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Microteaching Frequency and the Development of Teaching Skills and Pedagogical Content Knowledge among Prospective Mathematics Teachers

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Abstract: The teaching skills developed by prospective teachers are often repeated in different situations. Therefore, the optimal frequency of microteaching practices may influence both teaching skills and pedagogical content knowledge. This study used a cross-sectional design to compare teaching skills and pedagogical content knowledge among groups based on the frequency of microteaching practices conducted by prospective mathematics teachers. A total of 79 students were randomly selected from three universities in Yogyakarta that implemented microteaching with varying frequencies. These frequencies were classified into four categories: once, twice, three times, and more than three times. Teaching skills were assessed using observation sheets that outlined aspects such as explaining skills, asking questions, providing guidance, providing reinforcement, managing whiteboard use, and regulating body movement (non-verbal cues). Pedagogical content knowledge was measured using a test instrument. Data were analyzed using descriptive statistics and a one-way ANOVA test. The results showed that the frequency of practice has a different impact on teaching skills and pedagogical content knowledge. Prospective teachers who practiced microteaching more than three times significantly differed in their explaining skills, while their providing reinforcement differed significantly from those who practiced at least three times. Conversely, prospective teachers who practiced twice performed similar levels of skill in asking questions, whiteboard management, and regulating body movement compared to those who practiced more frequently. Pedagogical content knowledge of prospective teachers who practiced more than three times was significantly higher than that of those who practiced three or fewer times. These findings suggest that universities should carefully regulate the frequency of microteaching practices to optimize students' teaching skills and pedagogical content knowledge in mathematics education for those who aspire to become effective mathematics teachers. These findings suggest that universities should carefully regulate the frequency of microteaching practices to optimize students' teaching skills and pedagogical content knowledge in mathematics education students who aspire to become effective mathematics teachers.

Keywords: teaching skills, microteaching, mathematics.

▪ INTRODUCTION

The microteaching course is a course that incorporates activities in the form of micro-practice, specifically designed to provide opportunities for prospective teachers to develop their teaching skills through hands-on practice (Chaudhary et al., 2015; Bilen, 2014; Bell, 2007). Microteaching can also be defined as a training context in which the teacher's situation has been simplified, allowing for learning to occur in a short period with a narrow focus on specific teaching techniques (Spelman & Brook, 1972; Ledger & Fischetti, 2020). In addition, microteaching can also be defined as a systematic simulation designed for prospective teachers to explore pedagogical experiences and reduce errors in teaching before entering the practice of teaching in real classes, especially by applying knowledge about teaching that they have learned and applied (Bulut, 2016). Through

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microteaching, prospective mathematics teacher students have the opportunity to apply their mathematical content and pedagogical content knowledge in practice (Baştürk, 2016). The microteaching course is a systematic program designed to provide students with opportunities to develop basic teaching skills in a relatively short period and with a narrow focus, thereby transforming their knowledge of pedagogical content into practical application and reducing errors.

In general, prospective mathematics teachers study mathematical content and pedagogical knowledge separately in theoretical courses as prerequisites before attending a microteaching course. However, applying theory in actual mathematics teaching practice is challenging, as it requires the ability to integrate mathematical content knowledge with pedagogical knowledge. Many teachers face challenges in applying theoretical knowledge in practice (Ünver, 2014). Through microteaching, prospective teachers can acquire new teaching skills under controlled conditions, providing opportunities to develop fundamental teaching competencies (Bahjat, 2016; Otsupius, 2014). Specifically, the domains that prospective teachers need to master in order to effectively practice mathematics teaching include school mathematics knowledge, knowledge of students' characteristics in learning mathematics, knowledge of mathematics instruction, and curriculum knowledge.

Typically, microteaching practicums conducted in higher education utilize peer teaching, where peers act as students and receive feedback at the end of the practicum. Peer teaching methods encourage teamwork and social learning through peer interactions (Şen, 2010). Prospective mathematics teacher students implement microteaching practices based on lesson plans developed in consultation with their supervisor. Generally, the choice of mathematics topics for microteaching varies for each prospective mathematics teacher but remains within the scope of junior high or high school mathematics. This difference in topics results in a variety of teaching skills demonstrated during microteaching practicums. Although high school mathematics requires a higher level of mastery of mathematical content than junior high mathematics, the pedagogical skills required for teaching in junior high are slightly more challenging than in high school. Moreover, prospective teachers' knowledge of mathematical definitions varies significantly across domains, with greater accuracy in geometry than in algebra (Leikin & Zaskis, 2010).

The teaching practice of prospective mathematics teachers in microteaching can be carried out effectively if supported by a well-designed lesson plan, but the opposite is not true. Lesson plans are detailed at each stage of the learning process to facilitate the implementation of microteaching practices by prospective teachers (Karlström & Hamza, 2019). In developing lesson plans, prospective teachers are required to have skills in designing introductory activities, core activities, and closing activities. In these introductory activities, prospective teachers must understand how to prepare students physically and psychologically. Prospective teachers' pedagogical content knowledge includes the appropriateness of prerequisite materials and concept maps, particularly those related to the mathematics curriculum and student development. Teachers must know what to do, how to do it, and why to do it in ways that preserve core principles of mathematical understanding (Superfine, 2022). Designing introductory activities is not easy, especially when prospective teachers are not yet ready to participate in the learning process (Reid, 2009). Mathematical knowledge alone is not sufficient for selecting

prerequisite materials. Knowledge of student characteristics is necessary so that new material can be learned easily and implemented by students through the processes of assimilation and accommodation. Furthermore, the structure of school mathematics is structured in stages, with prerequisite concepts serving as a foundation for understanding subsequent topics or concepts. In practical learning, student teachers are trained to interact with students, preparing them both physically and psychologically through question-and-answer sessions. Therefore, the ability to ask questions is essential for student teachers to ensure that learning is carried out as planned. Mathematics teachers often struggle to maintain the cognitive demands of their tasks (Parrish & Bryd, 2022), and this also applies to student teachers.

In the design of the main learning activities presented, it is required to comply with process standards and incorporate more cognitively demanding tasks into their mathematics instruction; however, many teachers remain reluctant to do so (Russo & Hopkin, 2019). This also applies to student teacher candidates. Details of the learning design include student activities and the formulation of questions that will be presented to them. Good questions and effective questioning techniques can enhance learning effectiveness (Leikin et al., 2016; Shanmugavelu et al., 2020). There is interaction when asking questions and answers to deepen students' mathematical understanding (Brendefur & Frykholm, 2000). To formulate effective questions, a solid understanding of mathematics is necessary, as well as a technique for learning practice; therefore, the ability to ask questions plays a crucial role in developing mathematical conversation and thinking in mathematics learning. Thus, the ability to ask questions becomes one of the most important things, as it is a main competence developed in micro-teaching activities. Thus, to design effective learning activities, it is necessary to have a solid understanding of mathematical content knowledge and an understanding of students' ways of thinking (Ball et al., 2008). However, when implementing microteaching using the peer-teaching method, the technique of asking students questions and providing reinforcement often seems unrealistic because the responses given by peers generally do not accurately represent those of real students.

Lectures for prospective mathematics teachers are more specific. They must not only be able to grasp mathematical content knowledge for personal use but also present the results of their mathematical understanding in a way that students easily understand. This will be evident in the design of teaching materials and the performance of prospective students in microteaching practices. Prospective students must be able to identify teaching materials that make the material easy for students to understand, identify topics where students make common errors, prevent misunderstandings, and identify and correct student misunderstandings (Ball et al., 2008). Such knowledge provides the foundation for pedagogical content knowledge (Shulman, 1987).

Being a teacher means appearing in public, and of course, the skills and confidence of the prospective teacher are crucial. Limiting inappropriate behavior, giving clear instructions, and greeting students with good manners are important skills. Prospective teachers who are skilled at explaining the material must be able to understand mathematical content and student characteristics, as well as the mathematics curriculum for Middle School and High School, including student characteristics (Kÿlÿ, 2010); however, this is not enough. Many people can speak easily in everyday life in various situations, but become nervous when speaking in public (Luca, 2011). Appearing in front

of the class is the focus of attention, which can lead to anxiety (King, 2017). On the other hand, students learn more easily and actively participate in class when the teacher uses body language, movement, posture, and eye contact (Haneef et al., 2014), in addition to verbal language. A teacher is required to use body language effectively (Çalışkan & Yeşil, 2005). Body language is a non-verbal form of communication that must align with verbal language to ensure the message is delivered effectively (Banbury & Hebert, 1992). The learning process is essentially a form of communication, and to convey ideas, feelings, emotions, and skills requires both verbal and non-verbal communication (Henef et al., 2014). In the microteaching course, prospective mathematics teachers must not only master mathematical content and understand the characteristics of students and the mathematics curriculum, but also learn to control verbal and non-verbal discussions.

Managing the whiteboard is important; remembering to take notes on it will help teachers convey various instructions in multiple ways. A presentation on the blackboard provides a more visual representation, presents difficult concepts through modeling, motivates students more effectively, and can increase students' attention and focus (Kennewell & Beauchamp, 2007). Teachers can model problem-solving strategies for students through the Blackboard (Steedly et al., 2008). During microteaching, lecturers and colleagues will be able to evaluate the management of the blackboard, the correctness of the mathematical notation used, as well as the concepts and proofs presented by prospective mathematics teacher students.

The final activity in microteaching involves providing feedback from supervisors and colleagues, which is given directly after students have practiced microteaching. This is done so that feedback is more effective (Gürkan, 2018). Feedback in a constructive way becomes an important element of the microteaching process where peers, aware of the theory being taught, can reflect on the skills of the presenter; in doing so, they can develop their own skills (Ögeyik, 2016), and doing helping an overcoming the fears and concerns (Göçer, 2016). Feedback from peers is expected to provide students with a better self-assessment (Liu & Carless, 2006). Feedback can be related to the topic of teaching material presentation and activities during micro-teaching practice, whether it involves managing the blackboard or other media, asking questions, providing feedback, or offering other non-verbal information by prospective teacher students. The learning process is essentially a form of communication, and to convey ideas, feelings, emotions, and skills requires both verbal and non-verbal communication (Henef et al., 2014). By reading the feedback provided by peers, student teacher candidates can identify aspects that have been successful in carrying out teaching assignments and reflect on ideas for improving their teaching performance in the next practice (Matthew, 2018).

Feedback can significantly influence learning outcomes, yet it can have both positive and negative impacts (Hattie et al., 2007; Bashir et al., 2016). Providing feedback to prospective teacher students who have completed a teaching skill performance serves as a reflection for all participants and is therefore expected to be a reflection for all. This reflection is intended for all prospective teacher students in attendance to enhance the design and practice of microteaching in subsequent performances. Reflection encourages teachers to make informed pedagogical decisions, adapt to diverse classroom situations, and internalize best practices (Honigsfeld & Schiering, 2004; Ögeyik, 2016). Through reflection, the connection between theory and practice, as well as the development of knowledge, can be strengthened (Halim et al., 2011). However, too frequent practice

makes it very likely that students will not have time to accommodate all the feedback provided. On the other hand, the quality of feedback received by student teachers varies significantly, so the frequency of feedback provided does not always have a positive impact on teaching skills; rather, it affects knowledge. Another problem with microteaching techniques is the limited time and opportunity for each student teacher to practice (Chuanjun & Chunmei, 2011). Likely, supervisors do not assess every aspect of behavioral change following feedback from previous practicums (Schütze et al., 2017). On the other hand, if a learning practicum is only conducted once, prospective teacher students who have completed a teaching skill performance serve as a reflection for all participants. They do not repeat the learning practicum based on previous feedback or performance teaching skills, but are very likely to improve their pedagogical knowledge. However, suppose students can conduct more than one micro-practicum during the semester. In that case, they can repeat teaching skills and possibly improve their pedagogical knowledge, but this is highly dependent on the quality of the feedback provided. This study aims to compare pedagogical content knowledge and teaching skills based on the number of micro-practices students carry out. This study aims to: (1) compare the teaching skills of prospective mathematics teachers across groups differentiated by the frequency of microteaching practices, and (2) compare their pedagogical content knowledge based on the frequency of these practices.

▪ METHOD

This study used a cross-sectional design involving 79 students who were randomly selected from three universities in Yogyakarta, Indonesia. The inclusion criteria of participants were mathematics education students who took microteaching courses. The exclusion criteria for participants were mathematics education students who had administratively enrolled in microteaching courses but were not actively participating in lectures due to various obstacles, including resignation or other reasons. All participants received informed consent. This procedure was approved by the ethics committee of Universitas Negeri Yogyakarta. In general, universities do not impose strict requirements regarding the frequency of microteaching practicums, as this is largely influenced by the characteristics of the field of study. The frequency of these practicums often depends on the policies of individual lecturers or supervisors, as well as the study agreements established between the lecturer and the prospective mathematics teacher. Because the frequencies of required microteaching practices differed across universities, participants were grouped into four categories based on frequencies of practices: (1) students who practiced once, (2) students who practiced twice, (3) students who practiced three times, and (4) students who practiced more than three times.

Each prospective mathematics teacher was required to develop a lesson plan prior to the practicum, in consultation with a supervisor, to ensure alignment with curriculum standards, learning objectives, and pedagogical principles. During the practicum, the supervisor observed the teaching process, focusing on lesson structure, classroom management, content delivery, questioning techniques, and student interaction. After the practicum, the supervisor provided constructive feedback, addressing clarity of explanation, accuracy of mathematical content, engagement strategies, and the use of teaching aids. This feedback was both formative, supporting student improvement in subsequent sessions, and summative, contributing to the overall assessment of teaching skills.

Pedagogical content knowledge was measured using a test instrument that assesses three aspects: knowledge of student characteristics in mathematics learning, knowledge of mathematics instruction, and knowledge of the curriculum. This instrument consists of 30 multiple-choice questions with five answer options. The test was administered at the end of the course, after all students had completed their micro-teaching practicum. Teaching skills, or performance, were assessed using a semantic differential questionnaire with five aspects: explaining skills, asking question technique, providing guidance, providing reinforcing, whiteboard management, and regulating body movement (non-verbal cues). The aspects of teaching skills measured in this study were adapted from the research of Walkowiak et al. (2014). Its quality was confirmed through expert assessment for content validity, demonstrating an estimated reliability coefficient of 0.713.

Data were collected at the end of the semester after all participants had completed the microteaching practicum. Both instructors and peers evaluated teaching skills during microteaching sessions, while the pedagogical content knowledge test was administered in a controlled setting. Descriptive methods were used to provide an overview of pedagogical content knowledge and teaching skills, and a one-way ANOVA was applied to examine differences among the four groups based on the frequency of microteaching practices. The results of the ANOVA prerequisite test showed that the data were normal and homogenous.

▪ RESULT AND DISSCUSSION

This study aims to compare teaching skills and pedagogical content knowledge based on the frequencies of microteaching practices conducted by prospective teachers. The results of the average teaching skill scores across the four groups, analyzed using the F-test, show significant differences in several aspects: explaining skills, asking and questioning technique, providing reinforcement, whiteboard management, and regulating body movement (non-verbal cues). In other words, the frequency of microteaching practices influenced students' teaching skills. However, providing guidance produced different results (see Table 1).

Table 1. Teaching skill for each aspect

Aspect	Sources of Variance	Sum of Squares	df	F	sig
Explaining skills	Between Group	284.411	3	39.004	0.000
	Within Group	182.298	75		
	Total	466.709	78		
Asking a question technique	Between Groups	248.880	3	41.311	0.000
	Within Groups	150.614	75		
	Total	399.494	78		
Providing guidance	Between Groups	6.501	3	0.840	0.476
	Within Groups	193.398	75		
	Total	199.899	78		
Providing Reinforcement	Between Groups	43.188	3	80.98	0.000
	Within Groups	133.331	75		
	Total	176.519	78		
Whiteboard management	Between Groups	514.712	3	43.645	0.000
	Within Groups	294.826	75		
	Total	809.538	78		

Regulating body movement (non-verbal cues)	Between Groups	44.866	3	5.482	0.002
	Within Groups	204.609	75		
	Total	249.475	78		

The frequency of microteaching practice produced varying effects on teaching skills. Follow-up analysis revealed that the teaching skill scores for each aspect in the group with more than three practice sessions differed significantly from those in the other groups. Specifically, students with more than three practice sessions demonstrated significantly higher explanation skills compared to the other three groups. For providing reinforcing skills, three practice sessions produced significantly different results. Different patterns were observed for asking questioning techniques, whiteboard management, and regulation of body movement (non-verbal cues), with at least the second practice session yielding significantly different results (see Table 2).

According to skill acquisition theory, differences in the development of teaching skills can be explained by the nature of the skills being practiced. Whiteboard management and body movement patterns are largely procedural and motor-based, allowing prospective teachers to progress quickly from the cognitive stage, where they consciously recall instructions, to the associative stage, where their actions become smoother and more refined through practice and feedback. Consequently, even two practice sessions produced noticeable improvements in these areas. In contrast, the questioning technique requires higher-order pedagogical reasoning, such as anticipating student responses and scaffolding ideas, which are more cognitively demanding and less procedural in nature. As a result, improvement in questioning skills requires more extensive and varied practice before learners can move beyond the cognitive stage and begin to demonstrate greater fluency. However, research findings suggest otherwise. This is likely due to the peer-teaching method used, where asking questions that meet students' needs is very difficult, given that the audience's responses generally do not align with the characteristics of the average school student.

Table 2. Advanced test of teaching skill for each aspect

Aspect	Frequency (A)	Frequency (B)	Mean Difference (A-B)	Std. Error	Sig.
Explaining skills	1	2	0.974	0.676	0.154
	1	3	-1.724	0.513	0.001
	1	More than 3	-4.452	0.533	0.000
	2	3	-2.698	0.588	0.000
	2	More than 3	-5.427	0.606	0.000
	3	More than 3	-2.729	0.416	0.000
Asking Question technique	1	2	-4.479	0.615	0.000
	1	3	-4.954	0.466	0.000
	1	More than 3	-4.623	0.485	0.000
	2	3	-0.476	0.535	0.376
	2	More than 3	-0.144	0.551	0.794
	3	More than 3	0.331	0.378	0.384
Reinforcing skills	1	2	0.252	0.578	0.664
	1	3	-1.192	0.438	0.008
	1	More than 3	-1.772	0.456	0.000

	2	3	-1.444	0.503	0.005
	2	More than 3	-2.024	0.518	0.000
	3	More than 3	0.580	0.356	0.107
Whiteboard management	1	2	6.641	0.860	0.000
	1	3	7.167	0.652	0.000
	1	More than 3	6.488	0.678	0.000
	2	3	0.527	0.749	0.484
	2	More than 3	-0.153	0.771	0.843
	3	More than 3	0.679	0.529	0.203
Regulating body movement (non-verbal cues)	1	2	-2.637	0.716	0.000
	1	3	-1.833	0.543	0.001
	1	More than 3	-1.692	0.565	0.004
	2	3	0.803	0.623	0.201
	2	More than 3	0.944	0.642	0.145
	3	More than 3	-1.406	0.440	0.751

The results of the analysis of differences in the average pedagogical content knowledge scores among the four groups, using the F-test ($F = 8.692$, $p < 0.05$), indicate a significant difference in their mean scores. This finding suggests that the frequency of microteaching practices affects the pedagogical content knowledge scores of prospective mathematics teachers (see Table 3).

Table 3. Knowledge of pedagogical content

Sources of variance	Sum of Squares	df	F	sig
Between Group	4968.026	3	8.192	.000
Within Group	15161.981	75		
Total	20130.007	78		

Follow-up analysis revealed that prospective mathematics teachers who engaged in microteaching practice more than three times had significantly different pedagogical content knowledge compared to the other three groups. However, the pedagogical content knowledge of prospective mathematics teachers who practiced once did not differ significantly from those who practiced twice (Table 4).

Table 4. Advanced test of pedagogical content ability

Frequency (A)	Frequency (B)	Mean Difference (A-B)	Std. Error	Sig.
1	2	-1.589	6.270	0.801
1	3	-13.541	4.721	0.006
1	More than 3	-21.019	4.962	0.000
2	3	-11.953	5.364	0.029
2	More than 3	-19.430	5.322	0.001
3	More than 3	-7.477	3.576	0.044

Generally, prospective teachers' teaching abilities develop along with the frequency of microteaching sessions they undertake. Prospective teachers with only one practice opportunity can observe colleagues as learning models. The hope is that through

modeling, knowledge is acquired, as social learning theory suggests that people learn through imitation, modeling, and observation (Bandura, 1977; Muro & Jeffrey, 2008). However, generally, differences in teaching skill development can be attributed to the nature of the skills being practiced.

Extensive learning practice in microteaching provides students with sufficient opportunities to apply theoretical knowledge from various domains—especially mathematics content knowledge, student content knowledge, pedagogical content knowledge, curriculum understanding, and teaching skills (Ekşi, 2012). Prospective teachers with extensive experience in microteaching will naturally delve deeper into school mathematics, both high school and middle school mathematics. The high frequency of practice will give prospective teacher students the opportunity to try or observe various learning practices on different school materials, including those containing numbers (real numbers, integers, fractions, and rational numbers), algebra, geometry, statistics, probability, trigonometry, calculus, and logic. These demands require prospective teachers to develop the ability to select and organize material appropriately for different grade levels.

The responsibility of prospective teachers in explaining mathematical content goes beyond simply presenting concepts; they must also guide students toward conceptual understanding by monitoring and adapting to students' thinking, a process often described as the learning trajectory (Daro et al., 2011). Through learning trajectories, prospective teachers design and implement lessons that integrate constructivist principles, simultaneously considering learning objectives, students' cognitive characteristics, teachers' perspectives on student thinking, and research-based learning progressions. They also design detailed sequences of mathematical tasks and classroom interactions (Clements & Sarama, 2009). To fully grasp the idea of a learning trajectory, prospective teachers must recognize and understand the cognitive characteristics of students aged 12–18 (junior and senior high school), review subject matter appropriate to this age range, and demonstrate knowledge of school mathematics and curriculum. They must also be aware of students' varied cognitive abilities and levels of knowledge (Anderson & Krathwohl, 2001, p. 46). Through repeated practice, prospective mathematics teachers generally improve their ability to manage and deliver school mathematics content, although some still encounter difficulties in presenting material effectively.

Through microteaching courses, prospective teacher students can improve their teaching experience, learn the art of teaching more easily and effectively (Remesh, 2013). However, there are some weaknesses related to the implementation of microteaching, which is carried out in the form of peer teaching. With a detailed learning design, the implementation of microteaching activities is expected to emphasize real-life learning practices. Although conducted in a peer-teaching model, interactions between prospective teachers and their peers, who act as students, are still anticipated. The most prominent weakness is the development of interaction competence between students and teachers, as well as the responses given by students. These two factors make it challenging to provide guidance and ask questions that align with the needs of students, as the responses from the audience are generally not representative of the characteristics of school students in general. The limited time requires formulating the minimum number of practices that must be carried out to continue achieving the desired competence.

Some students struggled to explain school mathematics because the content is less advanced than the material typically studied by prospective teacher students in college, who generally study more advanced mathematics, which is crucial for providing a solid mathematical foundation. Different opinions suggest the importance of developing a theory of specific content knowledge that is useful for teaching; the content knowledge needed by teachers must be relevant to teaching practice and work. Therefore, it is essential to provide content material that is specifically tailored to the needs of prospective mathematics teachers in a particular area, while also not neglecting college mathematics, which provides the foundation of mathematical science.

Students' technical ability to ask questions is evident in the practice of preliminary activities, which are used to assess the mastery of prerequisite material that still needs improvement. Recalling the prerequisite material is a key indicator of students' readiness to participate in mathematics learning with the following material; therefore, the ability to ask questions is an expected competency in microteaching courses. If students lack mastery of the prerequisite material, they will struggle to understand advanced concepts, which can negatively impact their comprehension of subsequent material. The ability to prepare prerequisite material through challenging questions is crucial, as it enhances learning effectiveness (Boaler & Brodie, 2004). The ability to ask questions in practice during the core activity is carried out in a way that directs and maintains students' attention, helping them stay focused on the learning process. Other activities are demonstrated by responding to students' statements and questions. The ability to provide direction is demonstrated when student teacher candidates make presentations and provide explanations, utilizing the skills necessary to clearly and accurately convey concepts. These components include the enthusiasm of prospective teacher students, readiness to present apperceptions, readiness to create context as learning motivation, effective explanations, reinforcement in the form of planned repetition, and closing statements or key messages with summary explanations. In accordance with the characteristics of abstract mathematics, Teacher candidate students must be able to explain concepts correctly with simple, relevant, and interesting examples to increase students' understanding. On paper, knowledge related to teaching materials and pedagogical knowledge is already possessed; however, it is generally not easy to make the transition from theory to practice (Wrenn & Wrenn, 2009).

The practice of microteaching trains prospective mathematics teacher students to develop learning that fosters higher-order thinking skills, one of which is achieved through questioning techniques (Saeed, 2012), by attempting to explain questions, or by using other question words that require answers to provide explanations. Another technique used is an effort to gather findings from students through observing activities or taking measurements to identify patterns and formulate conjectures. However, the weakness of this activity is that the information provided to support an explanation is insufficient. The activity of making conjectures is very detailed in activities that present information, which can lead to conjectures. However, prospective teacher students rarely present conjectures or show proof through activities.

Prospective mathematics teachers demonstrated improved whiteboard presentation skills during their second practicum. Effective use of the whiteboard provides clearer visual representations, supports the modelling of difficult concepts, enhances student motivation, and improves attention and focus. These skills appeared to develop in the

second practicum, likely because preservice teachers benefited from feedback provided by their peers. During microteaching, both instructors and peers can evaluate preservice teachers' whiteboard management, the accuracy of mathematical notation, and the clarity of the concepts and explanations presented. This also applies to the ability to use non-verbal cues, with students benefiting from the reflection and feedback provided.

Adequate and constructive feedback is essential in microteaching because it supports the improvement of specific teaching skills through practice, refinement, and reapplication. Targeted feedback enables prospective teachers to identify effective strategies, correct errors, and strengthen areas of weakness. It also fosters the ability to evaluate the effectiveness of mathematics learning, which is a critical component of pedagogical content knowledge. Even when feedback is not delivered directly, the use of structured evaluation tools such as rating scales can encourage prospective teachers to assess learning outcomes more critically. Equally important is the role of reflection, which transforms feedback into actionable professional growth. Reflection allows prospective teachers to analyse their teaching experiences, recognize both strengths and weaknesses, and plan improvements for subsequent lessons. In microteaching, this process establishes a cycle of continuous development, where student teachers not only enhance technical classroom skills but also cultivate self-awareness of their teaching identity, beliefs, and instructional style. The integration of feedback and reflection serves as a bridge between theory and practice, ultimately preparing prospective teachers to become more effective mathematics educators.

Teaching activities involve many components, although student teacher candidates have prepared lesson plans and have pedagogical knowledge, implementing learning requires self-management and classroom management skills. Such studies have viewed teaching as a complex cognitive skill, based on knowledge of how to construct and conduct lessons, as well as knowledge of the content to be taught. It is even possible that the situation faced is that the student's response is unexpected and has not been anticipated in the design, thus requiring decision-making on the learning situation that is manifested in the actions taken. Through microteaching, students reflect on their pedagogical content knowledge, receiving criticism from both lecturers and the audience; therefore, indirectly, various practices contribute to students' understanding of pedagogical content knowledge. This can be seen from the difference in the acquisition of pedagogical content knowledge scores of prospective mathematics teacher students after attending microteaching lectures.

▪ CONCLUSION

Microteaching courses have demonstrated a positive impact on the professional development of prospective teachers. Within a limited time, they train prospective teachers in basic teaching skills, encouraging them to confidently present mathematics explaining material, employ questioning techniques, provide guidance skills, offer reinforcement, manage the whiteboard, and regulate body movement (non-verbal cues). However, there are some drawbacks associated with the peer-teaching implementation of microteaching. Guiding students is a fundamental skill that must be developed, but the responses of peers differ from those of typical school students, making providing guidance easier and less challenging.

The frequency of practice has a different impact on teaching skills and pedagogical content knowledge. Time constraints result in a limited amount of material being presented, making it difficult to select appropriate materials within the allotted time. Prospective mathematics teachers with extensive experience in microteaching naturally deepen their understanding of school mathematics, including both high school and junior high school, as well as their knowledge of mathematics instruction and the curriculum. Through frequent practice sessions, prospective teachers gain significant insight and knowledge into mathematical content, particularly in mathematics instruction, by engaging in activities such as practicing, observing peers' learning, and providing critical feedback.

These findings underscore the importance of universities adopting a more deliberate and structured approach to regulating the frequency and organization of microteaching sessions. It is crucial to strategically design microteaching experiences, striking a balance between quantity and quality. By carefully considering the appropriate frequency, sequence, and focus of sessions, universities can create opportunities for mathematics education students to progressively strengthen their teaching skills and pedagogical content knowledge. Such regulation is not simply an administrative necessity, but rather a pedagogical strategy that ensures microteaching serves as an effective bridge between theoretical lectures and real-life classroom practice. Ultimately, this deliberate structuring of microteaching contributes to preparing mathematics education students to enter the teaching profession as more reflective, competent, and effective mathematics teachers.

A key limitation of this study is that it did not account for the curricula of the participating universities, which may vary considerably in structure and in the policies governing prerequisites for enrollment in microteaching courses. These variations could significantly influence the opportunities provided for developing teaching skills and pedagogical content knowledge. As a result, the findings of this study should be interpreted with caution, particularly in terms of their generalizability across different institutional contexts. Future research should therefore examine not only the role of prospective teachers' motivation but also how differences in curriculum design and institutional policies shape the development of teaching skills and pedagogical content knowledge among prospective mathematics teachers.

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