathematics achievement and competency profiles, while qualitative responses were subjected to thematic analysis. Findings from both phases were integrated to develop the Inclusive Mathematics Teacher Readiness Framework (IMTRF).

Statistical Treatment of Data

Quantitative data were analyzed using descriptive statistics, including frequency, percentage, mean, standard deviation, and mean percentage score, to describe mathematics achievement and identify strengths and learning gaps across the mathematics content strands. Qualitative data were analyzed through thematic analysis to identify the factors influencing mathematics achievement and to provide explanations for the quantitative findings.

Development of the Inclusive Mathematics Teacher Readiness Framework (IMTRF)

The IMTRF was developed through an evidence-based framework development process. Quantitative findings identified participants' mathematical competence, strengths, and learning gaps, while qualitative findings explained the instructional, cognitive, motivational, and learning-related factors influencing achievement. Both datasets were triangulated to identify the essential components of mathematics teacher readiness and to develop a framework that supports diagnosis of readiness, identification of priority competencies, and the design of targeted interventions for continuous improvement in teacher education

3. Results and Discussions

Performance of the Pre-service Mathematics Teachers in the Mathematics Achievement Test In this portion, the performance of the pre-service mathematics teachers in the Mathematics Achievement Test is presented. The test items were categorized according to strand and were analyzed to determine the pre-service mathematics teachers' performance in each strand.

Table 1. Performance of Pre-service Mathematics Teachers in the Mathematics Achievement Test

Content Strand	Item Number	Number of Items	Mean	Standard Deviation	Proficiency Level	Performance
Numbers and Number Sense G7	1	5	4.27	0.78	Proficient	Very Good
	2					
	3					
	4					
	5					
Measurement G7	6	3	2.34	0.77	Proficient	Very Good
	7					
	8					

Legend:	Mean Ranges (For 5 Items)	Proficiency Level	Performance	Mean Ranges (For 3 Items)	Proficiency Level	Performance
	4.51 – 5.00	Expert	Excellent	2.67 – 3.00	Expert	Excellent
	3.76 – 4.50	Proficient	Very Good	2.33 – 2.66	Proficient	Very Good
	3.01 – 3.75	Competent	Good	1.99 – 2.32	Competent	Good
	2.26 – 3.00	Developing	Somewhat Good	1.65 – 1.98	Developing	Somewhat Good
	1.51 – 2.25	Adv. Beginner	Fair	1.31 – 1.64	Adv. Beginner	Fair
	Below 1.51	Novice	Needs Improvement	Below 1.31	Novice	Needs Improvement

Content Strand	Item Number	Number of Items	Mean	Standard Deviation	Proficiency Level	Performance
Patterns and Algebra G7	9	4	3.13	0.88	Proficient	Very Good
	10					
	11					
	12					
Patterns and Algebra G8	23	4	3.18	0.86	Proficient	Very Good
	24					
	25					
	26					
Patterns and Algebra G9	37	4	2.61	0.98	Competent	Good
	38					
	39					
	40					
Patterns and Algebra G10	47	4	3.36	0.96	Proficient	Very Good
	48					
	49					
	50					
Geometry G7	13	4	3.14	0.87	Proficient	Very Good
	14					
	15					
	16					
Geometry G8	27	4	2.70	0.93	Competent	Good
	28					
	29					
	30					
Geometry G9	41	6	4.17	1.15	Competent	Good
	42					
	43					
	44					
	45					
	46					
Geometry G10	51	5	3.73	0.94	Competent	Good
	52					

	53					
	54					
	55					
Statistics and Probability G7	17	6	4.42	1.14	Competent	Good
	18					
	19					
	20					
	21					
	22					

Legend:	**Mean Ranges (For 6 Items)**	**Proficiency Level**	**Performance**	**Mean Ranges (For 4 Items)**	**Proficiency Level**	**Performance**
	5.51 – 6.00	Expert	Excellent	3.51 – 4.00	Expert	Excellent
	4.51 – 4.50	Proficient	Very Good	3.01 – 3.50	Proficient	Very Good
	3.51 – 4.50	Competent	Good	2.51 – 3.00	Competent	Good
	2.51 – 3.50	Developing	Somewhat Good	2.01 – 2.50	Developing	Somewhat Good
	1.51 – 2.50	Adv. Beginner	Fair	1.51 – 2.00	Adv. Beginner	Fair
	Below 1.51	Novice	Needs Improvement	Below 1.51	Novice	Needs Improvement

Content Strand	**Item Number**	**Number of Items**	**Mean**	**Standard Deviation**	**Proficiency Level**	**Performance**
Statistics and Probability G8	31	6	4.24	0.99	Competent	Good
	32					
	33					
	34					
	35					
	36					
Statistics and Probability G10	56	5	3.29	1.22	Competent	Good
	57					
	58					
	59					
	60					

Legend:	Mean Ranges (For 6 Items)	Proficiency Level	Performance	Mean Ranges (For 5 Items)	Proficiency Level	Performance
	5.51 – 6.00	Expert	Excellent	4.51 – 5.00	Expert	Excellent
	4.51 – 4.50	Proficient	Very Good	3.76 – 4.50	Proficient	Very Good
	3.51 – 4.50	Competent	Good	3.01 – 3.75	Competent	Good
	2.51 – 3.50	Developing	Somewhat Good	2.26 – 3.00	Developing	Somewhat Good
	1.51 – 2.50	Adv. Beginner	Fair	1.51 – 2.25	Adv. Beginner	Fair
	Below 1.51	Novice	Needs Improvement	Below 1.51	Novice	Needs Improvement

Table 1 shows that the pre-service mathematics teachers demonstrated very good performance in Numbers and Number Sense, indicating strong proficiency in the foundational concepts of mathematics. Mastery of these fundamental concepts likely contributed to their competence in higher mathematics courses, as prior knowledge serves as the basis for understanding more advanced mathematical ideas. This finding also suggests the development of metacognitive skills, enabling learners to plan, monitor, and regulate their learning processes. Metacognition, defined as the ability to reflect on and regulate one's thinking, is recognized as a critical component of successful learning because it promotes self-regulation and strategic learning (Mitchell, 2015). Likewise, Denson and Seltzer (2011) reported that students' academic achievement improves when they are taught metacognitive strategies and given opportunities for self-regulated learning, while Briggs (2014) emphasized that authentic, real-life mathematical tasks enhance learners' appreciation of the relevance of mathematics.

The participants also demonstrated very good performance in Patterns and Algebra, particularly at the Grade 10 level, suggesting competence in applying algebraic concepts such as polynomial functions and equations. These topics serve as important foundations for mathematical modeling and problem-solving in real-world contexts (Boelkins et al., 2017). In general, the participants obtained a Good level of performance in the Mathematics Achievement Test, indicating satisfactory mathematical competence while also highlighting the need for continuous instructional improvement. These findings suggest that although the pre-service teachers possess a solid mathematical foundation, targeted interventions remain necessary to strengthen higher-order mathematical thinking and support their readiness for effective mathematics teaching. Furthermore, strong background knowledge has been shown to facilitate the acquisition of new learning and improve academic performance (Knight, 2018)

Strengths and Learning Gaps in Pre-service Mathematical Knowledge and Skills

In this section, the strengths and gaps in pre-service mathematics teachers' knowledge and skills were identified by analyzing their performance on the Mathematics Achievement Test.

Table 2. Strengths and Learning Gaps Across the Different Mathematics Content Strands

Mathematics Content Strand	Performance	Readiness Indicator	Competency Need
Numbers and Number Sense	Very Good	Strong conceptual foundation	Maintain competency
Patterns and Algebra	Very Good	Strong algebraic reasoning	Extend higher-order applications
Measurement	Good	Adequate procedural knowledge	Strengthen conceptual understanding
Geometry	Good	Adequate spatial reasoning	Improve geometric reasoning
Statistics and Probability	Good	Basic statistical literacy	Enhance data interpretation and application
Problem Solving (derived from overall findings)	Developing/Needs Enhancement	Emerging analytical competence	Strengthen higher-order problem-solving skills

Table 2 summarizes the strengths and learning gaps identified from the Mathematics Achievement Test, providing evidence of both mathematical competence and mathematics teacher readiness. Strengths in Numbers and Number Sense and Patterns and Algebra indicate strong conceptual and procedural knowledge that supports readiness to teach foundational mathematics. In contrast, learning gaps in Measurement, Statistics and Probability, and higher-order problem-solving highlight the need to strengthen conceptual understanding, analytical reasoning, and application skills.

These findings suggest that mathematics teacher readiness encompasses both demonstrated competencies and areas requiring further development. Thus, mathematics achievement serves not only as an indicator of academic performance but also as a diagnostic tool for identifying competency needs and informing evidence-based interventions in teacher education. However, mathematics achievement alone does not fully explain teacher readiness. Understanding the contextual factors that influence pre-service teachers' competence and professional preparation is equally important and is explored in the succeeding section through participants' perceptions of their learning experiences.

Perceptions on the Factors that have Influenced Mathematical Competence and Readiness for Teaching

In this section, the perceptions of pre-service mathematics teachers regarding the factors that have influenced their mathematical competence and readiness for teaching were explored. To preserve anonymity, the researcher used participant codes like HP, AP, LP for high-, average-, and low-performing students, and 1-9 for the nine TEIs. This was done to see that the perspectives come from participants with different academic performance profiles.

Table 3. Perceptions of Selected Pre-service Mathematics Teachers on the Factors Influencing Their Mathematical Competence and Teacher Readiness

Emergent Theme	Subtheme	Exemplar Texts
Personal Factors Supporting Mathematical Competence	Effective study habits	I always review lessons before and after class. [HP2]
	Problem-solving practice	I practice solving different types of mathematical problems every day. [HP6]
	Interest in mathematics	My interest in mathematics motivates me to learn even difficult topics. [AP8], [LP5]
	Learning management	Managing my study time helps me prepare for my mathematics subjects. [AP1]
	Learning initiative	I ask questions whenever I do not understand a lesson. [HP4], [HP7], [AP1]
Quality of Mathematics Teacher Preparation	Quality teaching	Our professors explain concepts clearly using different strategies. [AP2], [HP8]
	Interactive learning experiences	Group problem-solving activities helped me understand abstract concepts. [LP7], [AP4]
	Experiential learning	Microteaching activities improved my confidence in teaching mathematics. [AP5]
Challenges in Learning Mathematics	Insufficient learning opportunities	Some higher mathematics courses were difficult because we had limited practice exercises. [LP3], [HP9]
	Time constraints	Balancing coursework and internship responsibilities was challenging. [LP8], [AP2]
	Complex mathematical concepts	Some topics like Calculus and Statistics required more instructional time. [LP6], [LP5]
Recommendations for Strengthening Teacher Preparation	Mathematics enrichment	Provide regular mathematics enhancement and review classes. [AP9], [AP1]
	Authentic teaching practice	Expose students to more classroom-based teaching experiences. [AP8], [HP7]
		Integrate technology and AI tools in solving mathematical problems. [HP4], [HP2]
		Assign faculty mentors who can guide students individually. [AP3]
		Offer more problem-solving competitions and mathematics workshops. [HP6], [HP7]

Table 3 identified four themes influencing the mathematical competence and readiness of pre-service mathematics teachers: Personal Factors Supporting Mathematical Competence, Quality of Mathematics Teacher Preparation, Challenges in Learning Mathematics, and Recommendations for Strengthening Teacher Preparation. These findings indicate that mathematics teacher readiness is a multidimensional construct shaped by personal, pedagogical, instructional, and institutional factors.

The first theme emphasizes self-regulated learning behaviors, including effective study habits, regular problem-solving practice, motivation, and time management, as essential for developing mathematical competence. This

supports the work of Zimmerman (2002), who highlighted self-regulated learning, and Hattie (2009), who identified self-regulation and deliberate practice as strong influences on academic achievement. The second theme underscores the role of quality teacher education through clear instruction, collaborative learning, and authentic teaching experiences such as microteaching. These findings align with Shulman's (1986) concept of pedagogical content knowledge and the National Council of Teachers of Mathematics (2014), which advocates instructional practices that promote conceptual understanding.

The third theme identifies barriers to competence, including limited practice opportunities, insufficient instructional time, and competing academic responsibilities. These findings are consistent with Mayer (2002), who emphasized meaningful learning through active knowledge construction, and Boaler (2016), who highlighted productive struggle in developing deep mathematical understanding. The fourth theme recommends mathematics enrichment, mentoring, authentic teaching experiences, workshops, and the integration of digital technologies and artificial intelligence to strengthen teacher preparation, supporting UNESCO (2023) and the International Society for Technology in Education (ISTE, 2017).

The qualitative findings demonstrate that mathematics teacher readiness extends beyond mathematics achievement and is shaped by the interaction of learner characteristics, quality teacher preparation, instructional experiences, and institutional support, consistent with Darling-Hammond (2006). Together with the quantitative findings, these results informed the development of the Inclusive Mathematics Teacher Readiness Framework (IMTRF), an evidence-based framework designed to diagnose teacher readiness, identify competency needs, enhance curricula, and strengthen inclusive mathematics teacher preparation.

The Developed Evidence-Based Inclusive Mathematics Teacher Readiness Framework (IMTRF)

In this section, the Evidence-Based Inclusive Mathematics Teacher Readiness Framework (IMTRF) is developed through the integration of the results on mathematical competence and the teacher education. findings on the factors influencing teacher readiness, providing an evidence-based model for strengthening mathematics

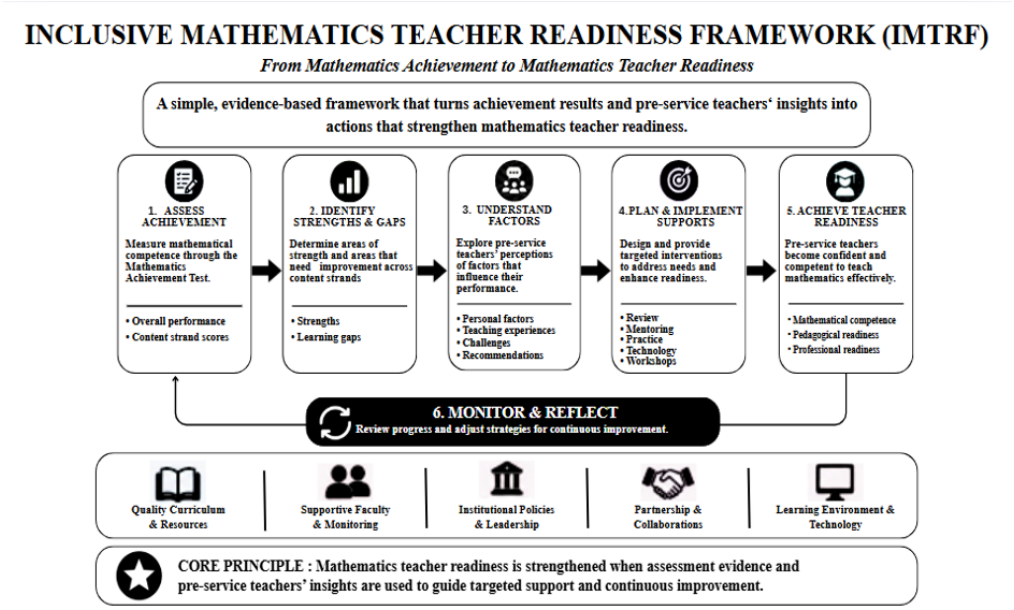

Figure 1. The Developed Evidence-Based Inclusive Mathematics Teacher Readiness Framework (IMTRF)

Based on the study findings, the Inclusive Mathematics Teacher Readiness Framework (IMTRF) is proposed as an evidence-based model that positions mathematics achievement as a diagnostic indicator of mathematics teacher readiness. The framework views readiness as a continuous process of assessment, diagnosis, contextual understanding, targeted intervention, and reflective improvement by integrating quantitative evidence of mathematical competence with qualitative insights into the factors influencing teacher readiness.

The framework begins with Assessing Achievement, where the Mathematics Achievement Test evaluates mathematical competence and informs quality improvement in teacher education (Abu Talib et al., 2025). Identifying Strengths and Gaps analyzes performance across mathematics content strands

to determine competency needs and guide targeted interventions (Dwirahayu et al., 2024). Understanding Factors examines personal learning behaviors, teacher preparation, learning challenges, and institutional support, recognizing that teacher readiness develops through authentic learning experiences and continuous professional growth (Yılmaz, 2022; Njiku, 2025). Planning and Implementing Supports translates these findings into evidence-based interventions, including mathematics enrichment, faculty mentoring, authentic teaching experiences, and technology-enhanced learning, reinforcing assessment as a tool for instructional improvement (Abu Talib et al., 2025).

The framework culminates in Achieving Inclusive Mathematics Teacher Readiness, characterized by mathematical competence, pedagogical readiness, professional confidence, and inclusive teaching practices. A continuous Monitor and Reflect cycle, supported by quality curricula, mentoring, collaborative partnerships, leadership, technology, and learning resources, promotes ongoing improvement. By integrating quantitative and qualitative evidence, the IMTRF provides Teacher Education Institutions with a systematic model for diagnosing readiness, identifying competency needs, and strengthening inclusive mathematics teacher preparation.

4. Conclusion

The findings demonstrate that mathematics achievement provides valuable evidence of mathematics teacher readiness among pre-service mathematics teachers. Although the participants generally demonstrated satisfactory mathematical competence, their performance revealed strengths in Numbers and Number Sense and Patterns and Algebra, as well as learning gaps in Measurement, Geometry, Statistics and Probability, and higher-order problem-solving. These results indicate that mathematics teacher readiness extends beyond overall achievement and requires balanced competence across the major mathematics content strands. The qualitative findings further revealed that readiness is shaped by the interaction of personal learning behaviors, quality teacher preparation, learning challenges, and institutional support, affirming that mathematics teacher readiness is a multidimensional construct influenced by both individual and contextual factors.

Drawing on the integration of the quantitative and qualitative findings, the study developed the Inclusive Mathematics Teacher Readiness Framework (IMTRF), which positions mathematics achievement as a diagnostic indicator of teacher readiness rather than merely a measure of academic performance. The framework provides Teacher Education Institutions with an evidence-based approach for identifying competency strengths and learning needs, informing targeted interventions, and supporting continuous improvement in mathematics teacher preparation. By integrating mathematical competence with contextual factors influencing teacher development, the IMTRF contributes to inclusive teacher education by providing a practical model for preparing mathematically competent, reflective, and professionally prepared mathematics teachers who are equipped to respond effectively to the diverse needs of learners.

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