Asia-Pacific Journal of Educational Management Research
Vol. 9, No. 2 (2024), pp. 17-32
http://dx.doi.org/10.21742/ajemr.2024.9.2.02

Exploring Pedagogical Design in Lesson Study through the SECI Model: A Case Study of Preservice Teacher Learning Metacognitive Pedagogies

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Abstract

This case study examines how Lesson Study (LS) enables Preservice Teachers (PSTs) to develop pedagogical knowledge, analyzing it through the SECI (Socialization, Externalization, Combination, Internalization) knowledge-creation model. The study investigated PSTs co-constructing metacognitive pedagogies in a teacher education program through LS, using an experimental design comparing control and experimental groups. Data collection included pre- and post-questionnaires on metacognitive pedagogies, lesson observations, and group interviews. Confirmatory Factor Analysis (CFA) identified five metacognitive pedagogies, while t-tests revealed significant differences in modeling thinking, provoking reflection, and reviewing thinking between the pre- and post-surveys. Results show that LS components (collaborative lesson planning, research lesson implementation, and post-lesson conference) facilitate PSTs in leveraging tacit pedagogies, codifying them into lesson plans, and internalizing them as implicit knowledge. The pedagogy-sharing process in LS communities enables PSTs to develop as knowledgeable practitioners and enhance their reflective learning about metacognitive pedagogies.

Keywords: *Lesson study, Metacognitive pedagogies, Metacognition, The SECI model, Learning to learn, 2.0+ curriculum*

1. Introduction

This paper explores the application of Lesson Study (LS) in teacher education programs to enhance preservice teachers' metacognitive pedagogies, addressing specific challenges posed by the Learning to Learn 2.0+ Curriculum in Hong Kong. This curriculum emphasizes developing students' metacognitive skills for self-regulation and problem-solving, presenting difficulties in curriculum implementation and instructional design [1][2]. Developing teachers' professional competency is critical for successful curriculum implementation [3]. Through collaborative lesson planning, observation, and reflection, LS provides a platform for teachers to refine their teaching strategies and monitor their effectiveness [4]. Despite the recognized potential of LS, few studies have examined its role in supporting Preservice Teachers (PSTs) in collaboratively developing the metacognitive pedagogies necessary for the Learning to Learn curriculum. This study adopts the SECI model to analyze teachers'

Article history:
Received (August 1, 2024), Review Result (September 5, 2024), Accepted (October 10, 2024)

knowledge sharing about metacognitive pedagogies within the LS framework. The SECI model facilitates interactive dialogue and knowledge creation [5], making it suitable for exploring how PSTs develop these pedagogies. Through pre-post surveys, lesson observations, and interviews, the study reveals that LS enables PSTs to transform tacit knowledge into explicit pedagogical strategies, thereby effectively enhancing their ability to address learners' needs.

2. Literature review

The core objective of the Learning to Learn (LtoL) curriculum is to develop students' metacognition, so the professional development of teachers in metacognitive pedagogies is essential to implementing the LtoL curriculum. As one of the powerful collaborative teacher professional development approaches, LS has great potential to develop teacher metacognitive pedagogies by inspiring others. The literature review articulates the nature of metacognitive pedagogy, how Lesson Study can serve as a knowledge-sharing platform to inspire teacher metacognitive teaching, and why the SECI knowledge creation model could be used to examine teacher learning in LS.

2.1. Metacognition and metacognitive pedagogies

Metacognition is a higher-order thinking process [6] that involves critical analysis of thought [7] and knowledge of cognitive phenomena [8]. It includes monitoring, regulating, and orchestrating cognitive processes and products [8][9]. Metacognition enables individuals to understand and manipulate their cognitive processes [10] and organize their cognitive structure [8][11]. Metacognition is described as an interactive process of four elements: metacognitive knowledge, experiences, goals, and cognitive strategies. Brown [12] proposes a similar model that encompasses knowledge of cognition, its regulation, and motivation. Both models emphasize what learners know about their cognition and how they control their learning through monitoring and regulation. Brown's model has been operationalized into metacognitive pedagogies, including modeling thinking, provoking reflection, reviewing thinking processes, enabling self-regulation, and providing motivational feedback [13][14][15]. These pedagogies facilitate students' plan-implementation-evaluation cycle for problem-solving and cognitive regulation. Key strategies involve teachers modeling thinking processes, engaging students in thought-provoking reflections, and facilitating a review of problem-solving processes to develop student metacognition [13][14].

2.2. Lesson study for teacher learning

LS involves cycles of collaborative lesson planning, peer observations, and post-lesson conferences to improve instructional design. This process allows teachers to share tacit knowledge about student learning and thinking [4], promotes peer learning [16][17], and focuses on effective instructional design [18]. LS is a platform for developing pedagogical knowledge to bridge curriculum implementation gaps [19]. Teachers can design activities to make students' thinking visible [20]. Consequently, LS enhances teachers' critical thinking, communication, collaboration, metacognition, and literacy skills, enabling them to develop students' Learning to Learn skills [21]. LS is increasingly used in teacher education to enhance PSTs' skills through micro-teaching [22][23][24] or practicums [25]. It helps in-service teachers master teaching skills [26][27][28], develop instructional design competency [29], and promote reflective abilities [30]. LS has been adapted to teach thinking skills [31]

and improve student learning through metacognition [32]. Cheng & Lee [33] show that LS components enable teachers to become critical friends and knowledgeable others, gaining a deep understanding of student learning behavior. Research indicates that metacognitive strategies in lesson planning positively impact teachers' instructional design skills [34]. While these strategies are included in teacher education programs, there's limited research on how LS facilitates PSTs' development of metacognitive teaching strategies for competency-based curricula. This study explores how LS enables teachers to develop metacognitive pedagogy and evaluates its effectiveness in crafting metacognitive teaching for instructional design.

2.3. The SECI model as an analytical lens

The SECI model [35] is a widely referenced theory for knowledge conversion [36], representing a knowledge spiral that transforms tacit knowledge into explicit knowledge and back [37]. It has been validated for enhancing student learning outcomes [38] and can support teachers in developing competencies and operational capabilities. This model is adopted to analyze collaborative lesson planning in LS. The SECI model, a prominent theory of knowledge conversion, describes a knowledge spiral that transforms tacit to explicit knowledge and back. Validated for enhancing learning outcomes, it's adopted to analyze collaborative lesson planning in LS, supporting teachers in developing competencies from experience and new knowledge. The SECI model is a matrix depicting four knowledge conversion processes: socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit), and internalization (explicit to tacit). These processes repeat in an ascending knowledge spiral, continuously creating new knowledge.

The SECI model comprises four interconnected processes of knowledge conversion in Lesson Study. Socialization involves transferring tacit knowledge between teachers through collaborative lesson planning and evaluation [39][40]. Externalization articulates tacit knowledge into explicit forms, such as lesson plans [35][41]. Combination systematically integrates explicit expertise from different departments into usable organizational pedagogies, exemplified by STEM activities design [19][42]. Internalization occurs when teachers absorb explicit knowledge through the enactment of lesson plans, transforming it into new tacit knowledge [43][44]. These processes form an iterative knowledge creation and transformation cycle in the Lesson Study context, facilitating continuous improvement in teaching practices and pedagogical understanding.

This study addresses critical gaps by exploring the role of Lesson Study (LS) in developing metacognitive pedagogies specifically for preservice teachers (PSTs). It evaluates how the SECI model can facilitate knowledge conversion and enhance instructional design within LS. Additionally, the study investigates how integrating metacognitive strategies into LS can tackle curriculum implementation challenges, offering a structured approach to teacher development. By addressing these gaps, the research contributes to a deeper understanding of how to leverage LS to improve metacognitive teaching strategies in teacher education.

3. Methodology

This study investigates how Lesson Study (LS) nurtures preservice teachers' (PSTs) metacognitive pedagogies and the mechanisms behind this development. A case study approach was chosen to provide an in-depth understanding of this complex educational phenomenon in a real-life context. The study focuses on a university that has integrated LS as a core component of its preservice teacher education program to enhance teaching capacities. This setting allows for a detailed exploration of LS implementation processes and outcomes,

offering insights that may be valuable for similar educational contexts aiming to strengthen teacher competencies.

This study compared 50 MEd PSTs (control group) with 60 MTeach PSTs (experimental group) at a Hong Kong university. The MTeach group participated in a nine-month program that included practitioner-based research courses, tutorials, consultations, and a research lesson practicum [45]. Metacognitive teaching principles were operationalized based on Schraw [46], Pintrich [47], and Veenman et al. [48]. The MTeach program incorporated these principles and featured guest lectures by experienced practitioners. The 60 MTeach PSTs were divided into eight subject-based groups to implement Lesson Study (LS) in partnership schools. They engaged in collaborative planning, peer observation, and post-lesson evaluation, focusing on metacognitive teaching strategies. Lessons were video-recorded, and the researcher analyzed lesson plans and teaching behaviors using a framework based on five principles of metacognitive teaching.

This case study [49] employed a mixed-methods approach to investigate PSTs' knowledge sharing, conversion, and creation in Lesson Study. The case study approach was adopted to enable an in-depth examination of how Lesson Study develops preservice teachers' metacognitive pedagogies within the authentic context of a university teacher education program, allowing researchers to capture the complexity of this educational phenomenon through multiple data sources and methods. The research design included pre- and post-questionnaires on metacognitive pedagogies, validated through Confirmatory Factor Analysis (CFA), and analyzed using T-tests, lesson observations, and unstructured group interviews. The questionnaire, grounded in Brown's model [50] and studies by Schraw [46], Pintrich [47], and Veenman [48], consisted of 20 items across five scales of metacognitive teaching principles. These principles were operationalized into teaching descriptions and assessed using a six-point Likert scale ("Always" to "Never") to measure the frequency of metacognitive teaching behaviors. This comprehensive approach yielded quantitative data on the learned metacognitive pedagogies of the control and experimental groups. In contrast, qualitative data from observations and interviews offered insights into how PSTs shared and co-constructed these pedagogies.

This study employed a comprehensive methodological approach to validate and analyze data on PSTs' metacognitive teaching practices. Confirmatory factor analysis (CFA) using principal axis factor analysis with Promax rotation confirmed the instrument's construct validity and reliability, with factors extracted based on eigenvalues greater than 1. Confirmatory factor analysis was used to verify that the 20 questionnaire items meaningfully clustered into the five intended scales of metacognitive teaching principles, providing statistical evidence that the instrument measured what it was designed to measure. T-tests examined pre-post differences and incremental scores across five teaching principles. Lesson observations, guided by a framework based on Schraw [46]. And refined by Cheng & Chan [51], documented PSTs' application of metacognitive strategies in the LtoL curriculum, addressing potential self-reporting bias. The framework assessed teacher modeling, reflection provocation, thinking process review, self-regulation promotion, and motivational feedback provision. Additionally, eight in-depth group interviews explored PSTs' knowledge sharing in LS, focusing on collaborative practices during material study and lesson planning [52][53]. This multi-faceted approach provided a comprehensive understanding of PSTs' development and application of metacognitive teaching pedagogies.

4. Findings and discussions

4.1. Confirmatory factor analysis on the framework of metacognitive teaching

The confirmatory factor analysis results in Table 1 suggest five-factor structures for the empirically feasible and theoretically acceptable variables. Eighteen items had factor loadings greater than 0.5. The five variables are modeling thinking, provoking reflection, reviewing thinking, enabling self-regulation, and providing motivational feedback. Reliability coefficients of 0.7 or higher are considered adequate for research purposes [54]. The reliability coefficients of the scales ranged from 0.714 to 0.848, which were judged adequate for this study. These coefficients indicate that the guiding principles for metacognitive teaching proposed by Schraw [46], Pintrich [47], and Veenman [48] are conceptually applicable and can be inferred from questionnaire items with content validity for measuring metacognitive teaching behaviors. Since these five guiding principles are derived from the elements of Brown's models - knowledge of cognition, regulation of cognition, and motivation for learning- these results verify the power of Brown's model to explain metacognitive teaching behaviors [50].

Table 1. Results of the factor analysis and reliability test for each scale

	Enabling self-regulation	Provoking reflections	Modelling thinking	Motivational Feedback	Review thinking
Q1.	0.987				
Q2	0.878				
Q3	0.645				
Q4	0.583				
Q5		0.763			
Q6		0.752			
Q7		0.600			
Q8		0.503			
Q9			0.779		
Q10			0.767		
Q11			0.560		
Q12			0.521		
Q13				0.794	
Q14				0.714	
Q15				0.707	
Q16					0.720
Q17					0.665
Q18					0.560
Eigen-value	7.751	1.493	1.303	1.226	1.026
Reliability α	0.848	0.756	0.738	0.814	0.714

4.2 Pre-post tests on PST learning

The pre-post survey results for the experimental group show that all teaching principles score higher than 5.0 on the 6-point scale (see Table 2). Positive incremental scores for all five teaching principles were identified between pre/post surveys in both the control and experimental groups. These incremental scores indicate that they practice the five metacognitive teaching strategies more after the course. The T-test results reveal significant improvements in some metacognitive teaching principles for the experimental group, specifically in modeling thinking, thought-provoking reflections, and reviewing the thinking

process. Regarding the metacognitive pedagogies learned by the PSTs, the results of the T-test showed significant differences between pre/post surveys for modeling thinking process (p=0.007), thought-provoking reflections (p=0.000), and reviewing the thinking process (p=0.044) in the experimental group. In the control group, only the incremental scores for the reviewing thinking process (0.015) were significantly different between the pre/post surveys. This indicates that implementing Lesson Study (LS) effectively enhances these aspects of metacognitive teaching among preservice teachers (PSTs). However, there were no significant changes in enabling self-regulation and motivational feedback, suggesting these areas require more time and repeated practice to develop fully.

Table 2. T-Tests on the five teaching principles

	Control group			Experiment group		
	Pretest Mean	Posttest mean	P-values	Pretest Mean	Posttest mean	P-values
Modeling thinking	4.99	5.00	0.920	5.05	5.34	0.007
Thought-Provoking reflections	5.05	5.01	0.739	5.11	5.48	0.000
Reviewing the thinking process	4.55	4.93	0.015	4.19	5.05	0.044
Enable self-regulation	4.92	4.95	0.809	5.08	5.27	0.139
Motivational feedback	4.99	5.09	0.489	5.06	5.30	0.072

An interesting finding of the T-test is the absence of significant differences between the pre- and post-survey scores for enabling self-regulation and motivational feedback. Motivating and nurturing pupils to become self-regulated learners will take much longer than the research lessons. Nurturing pupils' self-regulation abilities involves a few iterative cycles to set learning goals, whether short-term or long-term, and to review their learning strategies to achieve them before becoming self-motivating learners. The PSTs in this study implemented only two research lessons for a single lesson plan. Therefore, it is not surprising that the incremental scores for these two guiding principles cannot be significantly induced. However, the positive incremental scores of all the teaching principles have encouraging implications for teacher educators and serving teachers in LS communities. They can apply metacognitive teaching strategies to develop pupils' abilities to regulate cognition if they want to implement the learning-to-learn curriculum effectively.

The significant gains in modeling thinking and reflective practices suggest that LS can effectively target and improve specific teaching strategies. This highlights the value of LS in teacher education programs to cultivate these critical skills. However, the lack of significant changes in self-regulation and motivational feedback underscores the importance of providing PSTs with more opportunities and time to practice and refine these skills. This suggests incorporating more iterative cycles in teacher training to allow deeper development in these areas. Moreover, teacher educators should adopt a balanced approach, ensuring that PSTs receive comprehensive training covering all aspects of metacognitive teaching, possibly through extended practicums or additional LS sessions. The positive results support integrating metacognitive strategies within the Learning to Learn curriculum. Schools can leverage LS to enhance teachers' abilities to foster metacognitive skills in students, leading to improved learning outcomes.

4.3. Lesson observations on PST teaching performance

Table 3 presents the researcher's observations on lesson implementation. Regarding the instructional design activities, the PSTs designed problem-solving activities to provoke their pupils' thinking, arranged group discussions for problem-solving, and encouraged them to

share their thinking processes and ask questions. They arranged presentations in which pupils reported their problem-solving solutions and evaluated whether they could write down their learning processes. Finally, they assigned group reviews to help their pupils reflect on their thinking and learning processes.

Table 3. Participatory observation on developing metacognitive pedagogies

Group No.	Subject/Topic	Metacognitive Pedagogies	Focuses of discussion in the post-lesson conference
1	Chinese Language / Reading comprehension	Modelling and thinking aloud	The teacher thinks aloud, using self-questioning guides and models, so that students can comprehend the texts. Using self-questioning to produce a 6W1H framework for reading comprehension
2	Chinese Language / Understanding an argumentative essay	T-S co-constructs a mind map to visualize the argument of an essay	The teacher interacts with students by asking questions to construct a mind map for visualizing the overall structure and argument of an essay
3	English Language / Objects clause	Roleplay and learn by doing contextual teaching	Using contextual teaching to motivate the students to understand the *subject* of the clause does something to the object through role play, which provides an authentic learning environment
4	English Language / Elaboration of ideas	Engaging students in group sharing through Peers questioning	The teacher facilitates self-questions for the students to review their assumptions and uses peer questioning (5W1H) to guide students in self-monitoring and evaluation.
5	English Language / Sports	Peer assessment Error detection	Using peer assessment and error detection for promoting self-evaluation and enhancing learning motivation
6	English Language / The past tense and the perfect tense	Using a timeline to visualize and contrast the usage	Modeling and visualizing a timeline for differentiating past tense and perfect tense, then using think-pair share for regulation
7	General Science / Environmental protection	Inquiry-based learning Problem-based Learning	Apply the KWL approach with problem-based learning to promote student problem-solving skills and motivation
8	Liberal Study / Tertiary industry	Game-based activities Inquiry-based learning	Using game-based activities to motivate student learning and to model a case before conducting inquiry-based learning generalizes the concepts.

Regarding lesson implementation, all PST groups can visualize the differential value of alternative strategies in their minds through modeling and thinking aloud, thereby developing their pupils' metacognitive knowledge. The PSTs asked, "What do I want to achieve and what steps do I want to take to do that?" to enable their pupils to review and present their problem-solving thinking processes, helping them regulate their cognition. They can model their thinking process to pupils. The PSTs arranged presentations for pupils to report their thinking processes explicitly and asked them, "Why do you think so?" to assess their logic and thinking. Groups 4 and 6 facilitated students' cognitive regulation by questioning and engaging them in problem-solving and think-pair-share activities. They grouped students to discuss ways to solve problems and encouraged them to share their thinking processes and ask questions regarding the learning tasks. The PSTs implementing the research lessons can help the students review their thinking process by arranging pupils' presentations. Group 8 provided positive learning experiences through game-based activities to sustain pupils'

engagement. These observations triangulate with the findings of the T-test on the significant incremental scores of the modeling thinking process, thought-provoking reflections, and reviewing the thinking process in the experimental group. The incremental scores on the pre- and posttests, and the findings from the observation, echo Liyanage & Bartlett's study [55] on adopting a metacognitive teaching strategy to enhance PSTs' learning in Lesson Study.

The researcher observed the challenges PSTs face in nurturing pupils' self-regulated skills. PSTs of Group 4 applied self-questioning (5W and 1 H questions) to facilitate pupils' concretizing ideas to foster a metacognitive learning environment. They positively evaluated their pupils' efforts. Still, most pupils cannot thoroughly answer all the questions and seem overloaded and disengaged. Group 7 applied the KWL teaching approach to enable pupils to monitor, regulate, and orchestrate their cognitive activities. They guided their pupils to set learning goals (what to learn), formulate learning strategies (how to learn), conduct self-questioning to understand, and detect errors. Then, they conducted activities and used regulation checklists and strategy evaluation matrices to help pupils assess whether their goals were achieved and develop their self-regulation abilities. However, the results are not encouraging; their pupils lack time and alternative learning strategies to evaluate their learning goals and plan for regulations.

4.4. Group Interviews of PSTs on their learning process

To answer the research questions about why and how LS enables PSTs to develop their pedagogies, the SECI knowledge-creation model was adopted as an analytical lens to examine PSTs' learning processes in LS. The group interview findings show that LS enables the PSTs to socialize, externalize, and codify their tacit metacognitive pedagogical knowledge into lesson plans, and to absorb it through learning-by-doing during the research lesson implementation.

4.4.1. The socialization of tacit knowledge

There is evidence from the interviews that the PTSs share their ideas about the modeling thinking process, thought-provoking reflections, and participation in the thinking process during lesson planning and post-lesson evaluation.

We found it challenging to develop a lesson holistically and maintain alignment among aims, procedural steps, and assessments during planning and implementation. However, my teammate inspired me, and we tackled this challenge by brainstorming ideas and framing alternative solutions during the planning and review phases. (T2 group 3)

During collaborative lesson preparation, we share our understandings and views through demo modeling or think-alouds with students. We all can clearly explain and describe our points of view. I couldn't see the details if my group did not support it. (T1 group 6)

We shared the same views on improving pupils' learning, and we should encourage our pupils to think and plan possible alternative questions. Collaborative lesson planning makes us feel more confident applying metacognitive teaching to facilitate pupils' error detection. (T2 group 5)

The finding suggests collaborative lesson planning is a socialization process that provides opportunities for PSTs to share and co-construct their metacognitive pedagogies through social interaction. This finding is similar to Wallace's **Error! Reference source not found.**study, which claims individuals can develop and transfer tacit knowledge in a

pedagogy-sharing environment. The PSTs can share individual tacit knowledge through interaction within Lesson Study groups [19], and they can share and absorb knowledge through "knowledgeable others" in LS communities [57].

4.4.2. Externalization of tacit knowledge and document into lesson plans

The PSTs indicated that their ideas and concepts for developing a lesson could be combined into lesson plans, worksheets, and teaching materials. They reported in the group interviews that collaborative lesson planning is a knowledgeable other process. In this process, their tacit knowledge can be converted to explicit knowledge

The co-plan process allowed me to visualize my plan for teaching argumentation essays and model my thinking to my peer; my peer then provided alternative suggestions to improve it. I used a mind map to explain the flow of the lesson to team members during collaborative lesson planning (T1 group 2)

Metacognitive teaching could load my memory of PSTs, but writing the idea in the lesson plan helps me think clearly rather than speak without a thoughtful process. I wrote down what I thought, and then we exchanged it and discussed how to frame the lesson plan.

By documenting the teaching approach, we can transform unstructured teaching ideas into a structured, standardized template to support lesson planning and teaching materials among team members. Through the co-plan process, I transformed those preliminary teaching ideas into concrete viewpoints for sharing.

The finding supports knowledge sharing and interactive dialogues in selecting pedagogies for instructional design during collaborative lesson planning and post-lesson discussion. The PSTs could articulate their tacit knowledge into explicit knowledge from dialogue to text records, codifying the implicit knowledge in documents [35]. The meetings for collaborative lesson planning knowledge support the PSTs to externalize tacit pedagogical content knowledge, convert it into explicit knowledge, and express it in analogies, concepts, hypotheses, or concrete models in a lesson or unit plan. Such a finding also echoes the study of [41] about documented tacit knowledge to explicit knowledge and sharing among members for enhancing their learning outcomes. Their understanding of metacognitive pedagogies can be illustrated and represented via examples through languages and images. Lesson planning is a metacognitive activity; the PSTs need to think aloud, seek peers for insight and alternative solutions, and even have peers challenge their assumptions in planning lessons.

4.4.3. Combination of explicit knowledge

Participation in peer lesson observation and post-lesson conferences enables the PTSs to dialogue and combine ideas with others. The combination process triggered their metacognitive awareness to review if the instructional design is linked with the pupils' learning needs.

I listened to and adopted my peer observers' opinions. I can't evaluate myself if my deliberative thinking, modeling, and thinking aloud on the 5W1H approach were enacted according to our lesson plan. Still, my peer serves as a mirror, letting me know it. (T2 group 4) Our discussion improved the instruction design to enhance students' self-regulated learning in reading comprehension. (T1 group 1)

My peer asked me why I suddenly decided to prompt the pupils to refer to the lesson plan. This comment helped me reflect on my judgment of the situation, and I did not feel ashamed to ask for clarification of their teaching viewpoints (T2 group 7). We organize and summarize others' ideas to improve lesson-planning meetings.

I need to check whether my modeling and thinking aloud can help my pupils think. I shared my experience with peers during the post-lesson conference to determine if my understanding was thorough enough. Then, I compare the new teaching methods I know with my existing knowledge to understand the meaning of those methods (T1 group 6)

This finding is similar to Van Gestel's study [42], which states that combining knowledge sharing can cross different subject boundaries and thus enhance knowledge exchange. These findings support the claim by Lofthouse and Cowie [31], who assert that through LS, teachers can experience learning situations, activities, and content that can be resolved, understood, and applied through opportunities to engage in dialogue with others, thereby becoming metacognitive and self-regulated teachers. Peer lesson observations and questions could help the PSTs review their teaching strategies and reflect on their assumptions when selecting them. Such peer review practices and platforms combine their knowledge to enhance metacognitive teaching and self-awareness. Such teachers become familiar with the processes before using them to teach their students. They become aware of how they developed these skills within their cognitive skill repertoire.

4.4.4. Internalization of explicit knowledge

The PSTs who implemented their lessons reported that they treasured the opportunity to implement their lessons and that they could internalize the metacognitive theory in class through the research trial lesson.

My peers alerted me to focus on our teaching activities that trigger student thinking and review their learning tasks. I will ask myself what I may do differently next time to improve my lesson. (T2 group 2)

We could check our strategies in the trial lesson by observing how students regulated their learning approach to achieve their game tasks. Before that, I just taught and wanted them to learn, but now we know how they think and learn. We realize how to give feedback and notes instantly. (T1 group 8)

I can effectively link up and use the think-aloud knowledge through "Collaborative Lesson Preparation and lesson implementation, which can assist me in internalizing such pedagogies into my understanding. I develop better articulation skills through lesson implementation.

These findings align with the study by Smuts et al. [58] on transforming experience and new knowledge through lesson implementation into metacognitive competencies and instructional design capabilities. The PTSs who enact the lesson plan and practice explicit metacognitive pedagogies can then experience and internalize these pedagogies as tacit knowledge. As PSTs apply the pedagogies shared in collaborative lesson planning to their teaching practices, explicit pedagogies are internalized as personal or tacit knowledge [59]. The lesson implementation enables PSTs to focus on pupil learning difficulties and their thinking process. The PSTs can grasp the core metacognitive teaching principles and craft metacognitive knowledge to design activities and implement them in their research lessons.

The findings of this study support the use of Lesson Study (LS) in teacher education to enhance metacognitive teaching skills, complementing Mendonza et al. [44] application of

the SECI model to collaborative lesson planning. The research aligns with van Beek et al. [60] observations on teacher regulation and student self-regulation while reinforcing Calleja & Formosa's [57] emphasis on the role of knowledgeable others in triggering teachers' cognitive development for metacognitive teaching. Furthermore, it strengthens Vijayan et al. [38] claim that transforming tacit knowledge into explicit knowledge is fundamental for individual innovation and improved student learning outcomes. Through LS, teachers can develop their ability to teach pupils to use metacognitive skills deliberately, crafting effective metacognitive pedagogies. However, several limitations should be considered, including a small sample size, a specific educational and cultural context, a short intervention duration, potential bias from self-reported data, and variability in LS implementation. Addressing these limitations in future research could enhance the reliability and applicability of the study's conclusions, providing a more comprehensive understanding of LS's effectiveness in developing metacognitive teaching skills across diverse educational contexts.

5. Conclusion

Implementing Lesson Study (LS) has demonstrated significant potential in developing metacognitive pedagogies among Preservice Teachers (PSTs). This study reveals that LS is an effective platform for PSTs to craft, share, and refine metacognitive teaching strategies, integrating theoretical knowledge with practical classroom experience. The collaborative nature of LS enhances PSTs' metacognitive awareness and ability to design applicable pedagogies, preparing them to implement the Learning to Learn curriculum effectively. LS functions as a knowledge-sharing mechanism, aligning with the SECI knowledge conversion model. It facilitates externalizing tacit knowledge, validation through peer observation and discussion, and internalizing metacognitive teaching theories. This process contributes to the professional growth of individual PSTs and fosters the creation and management of pedagogies within learning communities. In 21st-century education, where continuous learning is paramount, the development of educators' metacognitive teaching skills is crucial. LS provides a structured approach for teachers to enhance their metacognitive abilities, enabling them to better equip students with lifelong learning skills. However, it is essential to note that this study, conducted in the specific context of a Hong Kong university, may have limited applicability to diverse educational settings. Further research is needed to examine the institutionalization of LS communities across diverse cultural and structural contexts.

Implications for future research and practice include expanding the study of LS and metacognitive pedagogies across diverse educational environments, conducting longitudinal studies to understand long-term impacts, and exploring the integration of technology into LS processes. Additionally, investigating the roles of mentorship and peer coaching, focusing on student-centered outcomes, and examining educational policies to create supportive environments for innovative teaching practices are essential areas for further study. In conclusion, as the educational landscape evolves rapidly, the ability to foster metacognitive skills in teachers and students becomes increasingly critical. Lesson Study offers a promising approach to achieving this goal, warranting further exploration and implementation across diverse educational contexts. By continuing to refine and adapt LS practices, educators can better prepare themselves and their students for the challenges of an ever-changing world, underscoring the importance of lifelong learning and adaptive thinking.

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Appendix 1

Scale 1: Model Thinking Process

- I ask students inferential questions and check their answers to see if they are correct.
- I demonstrate the thinking process in answering inferential questions to students.

Scale 2: Thought-provoking reflections

- I provide opportunities for students to discuss how to solve problems.
- I encourage students to share their thinking processes.

Scale 3: Review the thinking process

- I review with students the thinking processes that benefit their learning after class.
- I assess whether students can report their learning processes.

Scale 4: Enabling self-regulation

- I teach students the self-questioning method to help them monitor their understanding.
- I teach students to check their work occasionally to monitor their learning process.

Scale 5: Motivational Feedback

- I motivate students' learning by teaching them how to recognize their self-worth.
- I motivate students' learning by building on their strengths.

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