Kasetsart Journal of Social Sciences 46 (2025) 460230

Kasetsart Journal of Social Sciences

journal homepage: http://kjss.kasetsart.org

Implementing Japanese lesson study in a Thai private school: How to build a professional learning community for mathematics teachers

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Article Info

Article history:
Received 11 March 2024
Revised 16 May 2024
Accepted 18 June 2024
Available online 25 June 2025

Keywords:
collaborative culture,
lesson study,
math teachers,
open approach training,
professional learning community,
Thai private school

Abstract

This is a case study of a private elementary school in Thailand initiating an innovative project to transform its math curriculum and instruction. As the Japanese math education standard, approved internationally for its effectiveness in the teachers' continuing professional development, lesson study (LS) and open approach (OA) lessons were selected to apply in Grade-1 math course and program in the school. Through action research, it experimented with, studied, and developed the new math teaching practice. To implement the LS process, an LS team of 4 math teachers was formed with the project manager's supervision as the researcher. This study was qualitative research with two objectives: (1) to study the LS implementation in a Thai elementary school, and (2) to study the potential of the LS to build a professional learning community (PLC) for math teachers in the school. In data collection, the eight key informants were interviewed along with the researcher's observation and document review. The collected data were transcribed, analyzed, triangulated with the content analysis method. In the findings, reported were a management model of early implementing the LS process focused on OA lesson development, as well as the evidence of an LS-built PLC in terms of collaborative learning team for the math teachers in the school. Some key issues about LS and PLC were discussed with a critical theory lens, leading to recommendations to develop and sustain LS and PLC in the school.

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https://doi.org/10.34044/j.kjss.2025.46.2.30
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Introduction

Lesson study (LS)originated and has been long developed in Japan (Makinae, 2010), and accepted internationally for its effectiveness in teachers' continuing professional development (CPD) in terms of classroom teaching competence as well as curriculum and instruction development (Murata, 2011). It is the collaborative study of research lessons which teachers plan, conduct, observe, reflect, discuss, and improve (Lewis et al., 2019; Murata, 2011).With focus on student learning, LS stimulates teachers to learn how the students learn by expecting, observing, and understanding their reasoning and answers to the teacher's questions as well as misconception, which leads to developing true student-centered instruction, the teachers' pedagogical content knowledge (PCK) with insight into student learning, and instructional innovation.

Originally working on math, now LS is considered the professional development standard for Japanese math teachers, aiming to develop their PCK through open approach (OA) lessons. The success of LS as effective CPD for math teachers caught interest among educators from other countries around the world (e.g., the US, Europe, Asia, Africa), leading to the education reform in math instruction and professional development by initiating the Japanese standard into their education systems (Burghes & Robinson, 2009). The implementation of and research on LS and OA lesson development in various schools so far have approved the effectiveness in developing math teachers' classroom teaching competence and optimizing students' math learning. Due to the world-wide research approval and successful implementation, LS and OA lessons have been highly recommended by educational scholars and educators for applying them in math instruction in schools, but with the cautions that they need to be adapted into foreign (non-Japanese) educational settings.

In the Thai educational context, low math student achievement, traditional teacher-centered math instruction, and the lack and inappropriateness of professional development among math teachers created educational crises so that math curriculum and instruction reform was needed. LS and OA lessons have been evidently initiated by Maitree Inprasitha, a professor from Khon Kaen University, in local schools and then disseminated in many schools all around Thailand through his disciples' cooperation (Center for Research in Mathematics Education [CRME], 2023). Compared to other counties, however, such were considered very new to math teachers in Thailand. Besides, Thai school culture is very different from Japanese culture, the place of origin, particularly teacher behavior and competency, so there appeared to be failure or a struggle in LS implementation in most schools; very few LS projects succeeded and were sustained.

The case study was a private school in one of the lowest student achievement areas (a southernmost province). Like other schools in Thailand, having long suffered a crisis rooted in the traditional math education, it needed an educational innovation to reform its math curriculum and instruction. LS and OA lessons, as the Japanese educational standard, were a promising solution in terms of conducting action research on adapting and implementing them in the school. Theoretically, not only does acquiring OA lessons act as an effective math student-centered instruction, but also LS contributes to improving math teachers' classroom teaching competence, and building a professional learning community for them in school (Lewis et al., 2019).However, due to the lack of research on LS in Thai educational context, particularly qualitative case-study approach, the case-study school decided to initiate an action research project to experiment and study the LS implementation in math classes without any published best-practice model as the guideline. It applied the LS process, along with following the Japanese math OA lesson standard, into the school improvement plan to transform its math curriculum and instruction. This would be one of a few Thai school case studies with interesting research findings, such as reporting a specific management model of the LS implementation, as well as its outcomes in terms of building a PLC for math teachers in the school.

Literature Review

Japanese Lesson Study and Open Approach in Math Instruction

Lesson study originated and has been long developed in Japan as teachers' professional development culture. In history, it started at elementary schools where teachers conducted collaborative research on their classroom practices (Arani et al., 2010). As Makinae (2010) mentioned, in the 1880s Japanese education was reformed toward the modern trend such as student-centered instruction and teacher training system.

Student teachers had been trained in a microteaching-like method with live lessons. In school, teachers conducted action research in the classroom, experimenting with the new teaching method, observation of student learning, and discussion with critical reflection on a research lesson (RL) for lesson development. Due to Japanese culture of knowledge sharing and ongoing improvement, such teachers' regular practice became part of school culture and national standard.

Japan's success in students' learning outcomes and teachers' school-based CPD intrigued international education, so this innovative CPD, named "Lesson Study," was initiated and adapted in many countries (e.g., the US in 1990s, the UK in 2000s) and such verified the effectiveness in teacher learning and change in teaching practices (Burghes & Robinson, 2009; Murata, 2011). LS is globally known as collaborative action research focusing on student learning in teacher learning community with the signature actions of classroom observation, reflective discussion, and practice sharing with colleagues. Basically, LS process is cycles consisting of (1) studying and identifying lesson goal, (2) planning RL, (3) conducting and observing the RL, and (4) reflecting on and discussing it; if desired, revising and reteaching it (Burghes & Robinson, 2009; Lewis et al., 2019; Murata, 2011).

It has been said that LS, inquiry-based, is not aimed at developing a perfect lesson but learning teaching practice in the classroom (Fujii, 2014; Murata, 2011), specifically studying how students learn, anticipating their possible responses, and listening to their thoughts in order that teachers can effectively facilitate their learning. In the first step, crucial but usually ignored, teachers should take plenty of time to study curricular materials, research papers, and teacher manuals to gain knowledge and ideas for inquiry in their teaching practice (Fujii, 2016; Watanabe et al., 2008). Also, in live RL session, they should observe the class without participation and take notes on individual students' reactions. To implement LS, Burghes and Robinson (2009), as well as Lewis et al. (2019), suggested 5 stages: (1) Preparation, e.g., team management, schedule management, learning environment setup; (2) Planning. e.g., studying the content, identifying topic/goal, creating RL; (3) Observation, e.g., conducting and observing the live RL; (4) Reflection, e.g., reflecting on and discussing the RL for revision; and (5) Ongoing LS Cycles for the whole school year, normally 2 or 3 cycles, and at the end of the school year, the teachers share their findings among LS groups, organize an "open house" to demonstrate the model lessons to the public, and publish a report on LS (Takahashi & Yoshida, 2004). "Knowledgeable others," e.g., university professors and veteran teachers, are key persons as academic supporters (Takahashi, 2013), as well as, school leaders as managerial ones in LS implementation (Ngang& Sam, 2015).

Lewis et al (2009) proposed a theoretical model of LS improving math instruction. That is, the LS process of investigation, and then cycles of planning, live RL, and reflection contributes to teacher changes in 3 ways: (1) knowledge and beliefs (pedagogical content knowledge (PCK), student-centered learning); (2) learning community (commitment to ongoing instructional inquiry and improvement, mutual responsibility, knowledge sharing), and (3) instruction (lesson plans). Moreover, Lewis et al. (2019) explained theories of LS process, e.g., knowledge integration theory, self-determination theory, self-efficacy theory, and pedagogies of practice; Elliott (2019) stated pedagogical theory of variation, and clarified "teacher as researcher" in doing LS, different from action research, with "local teaching theory," experience sharing for learning, and less research methodology (Lewis et al., 2006).

The math instruction approach developed through LS is called "open approach" (OA). Makinae (2010) and Isoda (2010) stated the Japanese OA was originally based on the Pestalozzian method, "Object Lesson", in which teaching should start by letting students work with familiar objects to help them get the concepts through their intuition, or i.e., letting them do and learn by themselves, along with "Dialog Method", promoting learning through expressing and discussing their thought, and sharing their knowledge. These teaching methods brought about the open-ended problem-solving approach, in which students are given and engaged in open-ended day-to-day problems and asked to think about and seek open-ended diverse solutions (Inprasitha, 2006), and then facilitated to learn together through reflection and discussion. According to Burghes and Robinson (2009), OA process has 4 steps: (1) teacher posing a problem, (2) each student freely seeking a solution with teacher observation, (3) with teacher guideline, the students presenting and explaining the solutions and the others listening and discussing the comparison among them, and (4) all summarizing and recording what was learnt in their journals.

Professional Learning Community (PLC)

According to DuFour (2004), Bolam et al. (2005), and Schaap and Bruijn (2018), in the school context,

PLC is ongoing collaboration among a group of professionals (i.e., teachers, administrators, and school staff) within the school on inquiry, sharing, and learning in their practice to upgrade their competence and improve student learning. Rooted in learning organization (Admiraal et al., 2021), PLC transforms school into an organization promoting professional growth of all school people through the culture of collaborative learning and knowledge sharing. In other words, PLC is considered the concept of school-based CPD in that teachers are engaged in ongoing collaborative inquiry and improvement in their classroom practice, so teachers act as researchers who examine their practice, experiment with new methods, co-construct and share new knowledge about teaching (Lieberman & Miller, 2011). It enables CPD to become a normal activity for teachers to create and share knowledge in their daily lived experiences through reflective discussion with others.

PLC characteristics, based on originally Hord (2003) as well as Bolam et al. (2005), and having long been verified and elaborated by a wide range of researchers (e.g., Admiraal et al., 2021; Ismail et al., 2022; Zhang, et al.; 2022), consist of (1) shared vision, values, and norms as well as responsibility for student learning improvement, (2) culture of collaboration, (3) individual and collective professional learning, and (4) reflective professional inquiry, including formative assessments, peer coaching, joint observation, review, and feedback, reflective dialogue, and classroom practice improvement.

Leadership and management are also a key component to create and sustain effective PLC. School leaders should clearly promote and support PLCs in the school by focusing on people's learning (e.g., empowerment, teamwork, communication, CPD). There are recommendations for school leaders: (1) deprivatizing practice by optimizing supportive conditions, i.e., providing time and space to create opportunities and site facilities for collaborative learning (e.g., regular staff meetings), providing sufficient funding and resources, and enacting school policies facilitating PLC projects (Admiraal et al., 2021;Vescio et al., 2008); (2) sharing leadership by giving teachers autonomy and decision making in joint inquiry and letting them take leadership in instruction development (Admiraal et al., 2021; Schaap & Bruijn, 2018); (3) building mutual trust, respect, and support among colleagues, as well as positive relationships, collegiality, and caring environment (Antinluoma et al., 2018);(4) nourishing individual staff commitment and motivation; (5) managing group dynamics (e.g., conflict management); and (6) providing external support (networks and partnerships) and inclusive membership (Ismail et al., 2022).

As a collaborative CPD, PLC contributes to improvement of teacher practice, and finally student learning (Vescio et al., 2008). There are 3 changes in the school: (1) change in teachers, e.g., upgrading teaching culture into one supporting collaboration, instructional leadership, and teacher learning, as well as gaining PCK, focusing on student learning; (2) changing in instruction, e.g., student-centered instruction improvement as well as innovation through research and development; and (3) change in organizational capacity, e.g., teacher motivation, educational quality, teamwork, and learning organization.

Harvey and Teledahl (2022) studied and proposed characteristics of PLCs for math teachers:(1) developing norms of collaboration(e.g., building trust and safety among colleagues in critical inquiry and reflection, keeping their focus on relevant issues, listening to others' ideas and opinions, and sharing their practice to co-construct new knowledge) to enable and support active participation in PLCs; (2) developing their understanding in math content and teaching methods; and (3) developing their repertoire of classroom teaching by experimenting with new teaching methods, then reviewing and revising them, as well as their competence in observing, discerning, and gaining insights of how students learn math.

LS and PLC: Teachers' Learning Process to Learning Community

In general PLC is the CPD concept supporting collaboration of school people as professionals in the school. Regarding teachers, the PLC engages them in studying their classroom teaching, reflecting and sharing their practice, and improving the instruction and student outcomes. Particularly, Harvey and Teledahl (2022) indicated PLCs for math teachers characterized by classroom research, trial on math lessons, observation on student learning, reflective discussion, and teacher knowledge in math teaching. These characteristics correspond with the math LS process, an effective collaborative CPD method, consisting of lesson studying, observing, reflecting, and discussing for teacher learning in math. Lewis et al. (2009) and Murata (2011) stated LS enables a learning community in the school in terms of teacher collaboration of ongoing instructional inquiry and improvement, mutual responsibility for student learning, and knowledge sharing.

Thai Education Context: LS and PLC

In the Thai education context, PLC has caught Thai educators' attention for a decade, e.g., an international comparative study of teacher CPD as stated in the Ministry of Education (MOE)'s report (Office of the Education Council [OEC], 2016). In 2017 MOE enacted the teacher CPD policy requiring the use of PLC as a main approach for all public schools (OEC, 2018) along with a training system for in-service teachers and a criterion of teacher assessment and promotion. LS, in contrast, was introduced long before by Professor Inprasitha of Khon Kaen University (KKU) in 2002, and the innovation of LS and OA lessons in math has been developed and applied in a few local pilot schools, and until now in many alternative ones nationwide (CRME, 2023). However, both PLC and LS were very new for Thai teachers, familiar to a traditional education (teacher-centered learning and off-the-job short-term training), so these innovations were very difficult for them to apply properly (Inprasitha, 2006). Many schools applied and struggled with these, whereas just few succeeded in Thailand. Based on literature search and review, there was very little case-study qualitative research on implementing LS and PLC in Thai educational settings, as well as little on the outcome of LS to build a PLC in the school. Thus, this study was designated with 2 objectives:(1) to study the LS implementation in a Thai private school as the case study, and (2) to study the potential of the LS to build a PLC for math teachers.

Methodology

Design: A Case Study of Action Research

This study was qualitative research using one private school as the case study to explore in depth the LS implementation in the Thai school through action research of initiating the educational innovation, LS and OA lessons in math, project managed by a school administrator as one of the researchers. The initiative project had focused on LS cycles for 1 semester (4 months), but was implemented from October 2017 to April2018 (6 months).The theoretical framework of implementing LS, with critical theory lens, consists of preparation, LS cycles (Plan, observe, reflect), post review, and its effect on PLC. According to Creswell (2009) and McNiff and Whitehead (2002) action research is interpretive, inductive, holistic, and emergent design of action and reflection in that the researchers review, plan, act, observe, reflect, and revise their practice. In this way, the practitioner is researcher as key person and instrument who inquires, collects data, and analyzes interesting issues together with colleagues to learn and improve their practice within their own setting.

Case: A Private School in the Deep South of Thailand

The case is a medium-sized, private, elementary school (Grade 1–6) in the deep South of Thailand. There were 24 teachers and 474 students (all Muslims) in the school. The local community consisted of low-medium SES families, mostly Muslim farmers, in rural and sub-urban areas. This progressive school developed the Islam-integrated curriculum focused on community-based learning by doing. Its latest initiative was adopting the Japanese math curriculum, along with the startup of LS and OA lessons for teaching math at Grade 1.

Participants

The 8 participants were purposefully selected within the school as key informants, consisting of an LS group of 4 math teachers from the classrooms Grade 1–4 (Grade-3 math teacher as the head math teacher), 2 school administrators (one as both the project manager and researcher), and 2 non-LS-participant teachers.

Data Collection

The 3 ways of data collection were (1) semi-structured interviews, both one-on-one and focus group, spending 1–1.5 hour per session with the key informants, and then transcription of the interview-recorded audio files, (2) participant observation as the LS project manager with field notes in various events of the LS implementation, and (3) document review from the participants' journals, school documents, LS meeting reports, lesson plans, and so on.

Data Analysis

According to Creswell (2009), it starts at organizing and preparing the collected data, then doing "content analysis" by reading through all the data, coding them into themes with descriptions of the setting or people, interrelating themes/descriptions, and interpretating the data. In regards to the data reliability, triangulations were conducted with different data sources, participant perspectives, and collection times, along with spending prolonged time in the field and sharing and discussing the analysis and findings between the researchers.

Ethical Consideration

Throughout the research, the researchers respected rights, needs, and values of all informants and protected their rights: (1) articulating research objectives and methodology (ethical research protocol) to them, and getting their permission to collect the data; (2) sharing research reports and data with them; (3) setting freedom to participate and give data; and (4) strictly applying informant anonymity in the research reports.

Results

Implementation of the Lesson Study (Based on the Project Manager's Report)

Step 1: Preparation (in October 2017, before the second semester)

1. Site visit at a best-practice local school for inspiration. The school administrators and math teachers visited a best-practice private school in the event of open house at the big city nearby. During the LS and OA lesson exhibition, the teachers were very excited to participate in observation and reflective discussion with experts in the open classroom, as the school administrators were very interested in and supported the LS and OA initiative project in their school with regards to fun and creative student-centered instruction, as well as benefits of LS as the matching effective professional development and instructional development.

2. LS team formation. The principal appointed an administrative staff member (as the researcher) the LS and OA initiative project manager who formed an LS team of math teachers. A math teachers' meeting was setup to announce the project, reflect their site-visit experience, and recruit willing ones into the team. As a result, the LS team consisted of math teachers Grade 1–4 who were open-minded to learning and innovation.

3. LS and OA Training. There were training sessions to prepare the math teachers for operating LS and OA lesson, such as, the workshop of "Kyozai Kenkyu", one LS step, at a local university by Professor Inprasitha of KKU, focusing on OA lesson design and planning; the workshop of analyzing and managing OA lesson and Japanese Grade-1 math textbook at another local university by a professor with expertise in OA math teaching; and the workshop of managing LS and PLC within their school by a professor with expertise in PLC (as the researcher's advisor).

4. Study of the math textbook and OA lesson. Initially the LS team dedicated a whole day studying the math textbook and OA lessons to sketch the Grade-1 math lesson plans for the whole second semester (16 weeks). However, this innovation was very new to the school, so the team could not finish the study as planned. To fix the problem, the study was merged into the LS step of planning, occurring every Friday.

Step 2: Operating the LS cycles. (for the whole second semester, November 2017 – March 2018), each of which took one week; i.e., it started every week. In an LS cycle:

1. Planning. Every week the LS team studied the math text book and OA lessons, and then planned together Grade-1 math lessons for the whole next week in the math teacher meeting. As the lesson plans were shared in their Facebook group, the Grade-1 math teacher was assigned to prepare the lessons.

2. Doing and Observation. As planned, the teacher conducted the math lessons using the OA process (Burghes & Robinson, 2009). There was one weekly observation by the other LS team members; they observed the class for the whole period focusing on students' learning (their math problem solving), as taking notes with the assessment tool, they developed themselves to facilitate their data collection. Specifically, it was the non-participant observation, where the observers silently walked around the students to capture all their actions as observing the teacher's teaching. On other days, however, the teacher was responsible for the class observation, with a post-lesson report. The school event of open classroom was setup once a semester, in the final week of the semester, for public observation on the math lesson in the classroom. The external experts were invited in this event for their academic advice, and the same class observation protocols were applied.

3. Reflection. The reflective discussion started right after the class observation by the LS team. In the session, the math head teacher as the facilitator led and facilitated the discussion, as summarizing its content; the Grade-1 teacher reflected on her teaching and the OA lesson, then other teachers reported their class observation focusing on the students' learning as well as the teacher's teaching, and all of them discussed emergent key issues of math teaching and OA lesson to improve the students' learning. Finally, they came up with some suggestions to revise the lesson and math teaching. In case of the open classroom, the discussion kept the same process, but the invited experts were the last persons who reported the class observation and gave some advice on the lesson. Normally, this session was followed by the next Planning session in the same math teacher meeting.

Step 3:Postreviews(in April 2018, after the second semester).

There were 2 sessions in the end of the project: (1) the post review among school administrators, the LS team, and the external expert. In this session, they reflected, appreciated, and discussed the LS and OA lessons in the past semester, and then the expert gave some advice on this ongoing project for the next semester; and (2) the post review by the LS team and the project manager. In the session, they summarized and discussed what they learned about their project and then came up with a revised project and guidelines how to implement the LS in the next semester.

Potential of the LS to build a PLC for Math Teachers (Based on the Post Reviews)

Shared vision and value

According to the project manager, the vision and value of LS shared among the math teachers was a school-based CPD in terms of collaborative learning to improve and share their math teaching in the classroom, specifically for OA lessons, which transform math teaching and learning model in the school into a true student-centered approach. The manager, however, reported the shared vison and value was derived from the site visit of a best-practice school and the teacher meeting for experience sharing about the LS and OA lessons, which was initiated by the school administrators. Besides, she had to remind and ask the LS team of the shared vison and value during "reflection" sessions. Remarkably, there was no clear mention of this issue from any of the math teachers, just their appreciation of the benefits of LS and OA lessons for most of them and the students.

Shared academic leadership

Owing to this innovative project's protocol to empower the math teachers in project management on their own with the school administrators' supervision, all LS team members were key persons in team management and joint decision making in the LS implementation. Although the math head teacher was appointed as the LS team head, the other team members took leadership on math curriculum and instruction development, particularly lesson planning and assessment, action research, and peer coaching. In LS cycles, a Grade-1 math teacher was the key person who designed and prepared OA lessons since she was assigned to conduct the lessons in her classroom. She was aware of OA lessons being a very new lesson design, which needed more time and peers to help her finish it; then she asked the team to consider merging lesson "study" session into "planning" one every week. As she said

> *"… I am not sure of my lesson design, since we did not have enough time to study the Japanese textbook and OA lessons; I came to ask the team if we could have more time to do it in the planning session; it would help us learn OA lessons together and help me have some ideas to adjust the lesson design…"*

The team agreed with this offer, so the math teachers studied and adjusted their OA lessons together in the planning session. In lesson observation and reflection sessions, they played the roles as the researchers, lesson assessors, and peer coaches in lesson development and math teaching advice and sharing. Sometimes, the team members, as observing the lesson, came to help the teacher fix emergent crises in the classroom. The LS team head noticed academic leadership appearing in each of the team members but in different ways, as she said

> *"…such as, [the grade-1 teacher] was creative in lesson design; [the grade-2 teacher] had expertise in classroom management; [the grade-4 teacher] was a perceptive problem solver."*

Collaborative culture: Learning team

Normally, teachers in the school worked together in every task, and spent break, lunch, and after-school times talking and information sharing in the form of informal meeting, but this was the first time for them to form a formal learning team in formal meetings. The LS team head pointed out the need of learning team in OA lesson development, as she said

> *"…OA was a very new approach, which we had never applied in our math lessons, and some math teachers had never heard of it before. So, we as the LS team, needed to study and learn it together; we had to help each other out and give advice to each other in every [LS] step and [OA] component … For example, we studied and discussed about lesson designs and materials we made as well as our teaching methods; which ones would follow the OA concept."*

In the LS process, all the steps and activities required the math teachers to work together as a team to study and learn OA lessons and math teaching. All the team members reflected on how they learned in the LS steps, as follows: In planning sessions, for example, Grade-1 math teacher said *"… we met once a week, on every Friday, we studied and learned Japanese textbook and OA lessons along with a draft I made to revise our lesson plans together …"* In observation and reflection sessions,

Grade-2 math teacher said *"... as the teacher took the lesson plan to teach, we observed what happened in the classroom, and learned what the students thought ... were their answers [from solving the math problem] the ones we anticipated..."* as well as *"... in the reflection session ... we reflected on and discussed the students' emergent answers. What are their [misconception] problems. How could we revise the lesson plans..."*Specifically, in the issue of command and communication, the team members observed and noticed the students were confused about the commands the teacher gave, so they came to discuss this issue; as Grade-4 math teacher commented, *"... from the site visit at the school [its name], the principal suggested giving one command at a time; if giving all commands at one time, the students did not know how to start ..."*

As a result, LS created and sustained supportive learning environment in the school. The school administrators and other teachers noticed the change in the LS team as an active and supportive learning team, enticing the teachers to enter LS projects. As one teacher said

> *"... it was so good to see [the LS team] help each other out, reflect on their teaching, get some advice to improve themselves and the lessons.... they were able to create OA lessons and materials..."*

Collaborative instructional inquiry and development

The LS process enabled ongoing collaborative active research and development in OA lesson plans as well as math teachers' teaching in the classroom. The LS team members reflected on how to develop their OA lesson plans, as follows: The LS team head said *"... we made our lesson plans [learning materials and teaching methods] together: studied, planned, observed, and reflected together..."*; Grade-1 math teacher said *"...I made a draft of the lesson plans and then presented it to the team; we discussed and gave advice to revise the draft; made the revised lesson plans... [then] I made the learning materials with the team's help"*; Grade-2 math teacher said "... *as the teacher took the lesson plan to teach, we observed what happened in the classroom... in the reflection session, the math head teacher facilitated the discussion and the teacher started reflecting on the teaching and learning in the classroom, the success of the lesson, as well as the students' emergent answers; then the other team members reflected on their observation; the team discussed the problems [of the lesson plans and teaching] and brainstormed for some recommendations to fix the problems*..."After that, the teacher revised the lesson plans and taught the next class with the revised material.

The LS team were aware that the OA lessons revised through LS cycles changed the students' math learning behavior toward having fun to learn math, developing thinking skills, trying to solve the problem in different ways, and daring to express their thought. Remarkably, the math teachers were not aware that they did action research through the LS process.

Discussion

A Management Model with Alternative LS Process

Implementing the LS process as an ongoing project in every semester seemed practical and effective in the math teachers' CPD and lesson development, just like other case-study schools all around the world (e.g., Adler & Alshwaikh, 2019; Cheng & Yee, 2012; Richit, et al., 2021; Schipper et al., 2017). In one semester, Thai teachers work daily all day long (at least 8 hours a day and 5 days a week), so LS is a practical basic CPD for them to study the lessons together, and develop their own pedagogic competency, as working at the school. Besides, the longer formal meeting for team learning among the math teachers, with a tight work schedule, once a week, seemed practical in that they felt just right, not burdened, compared to a short meeting every day, which made it hard to reschedule to attend such meetings and gave too little time to study together. In the meeting, the LS team started at the session of observing and reflecting on the lesson that week, and finished with the session of studying and planning the lessons for the next week. The LS cycles kept within the semester gives rise to the right timeline of the project management in that the preparation step is in the recess before the semester, providing the teachers training courses and site visits outside the school, and the post-review step is in the recess after, providing them celebration and debriefing with external experts, as suggested by Lewis et al. (2019) as well as Takahashi and Yoshida (2004).

Regarding the LS process, the school's version was a routine of the LS cycles, spinning every week. In one cycle, the LS team started at planning, then conducting and observing, reflecting and discussing, and revising the lessons; after that, they started the next cycle with the next lessons. The cycle of planning, doing, discussing, and improving the lessons was like the Plan-Do-Check/Study-Act cycle, or Deming Cycle, the management method for quality control and development (Moen & Norman, 2009). This version was different from the original Japanese LS process (Murata, 2011;

Takahashi & McDougal, 2016), in which the LS team operated 2-3 cycles a year, or 4–6 months per cycle, and started at studying and planning, conducting and observing, and then reflecting on and discussing the lesson in one cycle. The original version was action research for teachers' learning and CPD. Thus, despite the same practice of collaborative study, the adapted version seemed to have the concept of quality management for OA lessons, but the original one had the concept of action research for the math teachers' CPD. The former used a very short time to study several lessons, resulting in every lesson in the semester being observed (i.e., monitored), discussed, and developed, but the latter used a long time to study only one lesson, causing in-depth research and reflection among the teachers. As a result, the former achieved lesson development, teaching assessment, and student support system, but the latter achieved mainly teachers' PCK from learning different student thoughts and misconception, and instructional innovation.

However, this phenomenon could be explained in that in the early stage of adapting LS in Thai schools, due to its novelty and unconventionality to Thai education, the school administrators needed to empower the math teachers to develop their teacher leadership, i.e., innovative curriculum and instruction management and development, to ensure the quality of math lessons suited for the students' learning. Thus, the math teachers were trained to focus their LS on developing OA lessons and materials as well as their teaching with a routine of structured practice. As the schools have continued and turned to the mature stage of LS development, when the math teachers, curriculum, lessons are qualified for the Japanese educational standard, the LS process becomes the original focus on action research for the math teachers' learning and pedagogic innovation.

The phenomenon seemed to appear similarly in ASEAN developing countries, such as the Philippines; Ebaeguin and Stephens (2014) reported cultural challenges of implementing LS in Philippines schools in terms of the lack of teacher autonomy and leadership (due to a hierarchical social system), low commitment to ongoing LS cycles (short-term one preferred), and de-emphasizing the "study and plan" phase (due to a strong sense of risk tolerance). In contrast, in most developed countries, LS aimed at classroom action research initiated and managed by teams of teachers mainly for their PCK development, e.g., the case of South Africa (Adler & Alshwaikh, 2019), Singapore (Cheng & Yee, 2012), Brazil (Richit et al., 2021) and The Netherlands (Schipper et al., 2017).

LS Contributing to Learning Team for Collaborative Lesson Development

From our findings, LS could contribute to build a PLC among math teachers. However, due to the initial stage of LS development, there appeared to be not all PLC characteristic evident in the LS team. That is, the vision and values about LS seemed not to be shared among the math teachers based on their expression, but initiated and reminded actively by the school administrator (see this issue discussed above). As the LS project is developed over time, the team is aware of the LS benefits and can specify its own LS vision, and finally the vision and values are shared among all the math teachers. Shared vision and values lead to build collective responsibility and mutual trust among the teachers for professional development and student learning (Schaap & Bruijn, 2018). Actually, the team has opportunities to review, revise, and share them in the planning session and the reflection one (Lewis et al., 2019). Regarding shared leadership (Admiraal et al., 2021;Schaap & Bruijn, 2018), when the team was empowered in the innovative project management, all the math teachers actively took their instructional leadership and mutual responsibility in implementing the LS process and OA lesson development, and through the LS cycles they evidently developed their own OA teaching competency and teacher leadership.

The most evident PLC characteristics for the LS team was collaborative learning culture and collaborative instructional development (corresponding to the case of Admiraal et al., 2021; Antinluoma et al., 2018). All the math teachers reflected on and appreciated how LS formed them into an effective learning team for OA lesson development. They worked together in every task and activity of the LS process; i.e., they studied, planned, observed, reflected, discussed, and revised the lessons together. Particularly, the team was aware of the "Kyozaikenkyu" session, added in the "Plan" phase, as the key step to studying and designing innovative OA instruction (Watanabe et al., 2008). Owing to ongoing projects of countless LS cycles, active learning teams from various groups of teachers would be accepted as a norm, and finally it becomes the school culture of collaborative learning. In the LS process, they learned not only how to develop OA lesson plans and materials, but also how the students think and learn math and how to make their teaching fit for the students. As Harvey and Teledahl (2022) as well as Lewis et al. (2009) supported, LS enables a PLC for math teachers in the school through lesson observation and reflection, and knowledge sharing; as a result, they gain student-centered math PCK,

teaching skills and lesson plans. With collaborative lesson experimentation in PLC, Schipper et al.(2017) argued for the teachers developing their adaptive teaching competence.

However, the teachers were not aware of themselves as researcher who did action research through the LS process due to its informal research methodology with local teaching theory (Lewis et al., 2006). As Elliott (2019) mentioned, teachers act as researchers in LS. Takahashi and McDougal (2016). Johannesson (2022) argued for their collaborative professional inquiry through classroom action research, called "Collaborative Lesson Research" to enhance the effectiveness of LS and PLC. In effective PLCs, Gore and Rosse (2022) suggested collaborative inquiry focused on pedagogy; also, Campbell and Lee (2017) suggested teacher discussion focused on specific math content.

The Need of Supportive Administration

As Elliott (2019) and Hord (2003) stated, school leaders, as well as knowledgeable others, initiate and sustain the school transformation, such as implementing LS process and building PLCs among teachers in the school. The case study was an exemplar of this notion. The school administrators, with transformational leadership (Zhang et al., 2022), initiated and prepared the LS project, e.g., inspiring and forming the LS team, leading to identifying and sharing the LS vision and values among the math teachers, providing them various trainings and site visits with experts on LS process and OA lesson, and empowering them to take leadership and mutual responsibility in the LS project and OA lesson development. In Thai bureaucratic context (corresponding to the case of the Philippines, Ebaeguin & Stephens, 2014), teachers as underlings need official devolution, great encouragement, and full support from their administrators for such an innovative project management. Furthermore, to sustain ongoing LS projects, the school administrators needed to provide the LS team funding and resources (e.g., Japanese math textbooks, teacher manuals, LS lesson plans and materials) in operating the LS process, as well as time, workplace, work schedule, and school policies enabling the math teachers' LS meetings (Admiraal et al., 2021; Ngang & Sam, 2015). Most important for Thai teachers was ongoing reinforcement of their motivation, e.g., praise, incentives, and celebration after the project. Remarkably, school-university collaboration (Murata, 2011; Takahashi, 2013) and schools' network (Prenger et al., 2019) were factors in the LS implementation success; i.e., in this case study, various professors with expertise in LS, OA, and PLC were invited to help the school in the LS project as well as site visits at local schools with LS good practice for shared practice and OA lesson plans.

Conclusion and Recommendations

As Japanese LS was initiated in other countries, its concept and practice were adapted into their socio-cultural contexts, so various school cultures shape and distort the LS implementation different from the original version (Ebaeguin & Stephens, 2014; Elliott, 2019). Seen in the findings, there are differences between the LS implementation in Japanese and Thai context as well as the initial stage and the mature stage of the LS development; even in the same Thai context there are differences among schools in various local areas. For example, the case study of a private school in a southernmost area reported its distinct LS implementation in the initial stage in terms of the weekly LS cycles and meetings for the whole semester to customize and develop all OA lesson plans, which built a distinct PLC among the math teachers with the focus on the collaborative culture of learning team for the OA lesson development. However, the recommendations to develop and sustain LS and PLC in the school, needed are (1) the supportive administration to initiate, prepare, and support ongoing LS projects among teachers, particularly providing LS time, funding, resources, meetings, trainings, and motivation, (2) knowledgeable others in the forms of school-university collaboration and school networks for academic advice and practice sharing, and (3) developing the LS routine toward full action research (Takahashi & McDougal, 2016), teacher competency development, particularly PCK and teaching skills (Lewis et al., 2019), and instructional innovation development (Liu et al., 2022).

Conflict of Interest

The authors declare that there is no conflict of interest.

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