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Enhancing prospective mathematics teachers' lesson planning skills through lesson study within school university partnership program

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Abstract

Planning a mathematics lesson plan is a complex process. Its quality contributes to the effectiveness of mathematics instruction. Given this significance, improving prospective mathematics teachers' lesson planning ability is essential for teacher preparation programs to produce effective teachers. This study examines how a lesson study within a school-university partnership program (SUPER-LS) could strengthen the lesson planning skills of prospective mathematics teachers. This study employed a case study, which included thirteen student teachers. Data were collected using four initial and four final drafts of mathematics lesson plans developed by four groups of prospective mathematics teachers and reflection reports. These were then analyzed qualitatively using the framework of MKT. The study found that sixteen categories of issues were present in the initial lesson plan, and six remained in the final lesson plan. In the final lesson plan, the 16 problems were reduced to 6, with an improvement of around 62.50%. In addition, prospective mathematics teachers improved their lesson planning skills because of their involvement in the SUPER-LS program, facilitated by intensive collaboration and interaction among participants, especially in-service teachers, and teacher educators, as well as peers' feedback.

Keywords: Lesson Planning Skill, Lesson Study, Mathematics Instruction, Prospective Mathematics Teachers, School-University Partnership

Teaching mathematics is an intellectually and emotionally demanding endeavor. It is developmental progress, which requires competent teachers with substantial knowledge of the content, the curriculum, the instructional approaches, and the student's talents, interests, and personalities to be able to deliver effective mathematics instruction (Boye, 2020; Chen & Zhang, 2019). A systematic method led by a lesson plan is necessary for teachers to provide mathematics lessons to their students (Chen & Zhang, 2019). In mathematics instruction, lesson plan plays a crucial role, which encourages teachers to reflect carefully on the tasks and activities they use in class. Teachers can try to predict how students might interpret them, the approaches they might take to solve right and wrong problems, and how teachers would like their students to learn (Courtney et al., 2015). Thus, future and early career teachers should be encouraged to inspire to envision and predict students' interactions during the instruction, understand their thinking and reasoning, and consider an alternative instructional approach.

It is an indication that lesson planning skills become one of the teachers' competencies to perform their job efficiently and successfully (Aliustaoğlu & Tuna, 2022). In addition, providing high-quality instruction to students is demanding for teachers; consequently, designing instructional units, including the entire academic year's curriculum, a unit of lessons, or even a single lesson, is crucial to the effectiveness of teachers' daily work (Baki & Arslan, 2016; Lai et al., 2015; Sadak, 2021). The literature demonstrates that lesson planning is crucial for mathematics instruction (Chen & Zhang, 2019; Yunianto et al., 2021; Taylan, 2018). It contributes to valuable and meaningful teaching and learning process. Detailed lesson planning is essential as it equips teachers with a strategy for gaining a deeper understanding of the content, student learning, and pedagogical content knowledge (Boye, 2020; Li et al., 2009). Given this significance, mathematics teachers must develop lesson planning skills to conduct effective mathematics instruction. However, this skill was limited among teachers, especially prospective mathematics teachers.

Lim et al. (2018) reported that preservice teachers and beginning teachers have difficulty recognizing the mathematical idea within the task and transferring it to a lesson plan. Chen and Zhang (2019) also discovered that prospective mathematics teachers lacked knowledge of how to modify planning aspects to meet the needs of their learning groups. They display a teaching style that is less adaptive and more formulaic, and they likely struggle to account for instructional contexts and make planning decisions. Generally, they construct lesson plans without understanding why this is the case and see a lesson as a disjointed set of chronological occurrences (Sadak, 2021). In addition, they struggle to identify the significance of mathematics classroom setting, connecting particular mathematical activities to the larger ideas of instruction, and reasoning about classroom occurrences based on their knowledge of the context (Lai et al., 2015). Moreover, Mayis et al. (2018) discovered that prospective teachers have difficulties comprehending the mathematical contents when developing lesson plans. This evidence indicates that future mathematics teachers confront a significant problem when developing a lesson plan, and their capacity to address various issues in creating a lesson plan was insufficient. Thus, they need support to overcome these obstacles. It urges teacher education institutions to provide exceptional learning opportunities or a program to practice designing a lesson plan for prospective mathematics teachers to overcome this challenging task (Utami et al., 2021).

A teacher educator could effectively assist future mathematics teachers in developing an awareness of the complexity of lesson planning by placing them in a learning environment where they can experience its difficulties. According to Mak (2019), the development of teacher knowledge is not linear and is a lengthy process. Shulman (2013) described it as a complex process requiring considerable coaching and continuous mentoring from lecturers as researchers, as well as an ongoing effort by participating teachers to develop the skills necessary to meet the challenge of an innovative teaching approach for teaching endeavors. School-university partnerships mediated by lesson study (SUPER-LS) have the revolutionary potential to change this issue concerning prospective mathematics teachers (Fitriati et al., 2022).

SUPER-LS is a school and university-based teacher professional development (TPD) model implemented inside a lesson study enterprise that strives to enhance teacher preparation programs, including field practical, ongoing professional development, and research activities. It plays a crucial role in developing innovative instruction that capitalizes on the expertise of university professors, school instructors, and academic researchers to bridge theory and practice (Green et al., 2020; Khin & Sin, 2021; Marsh, 2019). In recent decades, there has been significant interest in SUPER-LS. The potential and current interest of this program have been well documented in the literature, especially in developing

mathematics teacher competencies (Fitriati et al., 2022; Hendriana et al., 2016; Nurwidodo et al., 2018). However, the study of this program's effectiveness toward prospective mathematics teachers' teaching skill development is still limited. Therefore, this study used this program to support prospective mathematics teachers to develop teaching skills, particularly lesson planning skills. The purpose of this study is to advance the knowledge and skills of prospective mathematics teachers in lesson planning based on mathematical knowledge for teaching (MKT) through the lesson study within the school-university collaboration. The study addresses the following research questions: how does the lesson study within a school-university partnership program enhance the lesson-planning skills of prospective teachers?

This study is significant because it informs teacher educators about what teachers currently know and what they need to learn. Prospective mathematics teachers have the instruction to modify and improve the lesson plan after considering the feedback on which domains of MKT were lacking in the particular lesson plan. In addition, they learn which integration theory and practice areas must be enhanced for the future acquisition of content and pedagogical content knowledge.

Lesson Plan

A Lesson plan represents a teaching practice blueprint consisting of several activities undertaken by a teacher to guide student learning toward the attainment of specific objectives following a logical progression of lessons (Chen & Zhang, 2019; Ndihokubwayo et al., 2022; Ozkan, 2021). Thus, it plays a vital role in mathematics instruction, including providing a guide for teachers to conduct instruction using a specific pedagogical approach and preparing activities to anticipate student difficulties. By utilizing the lesson plan, the complexity of classroom instruction could be reduced to a tolerable level without diminishing its essential components for effective mathematics instruction (Ndihokubwayo et al., 2022). Thus, the lesson plan reflects the teacher's actual classroom activities or classroom-wide application. A lesson plan often includes illustrations of learning objectives, subject topics, activity processes, sequences ranging from basic to complex, organization, and assessment. Therefore, in planning the lesson, teachers write down the processes with a comprehensive and considerable evaluation of each phase (González et al., 2020).

An effective lesson plan is essential for facilitating effective instruction and fostering student achievement (Lim et al., 2018). According to researchers, the effectiveness of lesson plans and classroom execution are the most influential factors in teachers' performance (Chen & Zhang, 2019; Ozkan, 2021; Yunianto et al., 2021). They argued that excellent lesson plans should consider potential issues in the classroom and address them effectively by investigating thinking processes and steps in detail rather than systematically setting lesson objectives. When teachers concentrate on mental processes to comprehend students' learning and thinking to determine which activities are appropriate, teachers can set the sequence in which activities should be completed (Chen & Zhang, 2019; González et al., 2020; Ozkan, 2021; Yunianto et al., 2021). In short, planning a lesson entail visualizing the instruction before its execution, including prediction, anticipation, sequencing, organizing, and simplifying. These elements have been adapted by most educators while planning and teaching daily lessons.

Most researchers agree that the content of the lesson plan should include instructional objectives, materials or content, the teaching approach, the media, and the assessment techniques (Chen & Zhang, 2019; Ndihokubwayo et al., 2022). In Indonesian education, the format and example of the mathematics lesson plan are provided by the government, and teachers rely on these plans for daily instruction. This

form contains the primary competency and indicators, the learning objective, the material, the pedagogical approach/method, the learning phases defining student engagement, the learning tool, and the assessment, which are arranged within three activities (Fouryza et al., 2019). The first activity, called the preliminary activity, aims to build student readiness to engage in mathematics instruction. This practice includes praying, motivating students, fostering awareness, and outlining the learning goals. Second, the core activity consists of delivering mathematics content and facilitating students' learning through group work, presentation, and discussion following a particular pedagogical approach. The last activity consists of summarizing the learning activity, evaluating it, reflecting on it, presenting a follow-up activity, and dispersing the classroom. In this study, prospective teachers develop a mathematics lesson plan using this structure.

Lesson Study within School University Partnership for Prospective Mathematics Teachers

School university partnerships mediated by lesson study (SUPER-LS) is a professional development model that combines the school based TPD model from the USA and the lesson study model from Japan. It creates a new model of TPD for training preservice teachers from universities alongside in-service teachers from schools (Fitriati et al., 2022; Matoba et al., 2007; Tsui & Law, 2007). This model of TPD enables collaboration among prospective teachers, in-service teachers, and teachers educators to conduct lesson study cycles in schools and the university within a well-established structure (Fitriati et al., 2022; Nurwidodo et al., 2018). This type of TPD is essential for developing effective instruction for communities that use the experience of university professors, school teachers, and academic researchers to link theory and practice (Farrell, 2021; OECD, 2012). Following the lesson study cycle, the program concludes with three activities that facilitate collaboration between the school and university in achieving its goals: collaborative design, implementation and observation of the lesson, and reflection of the lesson (Lewis & Hurd, 2011; Lewis, 2016).

Lesson Study has the potential to strengthen crucial aspects of the SUPER program by contributing to the development of the prospective mathematics teachers' school practicum experience. The SUPER is enriched through the use of mediating tools to create a new activity system that facilitates the exchange of ideas, information, and experiences among SUPER-LS participants (Baldry & Foster, 2019; Hendriana et al., 2016). Previous studies have demonstrated the advantages of school-university collaboration in equipping mathematics teachers with considerable improvements in professional knowledge, research capacities, and knowledge generation (Green et al., 2020; Groth et al., 2020; Farrell, 2021; Fitriati et al., 2022). Thus, it is recommended to prioritize collaboration between schools and universities programs to stimulate knowledge production and dissemination in mathematics teacher education for quality of mathematics education.

Lesson study has played an essential role in enhancing the skills of pre-service mathematics teachers (PST), particularly lesson planning. Past research has shown lesson studies increased pre-service teachers' ability to make better lesson plans and gave them self-confidence (Mostofo, 2014; Yunianto et al., 2021). Also, lesson studies help PST develop essential teaching skills such as making and implementing lesson plans (Aykan & Dursun, 2021; Groves et al., 2013; Meiliasari, 2013). However, most previous studies were conducted without the full participation of in-service teachers (IST) from schools and were not based on actual classroom student requirements. According to Chen and Zhang (2019), a good lesson plan should consider students' difficulties, misconceptions, interests in the topic, and external factors such as classroom organization. This information is unavailable to prospective

mathematics teachers in universities unless they are placed in the classroom. In addition, the art of drafting a lesson plan is improved over an extended period due to Lim et al. (2018)'s discovery that prospective mathematics teachers' capacity for lesson planning is developed with time. Therefore, it is recommended to provide future mathematics teachers with authentic experience working with students in the classrooms to learn how students learn.

With knowledge of classroom experiences and student learning, prospective mathematics teachers could teach a lesson with the autonomy of revision, gain insight for structuring related tasks together, and ultimately construct an innovative lesson plan (Sadak, 2021). Embedded lesson study within the school-university partnership, thus, is suggested (Fitriati et al., 2022; Hendriana et al., 2016; Nurwidodo et al., 2018) to facilitate prospective mathematics teachers learning in the school environment to get knowledge about students so that quality lesson plan can be produced.

METHODS

In this qualitative study, we employed a case study design with a lesson study cycle as a case, which involved thirteen prospective mathematics teachers (2 males and 11 females) participating in secondary school mathematics instruction courses. They voluntarily participated in the school-university partnership program. Prospective mathematics teachers were grouped into four teams, with four to five candidates for each. In this study, the respondents were required to carry out a project in which they were asked to design a lesson plan for secondary school mathematics instruction with their teams. Prospective teachers could select any mathematics topics within the secondary school mathematics curriculum for their lesson plan project and use any suitable pedagogical approaches to deliver those topics. Following the microteaching approach, participants acted as either teachers or students when implementing their lesson plans, followed by lesson discussion and reflection. This activity was conducted over two lesson study cycles.

Research Setting

This study implemented a SUPER-LS program as a school-based TPD model to enhance prospective mathematics teachers' lesson-planning abilities. The Indonesian Ministry of Education began to support this project in 2021, which involves 60 partnerships between universities and schools in Indonesia and more than 300 schoolteachers from various academic areas. Our university-school partnership is one of the initiatives introduced as a community learning technique for implementing lesson study. The program began in August 2021 and concluded in February 2022 at a junior high school where in-service teachers worked and at a university where prospective teachers studied. Figure 1 provides a depiction of the SUPER-LS program cycle.

The program consisted of two sessions: The first session focused on lesson study practices by in-service teachers (IST) in school, where pre-service teachers (PST) from the university observed the LS implementation over the plan, do and see phase. The lesson study practice in school focus on solving the challenges encountered by PST in their initial teacher education program (ITE). Meanwhile, the second session consisted of a lesson study with a lecturer in the mathematics education department and prospective mathematics teachers at the university. This study focused on the second phase of university-based lesson study. In the initial phase, prospective mathematics teachers participated in lesson study practice led by in-service teachers, with university tutors serving as "knowledgeable others". In-service teachers engaged with the school learning community members to create,

implement, and reflect on the lessons. Prospective mathematics teachers were asked to observe the process and compose a reflective journal containing lessons learned and best practices from its execution. Based on this experience and best practices, university instructors incorporated a research-based lesson titled "Improving the Teaching Skills of Pre-Service Teachers Through Project-Based Learning" into a specific course with their colleagues. As their project, four groups of pre-service instructors develop a lesson plan comprising phases of lesson study.
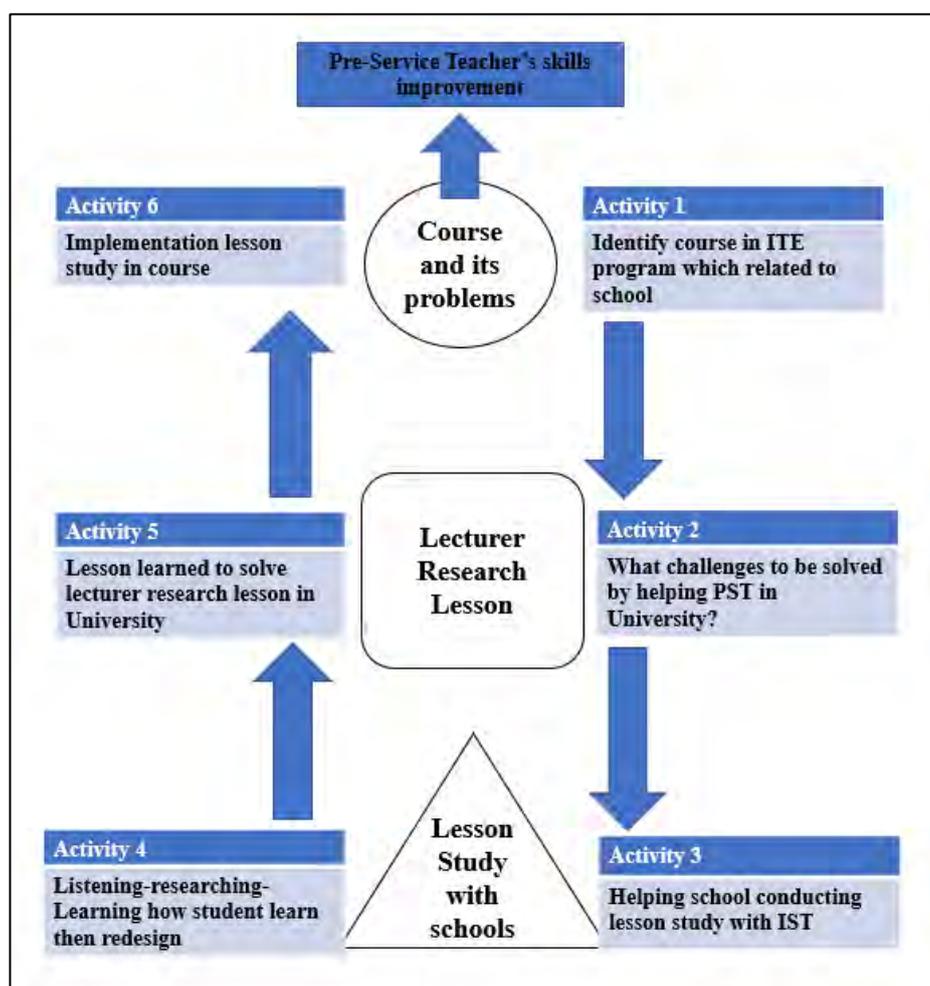

Figure 1. The cycle of the SUPER-LS program

Data Collection and Data Sources

This study uses document analysis approaches for data gathering, including participant-produced lesson plans and reflective essays. The lesson study practices collected three qualitative data sources from participants' work. A team of evaluators analyzed the initial and final lesson plans prepared by the prospective teachers to identify the flaws of the lesson plans based on the MKT framework. The initial and final drafts were compared regarding the number of flaws they included to determine the degree of progress. Groups' reflective reports were a second source for revealing their efforts in developing the lesson plan.

Data Analysis

All collected data, including lesson plans and reflective reports, were qualitatively analyzed using NVivo

version 20. The analysis was based on the MKT framework developed by Clivaz and Shuilleabhain (2019). The examination of reflections was open-coded and independently classified. Data triangulation was utilized to validate the findings by collecting and analyzing data from two distinct sources.

RESULTS AND DISCUSSION

The Overview of the Designed Lesson Plan from Each Group

All participants developed a lesson plan consisting of the main competency and indicator, learning objective, content, instructional approach, student activity, and assessment instrument. They were eager to construct lesson plans as a group and write a reflective essay while performing lesson study. Table 1 provides a summary of each group's respective project description. The prospective teachers produced a mathematics lesson plan for the 7th and 8th-grade mathematics curriculum using several instructional methods, including project-based learning, problem-based learning, and discovery learning.

Table 1. The overview of the lesson plan developed by preservice teachers

Group	Grade	Topic	Pedagogical Approach
Group 1	8	Pythagoras Theorem	Project Based Learning
Group 2	8	Function	Problem-Based Learning
Group 3	8	Relation	Discovery Learning
Group 4	7	Ratio	Discovery Learning

The Comparison of Weaknesses from the Initial Draft and Final Draft of the Lesson Plan

Examining the original lesson plans and final lesson plans generated by four groups of prospective teachers, as shown in Table 2, revealed that their initial lesson plans contained sixteen categories of problems, and their final lesson plans contained six problems. The analysis reveals that six concerns remain unresolved after participating in lesson study within the SUPER-LS program, particularly in content analysis (P2 and P3) and instructional process and activities (P7, P10, P12, P13, P14, P15).

Table 2. Prospective mathematics teachers' issues in the initial and final lesson plan

Components	Type of Problems	MKT	Frequency (Initial Lesson Plan)	Frequency (Final Lesson Plan)
Basic competencies and Indicators	No problem was found in this aspect	KCC	0	0
Instructional Objectives	P1. The objective of the learning process	KCC	75%	0
Content analysis	P2: No significant link among the concepts in the specified knowledge structure	HCK	100%	50%
	P3: Examples do not have mathematics topic characteristic	SCK	75%	0%

Instructional process and activities	P4: The content focus on essential formula or concepts only	SCK	100%	50%
	P5. The instructional process does not match the objective	KCC	100%	0%
	P6: the instructional process does not in line with the selected learning model phase	KCT	100%	0%
	P7: the coherence from one learning process to the next was lacking	KCT	75%	25%
	P8: Only procedural knowledge is emphasized in the lesson plan; the problem-solving task is excluded	SCK	50%	0%
	P9: The learning context's application is unclear	KCT	50%	0%
	P10: Examples and problems provided do not correspond to the levels of difficulty from easy to challenging	KCT	75%	25%
	P11. Unable to recognize students' difficulties and misconceptions	KCS	100%	0%
	P12. Unable to predict students' responses	KCS	100%%	0%
	P13. Difficult in getting students' attention in the classroom	KCS	100%	50%
	P14. Challenges in maintaining students' interactions	KCS	100%	50%
	P15. Unable to guide students with questions and examples	KCS	100%	50%
Assessment tool (student worksheet)	P16: Mathematical tasks in student worksheets, not problem-solving questions or contextual problem	SCK	100%	0%

A category of knowledge within the MKT framework was assigned to each problem, as indicated by the five major components of the lesson plans: main competencies and indicators, instructional objectives, contents analysis, instructional process, and activities, and assessment tool (students' worksheet). Table 3 summarizes the classification of challenges using the MKT framework. Two of the sixteen difficulties discovered in the initial lesson plan fell into the KCC category, four into the SCK category, four into the KCT category, five into KCS, and one into the HCK category. In the final lesson

plan, these 16 difficulties were reduced to six, representing an improvement of approximately 62.50%. The analysis also found that participants had no difficulty determining the primary competency and indication since they copied them from the government-supplied teaching guideline or curriculum.

In contrast, prospective teachers failed to recognize students' difficulties and misconceptions and predict their responses. They were initially unaware of this knowledge because the Indonesian lesson plan format excludes this part. In addition, their knowledge of students was lacking since they had limited exposure to actual classroom activity. Therefore, it is essential to include the student analysis component in the lesson plan style, as understanding students is one of the mathematical skills required to teach mathematics. A Lack of this information may hinder objective learning. By participating in in-service teachers' lesson study activities and implementing their lesson study, prospective mathematics teachers develop their knowledge of students. Therefore, this study suggests that Indonesian teachers modify the lesson plan template by including the component of student analysis, such as their level of ability, difficulties, and misconceptions.

Table 3. Summary of classified Issues based on the MKT framework

MKT		Type of Problem		Improvement
		Initial Lesson Plan	Final Lesson Plan	
SMK	CCK	-	-	None
	SCK	P3, P4, P8, P16	P4	Three problems were solved
	HCK	P2	P2	This problem still existed
PCK	KCS	P11, P12, P13, P14, P15	P12, P13,	Three problems were solved
	KCT	P6, P7, P9, P10	P7, P10	Two problems were solved
	KCC	P1, P5	-	All problems solved
Total		Sixteen problems	Six problems	Ten problems were solved (62,50%)

Note: P= Problem

Moreover, the findings show the most common problems in the SCK category (P3, P4, P8, P16) and KCS category (P11, P12, P13, P14, P15) in the first draft of lesson plans were still the most frequent ones in the final plan. Prospective mathematics teachers need to foster their specialized content knowledge as indicated by P2 and P4, knowledge of content and teaching as provided by P7 and P10 and understanding of the content and student as indicated by P12 and P13. This could be because they are still in their fifth semester, where more specialized mathematics, and have not registered in microteaching courses yet. They are expected to study these specialized mathematics courses during the sixth semester of the mathematics education program. However, the findings illuminate university teacher educators to focus on developing students' SCK, KCT, and KCS. To foster prospective mathematics teachers in acquire the essential knowledge and skills for teaching, lesson study could strengthen the process of equipping them with profound content and pedagogical content knowledge.

It was also found that the two groups had adequately addressed each of the earlier issues in their lesson plan. Although the other two groups had a few issues unsolved, the new strategy had advanced considerably from their original plan. They modified it by adding new ideas, eliminating some activities, or emphasizing a previously taught context. They received excellent feedback from their peers, in-service teachers, and teacher educator. Overall, the data shows that lesson study within the school-university partnership program was able to help prospective mathematics teachers to enhance their skills in planning a lesson.

Reflective Journal About the Lesson Study Activities

Prospective mathematics teachers also were requested to create a reflective journal on their lesson study activities and lesson preparation process, detailing what they have gained and what specific adjustments they need. Their reflective journals prove that their involvement in the SUPER-LS program benefited them, enhancing their lesson preparation abilities. During their participation in SUPER-LS, prospective mathematics teachers made specific observations about various elements of lesson plans through the lesson study cycles. Watching the planning and teaching of a mathematics lesson concretely demonstrated the importance of planning when teaching. They gained new perspectives on how lessons are designed and implemented. One of the prospective mathematics teachers noted, *"…observing in-service teachers' lesson study activity in school; I learn how a lesson should be designed, implemented in the classroom with all peers observed it and discuss its strengths and weaknesses for lesson improvement"*. Participants also learned to integrate the theory they learned in university into actual teaching practice, and most of them agreed that it was more challenging than learning the theory merely. This finding is in line with their reflection, which stated that "*it seems easy to develop lesson plan by filling the components as required in the template. They are many examples that I can follow. But I was surprised to find how difficult that was in reality. Many things must be considered, including content, pedagogy, students, assessment, and class management. I see how lesson study could facilitate this challenge through collaboration with peers and tutors".* The findings support Sadak's (2021) statement that prospective teachers who learn about teaching at university tend to fail to consider the complexity of the actual teaching situation because of the incoherence and inconsistency of the course structure. As a result, prospective mathematics teachers' teaching techniques do not support them in making knowledge connections for use in natural and different situations. The SUPER-LS program could close this gap, which creates stronger bonds between theory and practice. Prospective mathematics teachers stated the program provides them with an authentic teaching experience by getting in person involved in lesson study activities conducted by in-service mathematics teachers in schools. They valued the experience of designing their teaching process based on the best practices and lessons learned they got from the program. They also informed lesson study contributes significantly to the consolidation and development of their teaching skills, especially lesson planning skills. Similar findings were found by Amador and Galindo (2020), Aykan and Dursun (2021), and Fitriati et al. (2022), who presented the positive contribution of lesson study to prospective mathematics teachers' skill development.

Multiple collaborations and interactions between prospective mathematics teachers, in-service teachers, and university tutors encouraged enhancing prospective mathematics teachers' lesson planning skills throughout the lesson study process, both in school and university activities. They acknowledged the importance of collaboration in the lesson planning process by stating that *"…working together with peers and tutor to think which mathematical task is appropriate with the targeted mathematics topic, how to sequence the lesson using appropriate teaching method and anticipate student response was constructive. It will be a great challenge if I work alone"*. The collaboration allows participants to use each member's strengths in designing innovative lesson plans (Chen & Zhang, 2019). For instance, prospective mathematics teachers have received the most recent mathematical content knowledge and teaching method theory as part of their initial education program.

In contrast, practitioners in school have extensive experience with students, curriculum, and classroom management. At the same time, university tutors have produced new knowledge of mathematics instruction through their research. This knowledge can be used to create new lesson plans

that others can use. In other words, the SUPER-LS program provides prospective mathematics teachers with mutual encouragement, support, cooperation, and shared reflection (Richit et al., 2021). The program encourages young teachers to produce high-quality mathematics instruction without feeling left behind. Collaboration in lesson study prevents teachers from teaching alone in isolated classrooms, which may hinder improvement (Lewis & Hurd, 2011). The professional community in lesson study plays an essential role in facilitating teachers' involvement in the reform and fostering innovation to conventional classroom practices. It breaks down isolation by providing prospective and in-service teachers with a system or school-university culture that enables them to learn daily from colleagues, students, research, and external experts (Lewis & Hurd, 2011; Suilleabhain, 2015).

In addition, open class-which is a term in lesson study research that refers to the implementation of a lesson with other participants observing the lesson to provide meaningful evidence of student learning. This evidence was discussed in the reflection session as feedback on the instruction process. These feedbacks have significant educational value for prospective mathematics teachers (Baki, 2019; Sadak, 2021). Interaction with peers and experts is an effective way for teachers as a learner to construct new knowledge and skills (Schunk, 2014; Vygotsky, 1979). The findings indicate that prospective mathematics teachers' capacity for lesson planning is a developing process for teacher growth and long-term practice is required to develop the skill of designing a lesson plan (Lim et al., 2018). Therefore, the partnership between school and university mediated by lesson study activity may provide prospective teachers with an authentic experience planning lesson plan, observing how it is implemented in the classroom by focusing on students' learning, and reflecting and sharing it with the community learning. These experiences empower prospective mathematics teachers to independently construct and revise instructional programs (Aykan & Dursun, 2021; Lee, 2019). Taking charge of a class is a formative experience that leads to the professionalism of prospective mathematics teachers (König et al., 2020).

Based on the final lesson plan outcomes and group reflections, it is possible to infer that the SUPER-LS program improves the lesson planning skills of prospective mathematics teachers. Convincing evidence could be presented that planning skills have improved. This demonstrates the advancement of prospective mathematics teachers' lesson-planning skills during their involvement in the lesson study within the school-university partnership program and the growth of their expertise in lesson planning. Despite this positive impact, prospective mathematics teachers still need to advance their mathematical knowledge for teaching to develop effective lesson plans. Keep practicing lesson study through follow-up SUPER-LS program is recommended, which requires a strong commitment between the school and university to deliver the program. This should be anticipated carefully as partnerships are frequently reported as difficult and challenging (Baldry & Foster, 2019; Marsh, 2019).

CONCLUSION

This study investigates prospective mathematics teachers' planning skill improvement during their participation in the lesson study within the school-university partnership program to understand how they acquire these skills. The study confirms that the SUPER-LS activity provides prospective teachers with an authentic experience planning lesson plan, observing how it is implemented in the classroom by focusing on students' learning, and reflecting and sharing it with the community learning. These experiences empower prospective mathematics teachers to independently construct and revise the instructional design. Our empirical study shows that prospective mathematics teachers' difficulties in planning the lesson which is classified based on mathematical knowledge for teaching framework, could

be reduced as they are involved in the program. They were facilitated by intensive collaboration and interaction among participants, especially in-service teachers, and teacher educators as well as peers' feedback. However, prospective mathematics teachers still need to improve their specialized content knowledge, knowledge of content and teaching, and understanding of the content and student. These findings urge teacher education institutions and educators to focus their instruction on developing teachers' mathematical knowledge for teaching, particularly SCK, KCT, and KCS, by fostering the effectiveness of SUPER-LS program. The empirical findings provided by this study could increase our understanding of the potential of SUPER-LS in supporting prospective mathematics teacher learning and developing teaching skills.

This study was carried out exclusively in Indonesia; hence the results cannot be extrapolated to other countries. However, the study may apply outside of its specific environment. Many prospective mathematics teachers encounter difficulties developing MKT-based lesson plans that may also occur in other contexts. Therefore, the principles of developing lesson planning skills using SUPER-LS in the present study may also apply to different cultural settings and teacher training courses. Future research may benefit from modifying our empirical methodology to various scenarios, which could create a new important research subject in teacher education.

Acknowledgments

Declarations

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