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Effects of Microteaching Combined with Questioning Techniques on the Mathematics Teaching Ability of Student Teachers at Zhoukou Normal University

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Abstract

Background and Aims: As basic education reform in China continues to deepen, expectations for teachers' teaching abilities have increased. As normal universities that train teachers for basic education, they face limitations in traditional teaching models and can no longer meet the needs of cultivating high-quality student teachers. This study aims to explore the effectiveness of Microteaching combined with Questioning Techniques in improving the mathematics teaching ability of third-year Student Teachers majoring in mathematics at Zhoukou Normal University, and to assess whether the intervention can help Student Teachers meet the 70% mastery criterion.

Methodology: This quasi-experimental study adopts a one-group post-test design, and 20 third-year student teachers majoring in mathematics from Zhoukou Normal University are selected as the research subjects through cluster sampling. Implement teaching interventions that Microteaching integrates (pre-class preview, in-class case analysis, repeatable practice training, feedback, and reflection) and Questioning Techniques (question chains, timely questioning). The intervention lasts for 7 weeks with a total of 21 class hours, covering modules related to mathematics teaching abilities (design, implementation, reflection, evaluation). The study collected data through a mathematics teaching ability rubric assessment form and a satisfaction questionnaire, and used SPSS software to conduct descriptive statistics and a one-sample t-test for analysis.

Results: One-sample t-test results revealed that participants' overall teaching ability score (M = 53.55, SD = 5.23, out of 64) was significantly higher than the preset 70% criterion score (44.8), t =7.49, p < .01, Cohen's d = 1.67, indicating a large effect size. Scores across all four sub-dimensions also significantly exceeded the criterion. Moreover, participants reported high levels of course satisfaction (M = 61.15, SD = 4.86, out of 75), significantly surpassing the 70% criterion (52.5), t = 7.96, p < .01, with all sub-dimensions meeting or exceeding the threshold. These findings suggest

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that the intervention successfully achieved its intended outcomes in both competence enhancement and learner acceptance.

Conclusion: This study indicates that an integrated course combining Questioning Techniques is positively associated with student teachers' attainment of teaching ability standards, and that student receptivity to this approach is favorable. The observed effectiveness may be attributed to the dual synergy between behavioral rehearsal, Microteaching, and Questioning Techniques as cognitive scaffolding—the former facilitating the automation of pedagogical ability through simulated practice and iterative feedback, the latter externalizing instructional decision-making and promoting reflective adjustment via question-driven inquiry. This study provides preliminary empirical evidence for shifting the focus of practical training in teacher education from discrete ability acquisition toward integrated competence development. The limitations of this study include: a single-group post-test design without a control group or pre-test, which limits the ability to make causal inferences; the sample is only from a single institution, and the external validity needs to be further tested in future studies by expanding the sample, adding a control group, and conducting follow-up measurements.

Keywords: Mathematics Teaching Theory Course; Questioning Techniques; Mathematics Teaching Ability; Student Teachers' Satisfaction; Microteaching

Introduction

In recent years, the Ministry of Education has issued a series of policy documents, such as the National Standards for Teaching Quality of Undergraduate Programs in Regular Institutions of Higher Education, which emphasize the unique value and important role of mathematics and propose that student teachers majoring in mathematics should not only master systematic theoretical knowledge but also possess strong thinking ability, dialectical awareness, and practical ability. This reflects the transformation of curriculum reform from "knowledge-oriented" to "education-oriented" (Guo, 2022).

As a core course for training mathematics student teachers, Mathematical Teaching Theory is a key bridge connecting disciplinary knowledge and middle school mathematics teaching practice. However, according to the analysis of literature research in recent years, this course still has deficiencies in meeting the requirements of course reform. Taking Zhoukou Normal University as an example, through structured interviews with student teachers and reviewing relevant materials such as the course system, it is found that the current course content and teaching materials focus on theoretical elaboration, while neglecting the cultivation of practical teaching ability, resulting in a disconnection between theoretical learning and the practice of mathematics classrooms in primary and secondary schools. Teaching strategies centered on textbooks restrict student teachers from having practical operation opportunities, which hinders the development

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of their high-level cognitive abilities such as knowledge integration and problem-solving (Yang, 2015); the course evaluation method relies excessively on exam results (70% for theoretical exams + 30% for attendance rate) and lacks a process-oriented evaluation of the gradual development of teaching abilities (Duan, 2019). The above-mentioned issues have restricted the full play of the training function of this course, and there is an urgent need for a systematic reform of the teaching model.

Microteaching is a systematic, targeted student teacher training model widely adopted in disciplinary professional education with favorable outcomes. The Mathematics Teaching Theory Course encourages student teachers to engage in active exploration and repeated teaching practice, thereby fostering the steady development of their teaching competence. This model breaks the constraints of traditional lecture-based instruction, highlights student teachers' subject status, and effectively bridges the gap between pedagogical theory and classroom practice. Through a structured process of demonstration, hands-on practice, constructive feedback, and reflective summary, student teachers can systematically acquire and internalize core teaching ability in a targeted, evidence-based manner, ultimately achieving comprehensive improvement in their overall teaching ability (Peng & Zheng, 2019).

Questioning Techniques is an effective teaching model. As indicated by Walsh and Sattes (2009, trans. Liu), effective questioning can facilitate student teachers' learning and thinking processes. Given the abstract conceptual systems and rigorous theoretical content of the Mathematics Teaching Theory Course, student teachers often display low learning engagement and superficial learning outcomes. Precise questioning helps them move beyond superficial comprehension of pedagogical concepts and develop higher-order thinking ability, such as analysis and evaluation. Additionally, structured reflective questioning alleviates the situational anxiety and cognitive load of student teachers during their initial practice, enabling them to clearly identify their ability gaps (Tschannen-Moran & Woolfolk Hoy, 2001). Gaining a sense of control and incremental achievement in addressing these gaps enhances their learning motivation, while simultaneously advancing their mathematical pedagogical thinking and knowledge application ability (Yue, 2021).

Although both Microteaching and Questioning Techniques have been proven to be effective methods for cultivating the ability of student teachers, there are still many shortcomings in the current related research. A review of the literature reveals that current studies only conduct theoretical explorations on integrating the two as a strategy for cultivating student teachers' teaching ability, classifying it as an important means to optimize teaching practice. However, they fail to delve into the specific implementation paths of integrating the two and their actual application effects, and also lack quantitative verification of the application effectiveness. At the same time, the disciplinary coverage of related research has not yet extended to the field of

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mathematics teaching theory. This study aims to fill the above gap by implementing Microteaching combined with Questioning Techniques in the Mathematics Teaching Theory Course, focusing on 7 practical themes (such as classroom observation and evaluation). Through the teaching ability test scores after the teaching experiment, the analysis of the advantages and disadvantages of the research design, and the evaluation of student teachers' satisfaction, the practical value of this model in mathematics normal education courses is verified, and operable insights are provided for the reform of mathematics teaching in higher education.

Objectives

1. To compare student teachers' mathematics teaching ability after learning through the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques, with the criterion of 70 %.

2. To compare student teachers' satisfaction after implementing the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques, with the criterion set at 70%.

Literature Review

Mathematics Teaching Theory Course Based on Microteaching Combined with Questioning Techniques.

Microteaching is a student teacher's training model that relies on modern audio-visual technology. Its core value lies in deconstructing the holistic teaching process into specific teaching abilities, allowing for targeted practice within a miniaturized, observable, evaluable, and controllable training setting (Peng & Zheng, 2019). This model enables student teachers to experiment with various teaching strategies, obtain timely feedback, and make iterative adjustments so as to improve their professional ability and promote student teachers' engagement (Iliasova et al., 2025). Compared with traditional student teacher training models centered on theoretical instruction, it highlights learner autonomy and provides an effective approach to bridging the gap between educational theory and practice (Park, 2022). However, when overemphasizing rote imitation of operational procedures at the expense of pedagogical thinking development, it may give rise to "ability rigidity," leaving student teachers inadequately prepared to deal with authentic challenges in the mathematics classroom (Liu, 2023).

Questioning Techniques represent a key instructional strategy and a core medium for guiding student teachers' deep engagement and active thinking. Through hierarchical and progressive questioning design, instructors can guide student teachers to engage in active learning, collaborative interaction, and problem analysis, stimulate their critical thinking, and promote the

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development of their cognitive level from knowledge memorization to higher-order abilities such as analysis and evaluation (Walsh & Sattes, 2009). Meanwhile, embedding immediate feedback and positive guidance into teaching practice helps student teachers accumulate initial professional experience, effectively reduce learning anxiety, and gradually build confidence in responding to classroom situations. This supports the transformation of teaching ability from mechanical imitation to flexible application (He, 2023) and provides a feasible solution to the problem of "ability rigidity" that may arise in Microteaching. Although Questioning Techniques offer clear advantages, excessive use can easily deviate from the core goals of education. Therefore, this study will rationally design the types, methods, and timing of questions based on student teachers' cognitive levels, ensuring that questioning is fully aligned with the attainment of teaching objectives.

The integration of Microteaching and Questioning Techniques is supported by constructivism and information processing theory. From the perspective of constructivism, this provides student teachers with a practical environment close to real classrooms, enabling them to construct their teaching cognition independently. Meanwhile, Questioning Techniques can act as a cognitive scaffold to promote deep reflection and gradually help them form independent teaching thinking. From the perspective of information processing theory, decomposes complex teaching activities into trainable specific ability, reducing the cognitive load of information processing for student teachers and facilitating their knowledge reception and processing; in turn, Questioning Techniques guide learners to conduct in-depth cognitive processing, thereby accelerating the internalization and absorption of teaching knowledge and achieving the transformation of teaching ability from mastery to flexible application.

Although the two approaches demonstrate clear theoretical compatibility, existing studies indicate that empirical research remains scarce on whether the integration of Microteaching and Questioning Techniques can effectively enhance the teaching competence of student teachers when applied to mathematics teacher education. To fill this research gap, this study incorporates Microteaching and Questioning Techniques into the Mathematics Teaching Methodology course. Through instructional procedures including theoretical instruction, case analysis, ability practice, multiple rounds of feedback, re-teaching, and reflective summary, this study seeks to promote the internalization and transfer of student teachers' professional knowledge and improve their teaching ability.

Mathematics teaching ability

A review of the relevant literature reveals a substantial body of research on the classification of mathematical teaching ability. Researchers generally concur that a scientific and systematic classification of teaching ability enables more targeted teacher training, thereby effectively

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enhancing the overall instructional proficiency of student teachers (Jiang, 2022; Song, 2019; Zhao, 2022). Within the context of basic education, mathematical teaching ability can be specifically delineated into four dimensions: teaching design ability, teaching implementation ability, teaching evaluation ability, and teaching reflection ability. These abilities play a critical role in primary and secondary mathematics classrooms. However, at the initial stage of professional development, student teachers frequently experience challenges and anxiety due to limited exposure to authentic teaching contexts. Traditional teacher education models tend to emphasize the mastery and comprehension of theoretical knowledge, while providing insufficient opportunities for situational simulation and practical training. This pedagogical approach restricts student teachers' ability to effectively integrate theoretical principles with classroom practice, leading to relatively underdeveloped teaching ability. This study integrates Questioning Techniques to address these problems. By providing student teachers with ample situated practice opportunities, this integrated model aims to bridge the gap between theory and practice, thus directly responding to the challenges identified above.

Conceptual Framework

In this research, the independent variable is the implementation of the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques, and the dependent variables are mathematics teaching ability and student teachers' satisfaction with this course.

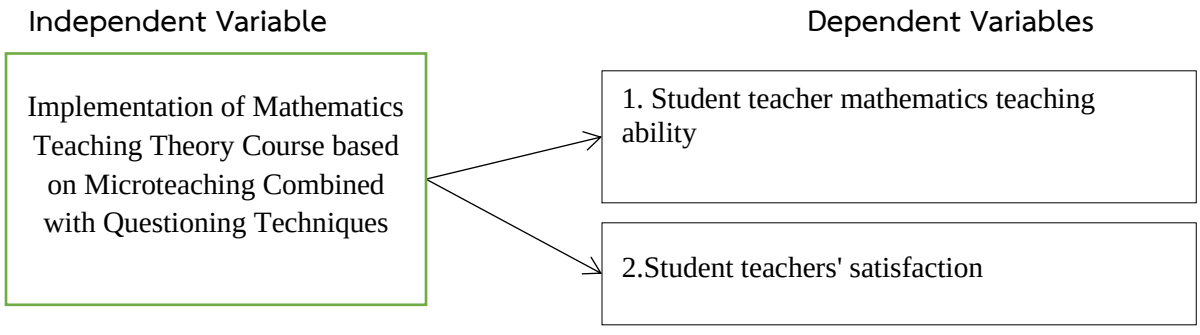


Figure 1 The Independent Variable and Dependent Variables

Methodology

1. Participants and Sampling: This study included 120 third-year mathematics student teachers from four classes at Zhoukou Normal University in Henan Province, China, during the 2024–2025 academic year. The university was chosen because of its well-established mathematics

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education programs, which provided a suitable environment for researching innovative teaching methods. Cluster sampling was used to select 20 student teachers (1 class) as the research sample. These student teachers include 11 female student teachers and 9 male student teachers. Their academic performance is relatively stable, with little difference among individuals, and none of them has experience in learning mathematics teaching theory or teaching practice. This method was adopted to support the effectiveness of implementing the seven teaching steps that are combined with Questioning Techniques. It should be noted that the sample size of this study is small, which may limit the generalizability of the research results. Future studies can expand the sample size and select multiple classes or multiple schools for research to improve the external validity of the results.

2. Research Instruments: All research instruments were revised per the feedback of five mathematics education professors with over 10 years of experience, followed by SPSS-based validity (IOC) and reliability (Cronbach's Alpha) tests to ensure the study's scientific implementation. Details are as follows:

2.1 Experimental Intervention Instruments:

2.1.1 Mathematics Teaching Theory Course based on Microteaching combined with Questioning Techniques

This course design includes seven core iterative steps, aiming to combine the modular ability training of Microteaching with the cognitive guidance of Questioning Techniques. The teaching process lasts 3 class hours (150 minutes), with the specific steps as follows: Step1Theoretical guidance- Before the class, teachers provide student teachers with course-related materials and design targeted questions to help student teachers prepare for independent study; Step2 Organize classroom observations and discussions (25 minutes)—Teachers organized group members to watch videos of high-quality teaching cases. Through pre-set questions, key teaching point reminders, and group discussions, combined with professional commentary and systematic summarization, they helped teacher trainees understand the core elements of teaching ability. Step 3: Determining training objectives and lesson plan writing (25minutes)- Building upon the knowledge constructed in the preceding stages, group members collaboratively discuss and develop teaching strategies and write lesson plans. Teachers observe and circulate, identifying design flaws in each group and providing guidance as needed. Step 4: Teaching practice and simulation (25minutes)- During the teaching and training period, student teachers take turns to assume the roles of "teacher," "student," and "evaluator" to carry out simulated teaching practice; teachers observe and record student teachers' teaching performance on-site. Step 5: Multi-Source Evaluation and Feedback (20 minutes)- After reviewing the teaching videos, student teachers conduct self-evaluation and peer evaluation. Finally, the teacher provides professional feedback

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and poses relevant guiding questions to help student teachers reflect on their shortcomings and clarify areas for improvement. Step 6: Lesson plan refinement and re-teaching (20 minutes)- Based on the feedback results, team members improved the teaching plan content and carried out the teaching. Step 7: Summary and reflection (15 minutes)- Teachers summarize common problems and practical experiences based on different types of questions, while student teachers reflect on the teaching process and write teaching practice reports. Five experts evaluated the draft course, in 26 items (including principles, objectives, content, strategies, resources, and evaluation) of the course evaluation form, the lowest mean score was 4.00 (SD=0.71), and the highest mean score was 4.80 (SD=0.45). It was revealed that the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques was at a high level (M=4.40, SD=0.61).

2.1.2 Lesson plan: A 21-hour teaching plan has been formulated for the Mathematics Teaching Theory Course, divided into 7 modules (3 class hours each):1) Mathematics classroom Teaching Design, 2) Mathematics classroom Introduction, 3) Mathematics classroom asking questions, 4) Mathematics classroom Lectures, 5) Mathematics classroom management, 6) Mathematics classroom observation and evaluation,7) Mathematics classroom post-lesson reflections. Five experts evaluated the lesson plans on 14 items (For example, the consistency between learning objectives and content) of the lesson plans evaluation form; the lowest mean score was 4.29 (SD=0.63), and the highest mean score was 4.53 (SD=0.51). It was revealed that lesson plans were at a high level (M=4.40, SD=0.57).

2.2 Assessment Instruments

2.2.1 Mathematics teaching ability rubric assessment form: The form comprises 16 items (For example, whether the teaching objectives in the teaching design are clear, etc.) centered on four core abilities: teaching design, implementation, evaluation, and reflection. Each item is rated on a scale from 1 (poor) to 4 (excellent). The Item Objective Congruence (IOC) values for the items in the form ranged from a minimum of 0.80 to a maximum of 1.00. Analysis of the IOC indices confirmed that all items were appropriate and suitable for use in the form. An analysis of the form's internal consistency was also conducted, revealing a reliability coefficient of 0.89, which exceeds the 0.70 threshold. This showed that the quality of the form was good (Cronbach, 1951). Two specialists independently scored 20 student teachers who were not in the sample for this research draft on teaching ability using a rubric. Inter-rater reliability (ICC) was .989 (95% CI: .971–.995), with Cronbach's Alpha at .989, and F-test results ($p < .001$) confirmed high agreement. This supports the rubric's reliability for assessing teaching ability.

2.2.2 Student Teachers satisfaction questionnaire: This questionnaire includes 15 evaluation items across four dimensions: course content, learning activities, teaching materials, and assessment (such as the clarity of the course content). The questionnaire uses a 5-point scale

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(1 = very low to 5 = very high). Five experts reviewed the questionnaire for content validity, with IOC values of all items ranging from 0.80 to 1.00, validating the appropriateness of the questionnaire items. The internal consistency reliability of the questionnaire was calculated as Cronbach's Alpha = 0.80 (Cronbach, 1951), which exceeded the 0.70 benchmark, demonstrating that the questionnaire met the reliability requirements for empirical research.

3. Data Collection: 1) The participants participated in the Microteaching Combined with Questioning Techniques -based Mathematics Teaching Theory Course as the teaching intervention. 2)After completing the course intervention, the participants completed the Mathematics Teaching Ability post-test via the designated assessment instrument. 3)The student teachers' satisfaction questionnaire was administered to the participants right after the post-test (response rate = 100%).

4. Data analysis: In this study, data were analyzed using statistical methods according to the research objectives:1) Compare student teachers' Mathematics Teaching Ability after learning through the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques, with the criterion of 70 %, by using a t-test for the sample. 2) Analyze the student teachers' satisfaction with the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques using Cronbach's Alpha method (Cronbach, 1951) and determine the level of student teachers' satisfaction.

Limitations of methodology

1. Sample Size: This study selected only 20 student teachers as research subjects. The small sample size may limit the generalizability of the findings. Future research should expand the sample to include institutions from different regions and types to enhance external validity.

2. Research Design: This study employed a single-group post-test design, which presents limitations in internal validity. Potential confounding variables—such as participant maturation, testing effects, and teacher expectations—were not effectively controlled. Future studies should adopt quasi-experimental designs incorporating control groups and pre-tests to more accurately isolate the net effect of the intervention.

3. Long-Term Effects: This study measured student teachers' mathematics teaching ability only immediately following the intervention, without examining long-term retention or transfer to authentic classroom contexts. Future research should include follow-up assessments, such as post-internship evaluations, to verify the sustained impact of the Microteaching combined with Questioning Techniques model.

Results

According to the research objectives, the results were as follows:

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1. The result of comparing the student teachers' Mathematics Teaching Ability after learning through the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques, with the criterion of 70 percent, by using a t-test for dependent samples.

Table 1 The results of student teacher mathematics Teaching Ability after learning through the Mathematics Teaching Theory Course, based on Microteaching Combined with Questioning Techniques, with the criterion of 70 %

Components	n	Full score	Criteria score 70%	M	SD	t	p	Cohen's d
1)Teaching design ability	20	16	11.2	14.30	1.17	11.81**	<.01	2.65
2)Teaching implementation ability	20	28	19.6	23.60	2.39	7.48**	<.01	1.67
3)Teaching evaluation ability	20	12	8.4	9.45	1.28	3.68**	<.01	0.82
4)Teaching reflection ability	20	8	5.6	6.20	0.89	3.00**	<.01	0.67
Overall (Mathematics Teaching Ability)	20	64	44.8	53.55	5.23	7.49**	<.01	1.67

**p<.01

As shown in Table 1, the one-sample t-test revealed that mean scores for all dimensions and overall mathematics teaching ability exceeded the 70% criterion, with standard deviations ranging from 0.89 to 5.23, indicating stable and consistent intervention effects. The t-values for each dimension and overall ability ranged from 3.00 to 11.81 ($p < .01$), demonstrating statistically significant improvement in student teachers' teaching ability following the course intervention. However, effect sizes (Cohen's d) varied across dimensions from 0.67 to 2.65, with teaching reflective ability showing relatively weaker improvement ($d = 0.67$). This may be attributed to student teachers' limited prior experience, learning environment, and individual reflective tendencies. As Korthagen (2004) noted, developing reflective ability requires a learning environment that supports core reflection, enabling student teachers to integrate external behaviors with internal beliefs. Overall, these findings confirm the effectiveness of the Microteaching Combined with Questioning Techniques approach in enhancing mathematics teaching ability. Nevertheless, the uneven effect sizes across dimensions suggest that future course implementation should incorporate targeted scaffolding support tailored to specific ability areas.

2. The results of analyzing student teachers' satisfaction after implementing the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques.

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Table 2 The student teachers' satisfaction with the Mathematics Teaching Theory Course based on Microteaching Combined with Questioning Techniques.

Components	n	Full score	Criteria score 70%	M	SD	t	p	Cohen's d
1. Teaching content	20	20	14	16.65	1.50	7.92**	<.01	1.77
2. Instructional strategy	20	30	21	24.35	2.46	6.10**	<.01	1.36
3. Teaching materials	20	10	7	8.05	0.89	5.29**	<.01	1.18
4. Evaluation	20	15	10.5	12.10	1.33	5.37**	<.01	1.20
Overall	20	75	52.5	61.15	4.86	7.96**	<.01	1.78

**p<.01

As shown in Table 2, one-sample t-test results indicated that mean satisfaction scores for all dimensions and overall satisfaction were significantly higher than the 70% criterion score (t = 5.29–7.92, all p < .01). The standard deviations ranged from 0.89 to 2.46, suggesting low variability and consistent intervention effects across participants. Effect sizes (Cohen's d) ranged from 1.18 to 1.78, indicating large practical significance across all dimensions. However, satisfaction with teaching materials (d=1.18) was comparatively lower than other dimensions (d=1.20–1.77), which may reflect student teachers' expectations for more diverse or authentic learning resources. Overall, these findings confirm the effectiveness of Microteaching combined with a Questioning Techniques-based approach in enhancing student satisfaction, though future course iterations should consider offering greater flexibility in material selection.

Discussions

1. This result found that after the implementation of the course, student teachers' teaching ability significantly exceeded the 70% standard. This result provides support for Research Hypothesis 1. Two theoretical frameworks can explain this outcome. First, based on information processing theory, the course broke down abstract teaching concepts into sequential, progressive learning steps. This "small-step" approach helped student teachers effectively encode and initially process complex information (Iliasova et al., 2025). Contextualized cases also provided support for student teachers to connect theoretical understanding with practical application. Second, drawing on constructivism, the course adopted a hierarchical training model. Theoretical

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guidance helped activate students' prior experiences and trigger cognitive conflicts, while collaborative case analysis allowed them to construct knowledge through interactions with peers and instructors. Lesson plan design and practical exercises followed an "extraction-application" cycle: theoretical knowledge was activated and tested in simulated teaching scenarios, eventually integrating scattered learning content into a systematic framework of professional teaching ability (Jonassen, 2011).

Notably, the improvement in student teachers' teaching reflection ability was relatively modest. As a higher-order cognitive skill, the development of reflection requires long-term, systematic training. The current intervention model was more effective in enhancing basic teaching skills than in promoting in-depth reflection. In addition, student teachers' lack of prior teaching experience, coupled with individual differences in their learning foundations and cognitive levels, further limited the depth and scope of their reflection (Yue, 2021). Given these limitations, future research should focus on factors such as the accumulation of practical experience and individual cognitive differences. It should also develop a phased system for cultivating reflection skills and combine multiple intervention methods to identify effective ways to enhance in-depth reflective ability.

2. This result found that student teachers held positive attitudes toward the course. This result provides support for Research Hypothesis 2. The core factors contributing to high course satisfaction include: the contextual nature of Microteaching (training based on real classroom practice), the autonomy given to student teachers (allowing student teachers to design instruction based on their own knowledge system and learning experience), the interactivity of Questioning Techniques, and the relevance of teaching ability training content to job requirements. Li (2022) found that diverse teaching strategies can accommodate different learner preferences and sustain motivation throughout the learning process. Student teachers particularly valued the feedback provided by supervising teachers through targeted questions. This clear and constructive guidance helped them identify learning gaps and clarify directions for improvement (Lauermann & Hagen, 2021). Positive feedback also reduced academic pressure and negative emotions, contributing to a better overall learning experience. As Ye (2021) noted, effective teaching feedback plays a crucial role in enhancing instructional quality and fostering learner engagement.

Despite generally high satisfaction levels, certain areas require further attention. Student teachers reported relatively lower satisfaction with the teaching resources and materials provided. This finding carries practical implications: when designing and implementing instructional models that integrate Microteaching with Questioning Techniques, educators should account for individual differences, design differentiated activities, and offer tiered learning resources. Those with weaker teaching skills or limited technical abilities need adequate support and targeted guidance.

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Moreover, teachers should continuously improve technology tools—such as online interactive platforms—based on student feedback to enhance both teaching quality and overall course satisfaction.

Limitations of the study:

Regarding research design, this study employed a post-test-only quasi-experimental design, which may restrict the internal validity and generalizability of the findings. The observed improvement in student teachers' teaching ability could be attributed to confounding factors, such as maturation effects, testing effects, or teacher expectations—rather than exclusively to the intervention integrating with Questioning Techniques. Furthermore, the small sample (N=20) comprising student teachers from a single class in one institution limits the external validity, making it difficult to generalize the results to a wider population of pre-service mathematics teachers. Future studies could adopt experimental or quasi-experimental designs with control groups to further validate the effectiveness of the integrated Microteaching combined with the questioning technique approach. Increasing the sample size across multiple classes or institutions, as well as conducting longitudinal follow-up assessments, would help overcome the present limitations and strengthen the robustness of the findings.

Recommendations

Practices Recommendations

1. Develop a comprehensive teaching resource library. The course should establish a specialized teaching resource library aligned with the core modules of the Mathematics Teaching Theory Course, providing students with integrated learning materials and research-based frameworks. This library should include video demonstrations of effective practices, sample lesson plans incorporating targeted Questioning Techniques, and analytical case studies of common mathematics classroom challenges. These curated resources will support students in deepening their understanding of teaching practice and pedagogical insights within authentic teaching scenarios.

2. Implement a multi-dimensional assessment system. The course assessment mechanism should adopt a multi-indicator evaluation system covering research achievements, academic performance, practical scores, classroom participation, and innovative teaching design. Assessment proportions should be adjusted dynamically according to course stages. Evaluation should integrate process-oriented self-evaluation and summative peer evaluation, including dimensions such as learning expectation achievement, active participation, autonomous learning initiative, reflective teaching experience, and curriculum improvement suggestions. This holistic approach provides a comprehensive reflection of student teachers' teaching ability development.

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3. Integrate reflective teaching practices. Given the relatively weaker improvement in reflective ability observed in this study (d = 0.67), more targeted interventions are needed. Structured guided reflection should be systematically integrated throughout the entire microteaching cycle. Student teachers could complete standardized reflection reports after each session, combining video self-review with collaborative evaluation. Video-guided recall can deepen reflection by pausing teaching videos at set intervals to help student teachers analyze questioning decisions, evaluate cognitive demands, and explore alternative strategies. Grounded in the intentional reflective practice framework (Zeichner & Liston, 1996), this approach enables student teachers to identify strengths and weaknesses and formulate targeted improvement plans, promoting a transformation from mechanical imitation to adaptive independent optimization.

4. Establish teacher-student collaborative learning communities. To enhance the practical application of Microteaching and Questioning Techniques, the course should foster interactive teacher-student collaborative learning communities where students share experiences, exchange questioning practices, and co-design effective mathematics classroom strategies for various teaching scenarios. This collaborative approach promotes seamless transformation of pedagogical theory into classroom practice and enhances students' mathematics teaching ability through precise teacher feedback, peer learning, and collective pedagogical inquiry.

Recommendations for Further Research

1. Longitudinal Comparative Studies with Diverse Samples. Future research should employ longitudinal comparative designs to track the development of student teachers' questioning competencies across multiple semesters and into their in-service teaching careers. Studies should include larger, more diverse samples from multiple institutions to assess the scalability and generalizability of the model. Comparative designs with control groups exposed to alternative teacher preparation approaches would provide valuable evidence on the relative efficacy of the microteaching combined with questioning techniques approach.

2. Explore Digital Transformation Pathways in Questioning Technique Development.

Given the absence of technology-assisted approaches in this study, future research should investigate how emerging digital technologies can support the development of questioning techniques. This includes using design-based research to explore AI-driven feedback systems for the real-time analysis of questioning patterns during microteaching, as well as video annotation tools and digital portfolios to enhance video-stimulated recall. Such work would align this line of inquiry with global trends in educational technology while maintaining methodological rigor.

3. Examination of learning transfer to authentic classroom contexts. Bridging the gap between controlled and live classrooms remains critical. Future studies should investigate the transfer of questioning competencies into actual student teaching internships in real secondary

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classrooms. This research would involve observing student teachers during field placements, analyzing their actual classroom questioning practices, and examining how they adapt learned strategies to accommodate authentic classroom complexity, including student diversity, time constraints, and unanticipated teachable moments.

4. Examination of the relationship between Questioning Techniques and mathematics teaching ability. Future studies should investigate the direct relationship between the use of specific Questioning Techniques in mathematics classrooms and the development of student teachers' mathematics teaching ability. This would involve collecting classroom data to analyze how different questioning strategies impact student engagement, depth of thinking, and problem-solving approaches, providing empirical evidence for the effectiveness of the proposed Questioning Techniques.

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