

Professional Ability System and Effective Strategies in Enhancing Teaching Competence Among Mathematics Student Teachers

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Abstract: This study compares mathematics student-teachers' professional ability system and instructional practices. Content, pedagogical, technical, classroom management, and reflective practice were examined as part of their professional ability system. Modeling, guided practice, co-teaching, differentiation, technology integration, formative assessment, and collaborative learning were also assessed. The study also examined if student-teachers' professional ability system affects their math teaching practices. Content knowledge and effective teaching practices, especially modeling and guided practice, are strongly correlated. Teaching tactics and pedagogical knowledge are strongly correlated, underscoring their value in guided practice and collaborative learning. Although technological skill has a moderate association, it is essential for using digital tools in mathematics instruction. Collaboration in teaching is highly linked to classroom management skills. Modeling, guided practice, and formative assessment are strongly correlated with pedagogical content knowledge. Reflective practice is linked to all teaching styles, demonstrating its importance in improving mathematics education and permitting varied teaching methods. Modeling is linked to content, pedagogical, and reflective practice in teaching methodologies. Guided practice correlates well with content, pedagogical, and reflective practice. Classroom management and pedagogical content knowledge are closely related to co-teaching. Differentiation tactics strongly correlate with reflective practice and technical competency. Classroom management and reflective practice are strongly correlated with technology integration. The association between formative evaluation and reflective practice and differentiation is substantial. Reflective practice and differentiation are strongly linked in collaborative learning environments. For effective mathematics instruction, a full professional ability system must include topic knowledge, pedagogical understanding, technical competence, classroom management skills, and reflective practice. These components enable varied teaching methodologies, improving mathematical education. These components together shape effective mathematics instruction, as shown by the substantial correlations.

Keywords: Knowledge; Pedagogical Understanding; Technical Competence; Classroom Management Skills; Reflective Practice.

1. Introduction

The development of effective teaching strategies to improve student learning outcomes is a major focus in the area of education (Indeed Editorial Team, 2023). In the field of mathematics education, student-teachers must have a solid professional ability system and use effective ways to promote teaching competence.

The professional ability system of mathematics student-teachers includes a number of critical components. The cornerstone of good mathematics education is content knowledge, which allows student-teachers to have a thorough comprehension of mathematical ideas and principles. Pedagogical knowledge is also significant because it provides student-teachers with the instructional tactics and pedagogical approaches required for successful mathematics teaching in the classroom. In today's digital era, technological competency is becoming more important, allowing student-teachers to incorporate technology tools and resources into their teaching methods. Classroom management abilities are required for establishing a learning atmosphere, sustaining student involvement, and encouraging healthy classroom dynamics. The capacity of student-teachers to successfully combine subject knowledge with pedagogical knowledge to facilitate students' comprehension and learning of mathematics is referred to as pedagogical content knowledge. Finally, reflective practice enables student-teachers to

critically analyze their teaching techniques, reflect on their instructional choices, and make appropriate modifications in order to constantly improve their teaching practices (Tang et al, 2021).

It is critical to discover successful solutions that correspond with the core components of the professional ability system in order to improve teaching competence among mathematics student-teachers. Modeling, guided practice, co-teaching, differentiation, technology integration, formative assessment, and collaborative learning are some of the strategies that have shown promise in increasing student engagement, knowledge, and accomplishment in mathematics. These tactics empower student-teachers to design meaningful learning experiences, meet the needs of various students, and establish a pleasant and inclusive classroom atmosphere (The Editorial Team, 2023).

1.1. Theoretical Framework

The Technological Pedagogical Content Knowledge (TPACK) framework may serve as a theoretical foundation for this research, giving a lens through which to examine and improve mathematics student-teachers' teaching skills. Technology, pedagogy, and topic knowledge are all critical components of TPACK.

Reflective Practice, which provides a systematic strategy for student-teachers to participate in critical self-reflection and continual development of their mathematics teaching

practices, might serve as a theoretical foundation for this research. It highlights the significance of actively examining teaching experiences, soliciting feedback, and utilizing this knowledge to make informed judgments and changes in instructional practices.

1.2. Definition of Terms

Classroom Management Skills. Classroom management skills refer to the student-teachers' abilities to establish a positive and conducive learning environment in the mathematics classroom. It encompasses their skills in organizing the physical space, managing student behavior, establishing routines, fostering a respectful classroom culture, and addressing individual student needs.

Co-Teaching. Co-teaching refers to the collaborative partnership between the student-teachers and mentor teachers or experienced educators in planning, delivering, and assessing mathematics lessons. It involves shared responsibilities, joint decision-making, and complementary roles to enhance the teaching and learning experience.

Collaborative Learning. Collaborative learning refers to the student-teachers' promotion and facilitation of learning experiences that encourage peer interaction, cooperation, and shared knowledge construction. It includes their ability to design and implement group work, cooperative learning structures, and problem-solving activities that foster collaboration, communication, and active engagement among students in the mathematics classroom.

Content Knowledge. Content knowledge refers to the student-teachers' depth and breadth of understanding in mathematical concepts, principles, and procedures. It encompasses their knowledge of mathematical content relevant to the grade level they will be teaching, including the ability to apply and explain mathematical concepts accurately.

Differentiation. Differentiation, refers to the student-teachers' ability to adapt instructional methods, materials, and assessments to meet the diverse needs of students in the mathematics classroom. It includes their skills in modifying and tailoring instruction based on students' abilities, learning styles, interests, and backgrounds.

Formative Assessment. Formative assessment refers to the student-teachers' use of ongoing assessments and feedback to monitor student progress and inform instructional decisions. It includes their ability to use a variety of formative assessment strategies, such as questioning techniques, observations, and informal assessments, to gauge student understanding and adjust instruction accordingly.

Guided Practice. Guided practice refers to the student-teachers' facilitation of structured and supportive practice opportunities for students to reinforce and apply mathematical concepts. It includes their ability to provide clear instructions, offer guidance and feedback, and scaffold learning experiences to support students' understanding and skill development.

Integration of Technology. Integration of technology refers to the student-teachers' incorporation and effective use of digital tools, software, and resources in their mathematics instruction. It encompasses their ability to integrate technology seamlessly into lessons, utilizing relevant technology resources to enhance student engagement, understanding, and learning outcomes.

Modeling. Modeling refers to the student-teachers' ability to demonstrate and guide students through the thought processes and problem-solving steps involved in solving

mathematical problems. It includes their skills in effectively presenting mathematical concepts and procedures through real-life examples, visual representations, and logical reasoning.

Pedagogical Content Knowledge. Pedagogical content knowledge refers to the student-teachers' ability to effectively integrate their content knowledge with pedagogical strategies in mathematics instruction. It includes their understanding of how to teach specific mathematical concepts, select appropriate examples and representations, design meaningful learning experiences, and address common misconceptions or difficulties that students may encounter.

Pedagogical Knowledge. Pedagogical knowledge refers to the student-teachers' understanding of effective instructional strategies, teaching methods, and approaches specific to mathematics education. It includes their knowledge of instructional techniques, assessment methods, differentiation strategies, and student engagement strategies that promote effective teaching and learning of mathematics.

Reflective Practice. Reflective practice refers to the student-teachers' engagement in critical self-reflection on their teaching practices. It involves actively analyzing their instructional experiences, seeking feedback from mentors or peers, and using this information to make informed decisions and improvements in their teaching approaches. Reflective practice includes the ability to identify strengths and areas for growth and the willingness to adapt and refine instructional practices accordingly.

Technological Competence. Technological competence, as operationalized in this study, refers to the student-teachers' ability to effectively and purposefully use technology tools, software, and digital resources in their mathematics instruction. It includes their proficiency in utilizing educational technology to enhance teaching and learning experiences, such as using interactive whiteboards, educational software, or online resources.

2. Methodology

2.1. Research Design

The research utilized a cross-sectional research strategy, gathering data from a selected group of mathematics student-teachers through the administration of surveys or questionnaires. The tests were specifically developed to assess the perceptions of student-teachers, their self-evaluation of teaching tactics, and their judgment of their own proficiency in mathematics instruction. The primary objective of this study was to investigate the correlations between the fundamental elements of the professional ability system and the approaches employed by student-teachers of mathematics to improve their teaching proficiency.

The research design did not entail the manipulation of variables or the implementation of interventions. Instead, it primarily aimed to investigate the magnitude and direction of correlations between the identified variables within their natural setting. The present study has yielded significant findings about the determinants of teaching proficiency among mathematics student-teachers, so increasing the current body of knowledge in the field of mathematics education.

2.2. Sampling Technique

The research employed purposive sampling as a method for selecting Mathematics student-teachers from five specific

colleges in China to serve as participants. The selection criterion for respondents encompassed several factors, namely enrolment in a Mathematics education program, active engagement in teaching practicum, varied degrees of teaching experience, and a range of academic performance. The study employed a deliberate approach by specifically selecting respondents who were enrolled in Mathematics education programs and were pursuing a degree in this field. This assured that the participants had a distinct emphasis on Mathematics instruction. The respondents' practical teaching experience and significant insights into their teaching techniques and competency were ensured by their active involvement in the teaching practicum.

2.3. Research Instrument

The instrumentation section of this study centered on the data collection approach, which entailed the utilization of a custom-designed questionnaire. This questionnaire was specifically crafted to elicit information pertaining to the fundamental elements of the professional ability system, as well as effective teaching strategies and the evaluation of student-teachers' approaches to teaching mathematics. The researchers constructed the questionnaire by drawing upon the findings of the literature study and aligning it with the research objectives. In order to ascertain the credibility and consistency of the questionnaire, a comprehensive validation procedure was undertaken. The content validity of the questionnaire was evaluated by specialists in the field of Mathematics education and evaluation. The questionnaire items were assessed by specialists in terms of their relevance, clarity, and comprehensiveness.

The questionnaire that was developed by the researcher, incorporating the modifications suggested during the validation and pilot testing stages, was employed for the purpose of data collection. The selected respondents for this study were Mathematics student-teachers from five universities in China. The questionnaire was administered to these participants. Comprehensive instructions were given to guarantee uniform comprehension and precise replies.

2.4. Statistical Treatment

Descriptive Statistics

In order to summarize the quantitative data, descriptive figures were made. To explain the variables of interest, measures like means, standard deviations, frequencies, and percentages were calculated. This made it possible to get a rough idea of how the data were spread out and what they were like.

Correlation Analysis

Correlation analysis was done to look at how the factors were related to each other. This study looked at the strength and direction of the links between the key parts of the professional ability system, teaching strategies, and how student-teachers' teaching methods for math were evaluated. Statistics like Pearson's correlation coefficient or Spearman's rank correlation coefficient were used to figure out how big and important the relationships were.

Regression Analysis

Regression analysis was done to find out how different factors could be used to predict each other. Multiple regression analysis could have been used to see how the key parts of the professional ability system and teaching methods affected the review of student teachers' ability to teach math.

This study showed how much the differences in the dependent variable were caused by changes in the independent variables.

3. The Relationship between Student-Teachers' Professional Ability System and Their Strategies in Teaching Mathematics

Table 1. The correlation matrix summarizes the measurement of the relationship between student-teachers' professional ability systems and their strategies in teaching mathematics

Correlation Matrix						
	CK	PCK	TC	CMS	PCK	RP
Modeling	0.77 < .001	0.77 < .001	0.85 < .001	0.53 < .001	0.76 < .001	0.48 < .001
Guided Practice	0.66 < .001	0.67 < .001	0.57 < .001	0.62 < .001	0.76 < .001	0.73 < .001
Co-Teaching	0.64 < .001	0.66 < .001	0.63 < .001	0.69 < .001	0.67 < .001	0.64 < .001
Differentiation	0.60 < .001	0.66 < .001	0.58 < .001	0.69 < .001	0.78 < .001	0.83 < .001
Integration of Technology	0.63 < .001	0.63 < .001	0.72 < .001	0.59 < .001	0.76 < .001	0.67 < .001
Formative Assessment	0.63 < .001	0.65 < .001	0.62 < .001	0.72 < .001	0.82 < .001	0.82 < .001
Collaborative Learning	0.38 < .001	0.45 < .001	0.37 < .001	0.70 < .001	0.65 < .001	0.83 < .001

Legend: .00-0.19: Very Weak; 0.20-0.39: Weak; 0.40-0.59: Moderate; 0.60-0.79: Strong; 0.80-1.00: Very Strong

The correlation matrix summarizes the measurement of the relationship between student-teachers' professional ability systems and their strategies in teaching mathematics. The analysis of Spearman's rho correlation revealed p-values of <.001, which are lower than the 0.05 level of significance for all the domains, suggesting that the null hypothesis will be rejected and that there is a significant relationship between the variables. Specifically, key components of a professional ability system that include Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Competence (TC), Classroom Management Skills (CMS), Pedagogical Content Knowledge (PCK), and Reflective Practice (RP) are correlated with strategies in teaching mathematics that are composed of modeling, guided practice, co-teaching, differentiation, integration of technology, formative assessment, and collaborative learning, with correlation coefficients that range from 0.38 to 0.85 (weak to very strong relationship). The correlation coefficients are positive, indicating that as the level of key components of the professional ability system increases, so does the assessment of strategies in teaching mathematics, and vice versa.

Specifically, the correlation matrix offers significant insights into the interconnections among various teaching methodologies and fundamental conceptions within the field of mathematics education. Significantly, a number of robust and highly robust associations arise, providing insight into the interrelatedness of efficacious pedagogical strategies. The significant positive associations between Modeling and both Content Knowledge (CK) and Pedagogical Content Knowledge (PCK) highlight the critical role of a teacher's competence in the subject matter and their pedagogical

abilities when employing modeling strategies. This implies that educators who possess a more profound comprehension of the content and employ efficient instructional techniques are more inclined to demonstrate mathematical concepts effectively to their students. Likewise, it has been observed that Guided Practice exhibits robust positive associations with both CK and PCK, underscoring the significant interdependence between proficient guided practice techniques and a teacher's mastery of subject matter and pedagogical topic knowledge. This discovery highlights the importance of teachers' expertise in both the content and teaching methods when implementing guided practice in the field of mathematics education.

In contrast, the practice of Co-Teaching demonstrates significant positive associations with Classroom Management Skills (CMS) and Reflective Practice (RP). This suggests that the effectiveness of co-teaching approaches is closely connected to a teacher's proficiency in classroom management and engagement in reflective practice. The implementation of effective classroom management practices and continuous reflection is necessary in order to enhance the teaching-learning experience through collaborative efforts among educators.

There exists a significant positive link between differentiation and Reflective Practice (RP), as well as a substantial positive correlation between differentiation and Technological Competence (TC). This implies that educators who actively engage in reflective practice and demonstrate proficiency in technology are more inclined to successfully apply differentiation tactics. These tactics are designed to accommodate the varied learning requirements of pupils, and the significance of reflection and competency in technology is essential in this context.

The integration of technology exhibits robust beneficial associations with Classroom Management Skills (CMS) and Reflective Practice (RP). This emphasizes the significance of proficient classroom management and thoughtful practice while incorporating technology into the realm of mathematics instruction. Educators who demonstrate exceptional proficiency in these domains are more adept at using technology to facilitate enriched educational encounters.

Formative assessment demonstrates robust beneficial associations with Reflective Practice (RP) and differentiation. This suggests that educators who actively participate in reflective practice and include differentiation tactics demonstrate greater proficiency in utilizing formative assessment methods to facilitate student learning and development.

Finally, there is a significant positive relationship between Collaborative Learning and Reflective Practice (RP) as well as Differentiation. This statement highlights the notion that educators who adopt reflective practice and differentiation tactics are properly equipped to cultivate collaborative learning settings in which students actively participate with their classmates to augment their comprehension of mathematics.

4. Conclusion

4.1. Evaluation of the Fundamental Elements of Professional Competence in Mathematics Student-Teachers

The system emphasizes the importance of possessing a solid foundation of subject knowledge, expertise in pedagogy,

proficiency in technology, efficient classroom management skills, pedagogical content knowledge, and a commitment to reflective practice in order to adequately train educators who are capable of effectively transmitting mathematical concepts while utilizing contemporary teaching approaches.

4.2. The Assessment's Implications Underscore the Importance for Student-teachers to Cultivate a Wide Range of Pedagogical Skills

These skills encompass a solid grasp of subject matter, adept classroom management, pedagogical content knowledge, and the ability to engage in reflective teaching. By acquiring these skills, student-teachers can proficiently employ various teaching strategies in mathematics education, such as modeling, guided practice, co-teaching, differentiation, integration of technology, formative assessment, and collaborative learning.

4.3. It is Important for Student-teachers to Give Priority to Reflective Practice Because of its Significant Impact on the Alignment of their Professional Ability System with Teaching Strategies

Additionally, the interconnectedness of pedagogical content knowledge and content knowledge is essential for effectively implementing diverse teaching strategies in the context of mathematics education.

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