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WHAT KNOWLEDGE DO MATHEMATICS TEACHERS DEVELOP DURING THE LESSON STUDY PRACTICE? A CASE STUDY FROM SECONDARY SCHOOL

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ABSTRACT

Understanding what knowledge mathematics teachers develop during lesson study is crucial for improving teaching practices and student learning outcomes. Despite widespread use of lesson study as a professional development approach, limited research has explored the specific types of teacher knowledge that emerge through this collaborative process, especially in secondary education contexts. This study explores the types of knowledge developed by mathematics teachers during the implementation of Lesson Study. Using a qualitative case study design, data were collected from three Lesson Study cycles involving four junior secondary school mathematics teachers. Data sources included classroom observations, video recordings of planning and reflection sessions, and teaching documents. Transcript-based lesson analysis was employed to examine changes in teachers' knowledge across three key domains: mathematical content knowledge, pedagogical content knowledge (PCK), and awareness of student thinking. Findings indicate that participation in Lesson Study encouraged deeper conceptual understanding, more deliberate instructional decisions, and greater sensitivity to students' learning processes and misconceptions. These outcomes highlight the transformative potential of Lesson Study in fostering collaborative, practice-based professional growth. The study concludes by recommending the strengthening of school–university partnerships and the institutionalization of Lesson Study as an effective and context-responsive approach to mathematics teacher development in Indonesia.

INTRODUCTION

The quality of mathematics education is closely tied to the quality of teaching and the professional capacity of teachers. Across many education systems, particularly in developing countries like Indonesia, mathematics teaching is often characterized by teacher-centered approaches, limited problem-solving opportunities, and minimal student

engagement in conceptual reasoning (Stigler & Hiebert, 2016). Teachers frequently rely on procedural instruction and textbook-driven lessons, which inhibit students' ability to develop higher-order thinking skills (Fitriati et al., 2021). These challenges contribute significantly to persistent learning poverty, especially in mathematics.

Indonesia's performance in international assessments such as the Programme for International Student Assessment (PISA) has highlighted this crisis. In the most recent PISA cycle, Indonesian students scored an average of 366 in mathematics, below the OECD average of 47 which placing them among the lowest-performing countries (Markus, 2019). The report also revealed that over 70% of Indonesian students failed to reach the baseline proficiency level, indicating an inability to interpret and apply mathematics in real-world contexts. Such results have raised concerns among policymakers and educators about the effectiveness of current teaching strategies and the need for more robust teacher development efforts.

At the heart of the problem lies the professional knowledge of teachers. Many mathematics teachers enter the classroom with inadequate subject matter knowledge (SMK) and underdeveloped pedagogical content knowledge (PCK), limiting their ability to teach for deep understanding (Hill et al., 2008). These deficiencies are compounded by a lack of ongoing, school-based professional development that focuses on real classroom practice. Most in-service training programs in Indonesia are one-off workshops that fail to support long-term learning or collaboration among teachers (Putri & Zulkardi, 2019).

To address these issues, Lesson Study has emerged as a promising professional development model. Originating in Japan as *jugyō kenkyū*, Lesson Study engages teachers in a cyclical process of collaboratively planning a lesson, teaching it while others observe, and reflecting on the outcomes to improve instruction (Yoshida & Jackson, 2011). The approach is grounded in the belief that deep professional learning occurs through sustained inquiry into teaching and learning in the context of actual practice. International research has shown that Lesson Study supports the development of both SMK and PCK, encourages teacher collaboration, and enhances responsiveness to student thinking (Fitriati et al., 2023; Ni Shuilleabhain, 2016; Perry et al., 2009).

In the Indonesian context, Lesson Study has been introduced through university-school partnership programs and teacher networks. However, its implementation remains uneven and under-researched, particularly in regions like Aceh where teacher support systems are still developing. While some studies have reported positive outcomes, there is a need to examine how Lesson Study actually supports teacher knowledge development

in specific school settings. What kinds of knowledge do teachers develop? How do they learn through planning, teaching, and reflecting together? This study responds to that need by exploring the knowledge developed by mathematics teachers during the implementation of Lesson Study in an Aceh secondary school. Drawing on the case study method, it seeks to capture the dynamic and situated nature of teacher learning as they engage in collaborative inquiry.

Given the pressing need to improve the quality of mathematics education in Indonesia, particularly in regions grappling with systemic and resource-related challenges, this study addresses a critical gap in teacher professional development. While Lesson Study has gained traction as a collaborative model for enhancing teaching practice, little is known about the specific types of professional knowledge that mathematics teachers develop through this process in the secondary education context. This study focuses on how teachers construct professional knowledge during Lesson Study cycles, including planning, teaching, and reflection phases. It examines the situated learning that emerges as teachers deepen their mathematical content knowledge, enhance their pedagogical content knowledge (PCK), and become more attuned to students' mathematical thinking. By foregrounding the complexity and depth of teacher learning, the study offers timely insights into how Lesson Study can be harnessed as a sustainable, context-responsive strategy for advancing mathematics education in Indonesia.

To guide this inquiry, two main research questions are proposed. First, what domains of teacher knowledge evolve through the Lesson Study process? This includes not only content knowledge (CK) and PCK as defined by Shulman (1983) and expanded by Hill et al., (2008) but also teachers' awareness of student misconceptions, their instructional decision-making, and their ability to adapt lessons responsively. The second question asks, how do the planning, observation, and reflection phases of Lesson Study contribute to these knowledge gains? Each stage of the Lesson Study cycle is assumed to offer distinct opportunities for learning, through collaborative lesson design, real-time classroom observation, and deep analysis of student learning during reflection. Understanding how these phases function in practice will provide insight into the mechanisms that support teacher knowledge development.

The significance of this study is both practical and theoretical. Practically, it offers evidence-based insights into how Lesson Study can serve as a viable model for improving teacher quality in low-resource and post-conflict settings like Aceh. The study highlights how ongoing, collegial, and classroom-embedded professional development can lead to

meaningful improvements in teachers' instructional practice, contrasting with the fragmented and top-down nature of many current teacher training initiatives in Indonesia. The findings may inform school-university partnership programs, government professional development strategies, and broader educational reforms targeting the improvement of STEM education in the country.

From a theoretical perspective, the study contributes to the growing body of international literature on teacher learning and professional knowledge. While many studies have investigated the effectiveness of Lesson Study in countries like Japan, the United States, and Ireland, fewer have focused on its implementation in Southeast Asian contexts where systemic challenges are prevalent. By situating Lesson Study within the socio-cultural and educational realities of Aceh, the research extends understandings of how teacher knowledge evolves in diverse settings. Moreover, it sheds light on how collaborative inquiry and structured reflection can empower teachers as agents of change in addressing mathematics learning poverty.

METHODOLOGY

This study adopts a qualitative case study approach to explore the development of mathematics teachers' professional knowledge through Lesson Study. The case study design is particularly suitable for investigating complex, context-dependent educational phenomena, as it allows researchers to examine real-life processes in depth and from multiple perspectives (Yin, 2018). By focusing on a bounded system, namely, a group of secondary school mathematics teachers in Aceh engaged in Lesson Study, this research seeks to understand not only *what* knowledge is developed, but also *how* it evolves through interaction, reflection, and practice.

Participants were selected using purposive sampling Palinkas et al. (2015), targeting mathematics teachers who were actively involved in a school-university partnership Lesson Study initiative in Aceh. The selected group consisted of four teachers from a public junior secondary school who had between 5 and 20 years of teaching experience. All participants had voluntarily joined the Lesson Study program and had prior exposure to collaborative lesson planning and peer observation practices. The school itself was part of a broader professional development network supported by a local university, aiming to improve mathematics instruction and reduce learning poverty through reflective teaching practices.

Data were collected over three complete Lesson Study cycles conducted over a two-month period. Multiple qualitative data sources were employed to ensure triangulation and depth of analysis (Creswell, 2015). These included video and audio recordings of planning meetings, classroom teaching (research lessons), and post-lesson reflections; and lesson plans, student work samples, and classroom observation notes. All data were transcribed verbatim and, where necessary, translated from Bahasa Indonesia to English for analysis.

The primary analytic method employed was Transcript-Based Lesson Analysis (TBLA), which enables researchers to closely examine teacher discourse and interactions across the stages of the Lesson Study cycle (Sarkar Arani, 2017; Typelo & Moss, 2011). Transcripts from planning meetings and post-lesson reflections were coded using an inductive-deductive approach: codes were first derived from the literature on teacher knowledge, specifically content knowledge, PCK, and knowledge of student thinking (Ball et al., 2008; Shulman, 1983), and then refined through iterative readings of the data. Emergent themes were further analyzed to identify patterns of professional learning and shifts in instructional thinking.

Coding was conducted manually and then checked by two additional researchers to enhance reliability. Discrepancies in code assignment were discussed and resolved through consensus. Data were also examined across time to trace how teachers' knowledge evolved from one cycle to the next, thus capturing the developmental nature of teacher learning within Lesson Study.

FINDING AND DISCUSSION

The analysis of Lesson Study cycles revealed three major domains in which mathematics teachers' professional knowledge was notably developed: deeper understanding of mathematical content, enhanced pedagogical content knowledge, and increased sensitivity to student thinking and learning strategies. The findings is summarized in the following Table 1.

Knowledge Domain	Cycle 1 – Initial Observations	Cycle 2 – Emerging Insights	Cycle 3 – Consolidated Understanding
Mathematical Content Knowledge (MCK)	Teachers focused on procedural accuracy but showed gaps in conceptual explanations.	Improved clarity in linking concepts and addressing common misconceptions.	Demonstrated deeper conceptual explanations and use of representations.
Pedagogical Content Knowledge	Lesson plans lacked differentiated strategies; limited use of examples.	More deliberate use of varied strategies and questioning techniques.	Effective integration of examples, scaffolding, and formative feedback.

Knowledge Domain	Cycle 1 – Initial Observations	Cycle 2 – Emerging Insights	Cycle 3 – Consolidated Understanding
(PCK) Awareness of Student Thinking	Limited attention to student errors or reasoning.	Began to notice patterns in student misconceptions during reflection.	High sensitivity to student thinking; adjusted instruction accordingly.

These findings align with prior research suggesting that Lesson Study supports multidimensional professional growth through collaborative, practice-based inquiry (Huang & Shimizu, 2016; Lewis et al., 2019).

Strengthening of Mathematical Content Knowledge

Throughout the planning and post-lesson discussion phases, teachers demonstrated a clearer and more connected understanding of mathematical concepts. For instance, during the design of a lesson on ratios and proportions, teachers initially approached the topic procedurally, focusing on how to calculate ratios, without fully addressing conceptual underpinnings. However, through collaborative discussion and feedback from university-based facilitators, the team revised the lesson to emphasize the *multiplicative relationships* underlying proportional reasoning. This shift reflected an increased depth in content knowledge, moving beyond surface-level procedures to foundational mathematical ideas.

This finding is consistent with Nguyen and Tran (2023) and Fitriati et al., (2024), who emphasize the importance of SCK, mathematical knowledge uniquely required for teaching. Lesson Study provided opportunities for teachers to engage in mathematical reasoning themselves, identify gaps in their understanding, and negotiate meaning collaboratively. Such experiences are crucial in contexts like Indonesia, where many in-service teachers have limited formal preparation in mathematics (Putri & Zulkardi, 2019).

Development of Pedagogical Content Knowledge (PCK)

The Lesson Study process also contributed to the development of teachers' PCK, particularly in terms of anticipating student difficulties, selecting appropriate representations, and designing instructional strategies that support conceptual understanding. For example, during the research lesson, one teacher used a double number line to represent proportional relationships, an instructional strategy introduced during the planning session. The use of this visual tool was later identified in the

reflection phase as key to helping students grasp the relational meaning of ratio, illustrating a practical application of refined pedagogical knowledge.

This development echoes findings by Yoshida and Jackson (2011) and Fitriati et al., (2024), who argue that Lesson Study enables teachers to learn from each other's instructional moves and consider the pedagogical rationale behind those moves. In this study, post-lesson reflections served as a forum for teachers to articulate the why behind their instructional decisions, moving from tacit practices to intentional pedagogy. Teachers also became more adept at evaluating the effectiveness of their teaching strategies based on direct classroom evidence.

Increased Awareness of Student Thinking

One of the most significant shifts observed was teachers' increased attentiveness to student thinking. During the reflection phase, teachers discussed specific student responses both correct and incorrect and used these observations to understand how students were making sense of the mathematics. In one case, students interpreted a problem involving scale incorrectly by adding instead of multiplying values. Rather than labeling this as a simple error, the teachers explored the possible reasoning behind the misconception and discussed how future lessons could be structured to address it.

This heightened focus on student thinking aligns with recent literature emphasizing the value of knowledge of learners and learning trajectories in mathematics teaching (Ni Shuilleabhain, 2016; Schoenfeld, 1992). Lesson Study created space for teachers to view student mistakes as learning opportunities and to refine their instruction based on evidence of student understanding, a shift that is foundational for adaptive teaching.

Integration and Reflection

These findings highlight how the cyclical structure of Lesson Study, planning, teaching, reflecting, creates multiple, reinforcing opportunities for teacher learning. Importantly, the research underscores the role of collaborative dialogue and observation in fostering this development. Teachers did not simply accumulate knowledge; they constructed it socially, through joint inquiry into practice (Jaworski, 2017). This approach is particularly powerful in contexts such as Aceh, where access to sustained professional development is often limited.

In sum, the Lesson Study process facilitated meaningful growth in teachers' professional knowledge, with direct implications for improving classroom instruction and

student understanding. These findings contribute to a growing body of international research suggesting that Lesson Study is an effective, scalable model for in-service teacher development, particularly in mathematics education (Takahashi & McDougal, 2016), 2016).

CONCLUSION AND RECOMMENDATION

This study set out to explore the kinds of professional knowledge mathematics teachers develop through their participation in Lesson Study practices, focusing on a case study in Aceh, Indonesia. In a context where mathematics education continues to struggle with procedural teaching, limited student engagement, and low international assessment results, the findings offer timely and practical insights into how collaborative, practice-based professional development can serve as a catalyst for meaningful teacher learning.

Through three cycles of Lesson Study, teachers in this study experienced significant growth in their content knowledge, PCK, and awareness of student thinking. The planning phase encouraged teachers to deeply examine mathematical concepts and anticipate instructional challenges, leading to stronger conceptual foundations. The teaching and observation phase created authentic opportunities for classroom experimentation, while the post-lesson reflection sessions facilitated rich, collaborative dialogue about instructional effectiveness and student understanding. These stages collectively contributed to a more reflective, student-centered teaching orientation.

Importantly, this research highlights that teacher learning is not merely an individual process but a collective and contextual one. The structured collaboration facilitated by Lesson Study empowered teachers to build on each other's strengths, question assumptions, and co-construct instructional improvements. This collaborative professionalism is especially vital in educational systems where traditional in-service training remains fragmented and disconnected from classroom realities.

In conclusion, this study demonstrates that Lesson Study holds great promise as a sustainable and contextually relevant approach to mathematics teacher development in Indonesia. It not only supports the deepening of professional knowledge but also contributes to long-term improvements in instructional quality and, ultimately, student learning outcomes. These findings advocate for the institutionalization of Lesson Study through school-university partnerships, policy support, and ongoing capacity building among educators and facilitators. As Indonesia continues to address its learning poverty

in mathematics, models like Lesson Study provide a pathway toward more effective, locally grounded educational change.

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