Introducing a Structured Problem-Solving Approach Through Lesson Study: A Case Study of One Fijian Teacher's Professional Learning

Indra Wati
The University of the South Pacific
S01001880@student.usp.ac.fj

Worldwide interest in Lesson Study (LS) and the opportunities offered for student learning through the use of a Structured Problem-Solving Approach (SPSA), as typically adopted in Japanese LS research lessons in mathematics, have left largely unanswered questions about the extent to which these can be replicated elsewhere. This paper presents a case study of one primary school teacher's learning experiences, and his views about LS and SPSA, as a result of participating in a project introducing SPSA through LS in three Fijian primary schools. The results reveal that engaging in the LS process was instrumental in supporting this teacher's implementation of SPSA in his mathematics classroom. The findings are important for teacher professional learning (PL) in Pacific cultural contexts.

Lesson Study (LS) is a professional learning approach originating in Japan. LS involves the careful planning, implementation and observation of a research lesson, followed by a post-lesson discussion and reflection by members of the planning team, observers and a 'knowledgeable other'. As teaching is socially and culturally situated, research is also socially and culturally situated. LS is based on collegial conversations focused on improving teaching. It sets out to ensure all students learn optimally, including those with learning challenges. Research lessons in mathematics in Japan, where LS originated, typically adopt a Structured Problem-Solving Approach (SPSA). A typical mathematics lesson using SPSA focuses on a single problem and consists of four phases: posing the problem, students solving the problem, comparing and discussing of student solutions–*neriage*–and summarising and reflecting on learning—*matome* (Shimizu, 1999).

While there has been worldwide interest in LS as a model for teacher professional learning and the use of SPSA as a means of engaging students in creative mathematical activity, questions about the extent to which these can be replicated elsewhere have been largely left unanswered (Groves, 2013; Groves et al., 2016).

This paper presents a case study of one primary school teacher's learning experiences (at his school), and his views about LS and SPSA, as a result of participating in a project introducing SPSA through LS in three Fijian primary schools. It addresses the research question:

- What are the opportunities and challenges in implementing SPSA through LS in Fijian primary schools? This study is significant because it explores the opportunities and challenges of implementing innovative pedagogy and a professional learning model that is foreign to Fijian teachers.

Theoretical Framework

The study draws on Vyogotsky's (1978) sociocultural theories. Vygotsky posited that knowledge is socially constructed through social interaction and argued that it is a shared experience, rather than an individual experience. Teaching is viewed as a social activity, involving co-construction, mediation and scaffolding, and formative interaction (Bell, 2010). As teachers work through the LS process, there are multiple opportunities for them to reflect, analyse, decide on actions to be taken, evaluate, and share their understandings with other teachers. These conversations can take place in a social setting where teachers negotiate and discuss mathematics with more knowledgeable others (Takahashi, 2004). The collaborative practice and interaction with one another in a sociocultural environment during LS can enhance teachers' cognitive growth in terms of knowledge and effectiveness (Vygotsky, 1978; Warford, 2011).

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Literature Review

LS has been adapted and implemented in many countries outside of Japan, with Fujii (2014) cautioning that there are many misconceptions regarding the implementation of LS in foreign countries—for example, implementing LS as a workshop; believing that SPSA is about solving a task; a focus on evaluating the teacher during the post-lesson discussion; and believing that the research lesson has to be re-taught. On the other hand, Takahashi (2014) talks about the importance of a knowledgeable other. He proposes that "final comments are important for effective LS and the best way to develop the ability to serve as a knowledgeable other is through participating in LS with colleagues" (Takahashi, 2014, p. 18).

Studies done on LS and SPSA outside Japan have reported several affordances and constraints. For example, findings from a study of the implementation of SPSA through LS in three primary schools in Victoria, showed that the meticulous planning procedure involved in Japanese LS gives teachers a chance to review and further their understanding of both the subject matter and the thinking processes of their students (Widjaja & Vale, 2013). In addition, Widjaja et al. (2017), reporting on the same project, concluded that teachers were becoming more adept at working collaboratively and orchestrating whole-class discussions based on anticipated student responses and targeted questions.

Based on their 20 years of experience, Lewis et al. (2019) identified some of the challenges in implementing LS in the USA. These included a culture of politeness regarding critique which can undermine inquiry as well as observers interfering in the lesson together with a reluctance to listen to students and collect data on student learning.

Despite the challenges, misconceptions, and successes identified in studies of the implementation of LS outside of Japan, it is nevertheless important to continue to implement LS in diverse settings to investigate its impact and whether it is transferrable to new cultural contexts while fully adopting the underlying principles of LS and SPSA in their authentic forms. Hence, this study set out to implement LS in its most authentic form as much as possible, highlighting the salient elements of LS and SPSA.

Methodology

The overall project consisted of three introductory workshops, followed by three LS cycles in each school. Each LS cycle entailed extensive collaborative lesson planning of a research lesson, one member of the planning team teaching the research lesson, other participants across schools observing the research lesson in person or on video, an online cross school post-lesson discussion, and a subsequent focus group discussion (FGD) at the school. A total of nine research lessons were completed in this way. Interviews were also conducted with the headteachers at each school, together with a selection of the teachers. This paper focuses on one teacher who participated in the project, who taught the second (Cycle 2) research lesson at his school.

The School Context and the Teacher's Background

Kini has a bachelor's degree and 24 years of teaching experience in middle primary schools in a semi-rural location. Note that all names used in this paper are pseudonyms. The school is comprised of 284 children–191 boys 93 girls–mostly iTaukei students or Indigenous Fijians. The school has nine teachers with a support staff.

Case Study Methodology

The study reported in this paper employs a case study methodology (Cohen et al., 2018). The data collection process included video recording of the three introductory workshops, lesson planning sessions, research lessons, post-lesson discussions (PLDs), focus group discussions

(FGDs) and interviews, carried out over a period of approximately eighteen months. Field notes, photographs of student work samples and lesson plan samples were collected. The qualitative data analysis software Transana© was used to code and analyse video data.

All the activities were video recorded for analysis. Video recording of the research lesson presented by Kini was coded, using Transana. Codes and categories were generated to capture key aspects of the lesson in terms of its use of the SPSA approach. Twenty-three keywords were generated from viewing Kini's lesson multiple times. These were organised under four categories—namely organisation of the class, phases of the lesson, student activity, and teacher activity. Table 1 presents the phases of the study as applied to Kini's involvement, together with the corresponding data sources and data analysis techniques.

Table 1

Phases of Kini's Involvement in Implementing SPSA Through LS

Phases	Activity	Data Sources	Data Analysis
1	Introductory workshop on LS and SPSA	Video recording & transcript of Focus Group Discussion	Content analysis
2	Collaborative planning for Kini's research lesson	Lesson plans (5 versions)	Comparison of first and final lesson plans
3	Implementation (and observation) of Kini's research lesson	Video recording & transcript of lesson (1 hour 15 minutes)	Coding of lesson video using Transana—generating 23 keywords under 4 categories
4	Post-lesson discussion and reflection—Kini, planning team & others from the three participating schools	Video recording & transcript of Post-Lesson Discussion	Content analysis of teachers' reflections on Kini's lesson
5	Focus Group Discussions after each LS Cycle	Video recording & transcript of Focus Group Discussion	Content analysis of teachers' reflections on LS and SPSA processes
6	One-on-one interview	Video recording & transcript of interview	Content analysis

Findings

The findings are organized in order of the study's phases showing how Kini navigated through the SPSA processes through LS.

Kini's Initial Experiences

Kini was introduced to LS and SPSA through workshops using an online platform. Throughout the process Kini actively participated in an activity involving planning a research lesson in collaboration with participants from other schools. Kini valued the planning process in informing teacher's pedagogical approach as reflected in his comment, "lesson preparation is important as teachers will be able to come up with new strategies and ways of presenting the lesson" (FGD, 21 October 2021). Kini could see the potential for his students to learn mathematics by expressing themselves and believed that this could only happen if teachers "move away from the traditional way of teaching" (FGD, 21 October 2021).

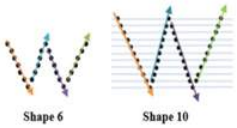
Lesson Planning

Kini was an enthusiastic member of the planning team for all three research lessons conducted at his school—that is, in each of Cycles 1, 2 and 3. He also taught the Cycle 2 research lesson in his

Year 6 classroom. While planning the research lesson, Kini's team initially came up with four solutions which were focused on getting the correct answer, rather than focusing on students' strategies in deriving patterns through diagrams. The team members stated that they did not see, think, nor teach patterns in this manner and they had not thought of deriving rules or formulas using patterns. Excerpts of the initial and final lesson plans are shown in Table 2. The depth shown in the final lesson plan regarding solution 4 and arriving at the rule is a stark contrast to the team members' previous approaches in teaching mathematics. Kini realised this and added that "I still have a lot to learn, still have a lot to learn" (FGD 1, 25 March 2022).

Table 2

Lesson Plan Comparison

Elements of SPSA	Initial Lesson Plan	Final Lesson Plan
Anticipated Student Solutions	Solution 4 6th Shape = 4(6) + 1 = 24 + 1 = 25	Solution 4 [Arrow down, arrow up, arrow down, arrow up] # of dots for shape 6 = 7 + 6 + 6 + 6 = (n+1) + n + n + n = n + 1 + 3n = 4n + 1  Shape 6 Shape 10 # of Dots in W-Shapes: Shape 6 – 7+6+6+6 = 7 + (3x6) = (6+1) + (3x6) = 7 + 18 = 25 Shape 10 – 11+10+10+10 = 11 + (3x10) = (10 + 1) + (3x10) = 11 + 30 = 41 Students can come up with a rule for number of dots in the nth Shape where n represents the Shape Number) Number of dots in nth shape = (n+1) + (3 x n) Number of dots in 6th Shape = (6+1) + (3x6) = 7 + 18 = 25 Number of dots in 6th Shape = (10+1) + (3x10) = 11 + 30 = 41

The Research Lesson

Details of Kini's implementation of the research lesson are captured in the *keyword sequence map* produced from the Transana analysis described earlier. The keyword sequence map, as shown in Figure 1, uses keywords (codes) to capture details of the organisation of the class, the different phases of the lesson, and student and teacher activities during the lesson, and displays these against the passage of time during the lesson.

As can be seen in Figure 1, Kini's class organisation shifted from whole class to individual work, to whole class, and then to group work, in close alignment with the phases of the lesson.

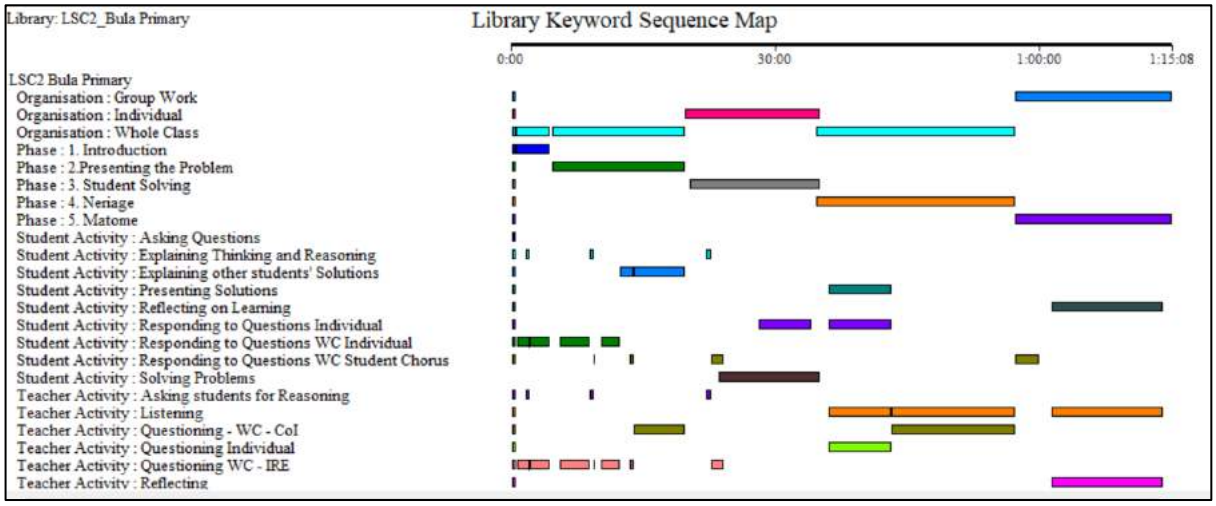


Figure 1. Keyword sequence map.

Kini was able to incorporate elements of SPSA into his lesson. For example, when presenting the lesson, he was able to engage a number of students in responding to questions as he tried to unpack a single problem. Moreover, the time taken for students to work on the problem individually was relatively brief, while the considerably longer *neriage* (comparing and discussing student solutions) phase involved students presenting their solutions while the teacher listened and involved as many students as possible in the discussion. Students were involved in explaining their thinking and reasoning and explaining other students' strategies. The teacher also asked questions and listened, identifying any gaps in students' learning and thinking. Kini stated that, "to wait is a virtue" (FGD 2, 22 June 2022). He also asked probing questions, prompting students to explain their reasoning, as well as asking scaffolding questions to enable students to think for themselves and come to a conclusion. In the process, Kini engaged the whole class, promoting the idea of a community of inquiry, rather than adopting a traditional *Initiate-Response-Evaluate* (*IRE*) model of questioning. He spent a considerable amount of time allowing students to reflect on their learning in pairs, groups and as a whole class. Kini set the tone for a new learning space for the students by concluding his lesson by saying, "I hope that's the way we're going to learn as we move forward, to share, discuss and discover things with other students" (Research Lesson, 19 May 2022).

Kini also showed an increased awareness of individual students' ownership of learning and how this was more inclusive of the average learner. This was captured in the FGD when Kini stated that, "I look at those lower bracket students or below average students, this approach really works well with them when they learn from fellow peers or other students" (FGD, 22 June 2022).

Post-lesson Discussion

One of the key points highlighted by Kini while he was reflecting on his own teaching was that he missed out on some possible 'teaching moments'. For example, he overlooked that Rom's explanation was useful to other students because he arranged the magnets correctly to form the W-dot pattern as shown in Figure 2. Kini reiterated the importance of this, stating that he "should be careful to allow students to do their work on the board and display … it to other students, ensure other students are able to take that … up and … compare his work with the other two students" (PLD, 2 June 2022).

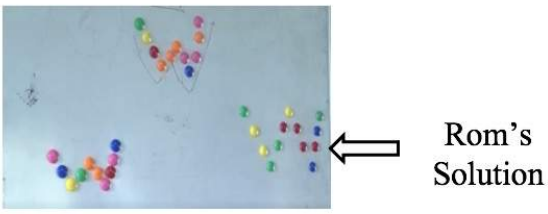


Figure 2. Student work on the board.

Kini also reflected on the fact that it would have been better if he had not deviated a little from the task at hand, when he focused more on the direction of the formation of the W-Dot shape, rather than the number of dots in the growing pattern. This affected the students while solving the problem, as reflected in his comment that the students were focusing on the direction they followed to create the W, rather than the dot formation and the number of dots used.

Learning Gains and Challenges

By the end of Cycle 1 of LS, Kini had realized the challenges faced by the teachers of the three participating schools. He mentioned several challenges: 1) being observed when teaching a lesson was not easy; 2) working in a team and collaborating, 3) the demand for collective, voluntary commitment by the teachers was paramount for success (he thanked his team for making this commitment); and 4) the difficulty posed by extensive *neriage* in SPSA-based mathematics lessons to completing the lesson in the timetabled slot "to finish the lesson on time is challenging" (FGD 1, 25 March 2022). In spite of these challenges, Kini encouraged teachers to incorporate SPSA and to participate in LS, as he had observed positive changes in students. When the teacher incorporates SPSA, students use their prior knowledge, which builds students' confidence and excitement and curiosity to learn. According to Kini, SPSA provides a platform for these changes to manifest, "what I'm saying is, look at the excitement in the eyes or the faces of the students…let the student guess… 'What will happen today?' Oh, we going to do this today… coming to school is something exciting" (FGD 2, 22 June 2022). He also noticed that the teachers at his school were implementing aspects of SPSA in their classes. Kini observed that, "as I walk past, I can see students standing up, giving their answers … they are discussing among themselves. They stand up trying to correct the one standing at the board" (FGD 3, 3 November 2022).

Discussion

This study examined the opportunities and challenges in implementing SPSA through LS in Fijian primary schools. The findings show that after active participation in LS and SPSA, the case study teacher demonstrated an emerging understanding of LS and SPSA. Some of the important findings in the lesson planning phase showed that this teacher benefitted from the collaborative process while anticipating student solutions. He echoed the power of good planning in all discussions (PLDs and FGDs). He asserted that his content knowledge and pedagogical skills were heightened in the process. He also realised the drawbacks of his current practice based on a traditional model of 'chalk and talk' and teacher telling. This resonates with finding from Groves (2013) in the Australian context, relating to the importance of anticipating students' solutions, and the need to plan for good questioning in order to elicit student responses and maximise the impact of SPSA's focus on sharing student solutions to develop students' higher order thinking. These aspects are also highlighted in the keyword sequence map of Kini's lesson, where he is asking probing and scaffolding questions to elicit student thinking and reasoning. These changes were seen in Kini's lesson due to consistent active engagement in the LS professional learning program. Kini planned, observed other teachers teach, and critiqued their lessons. He also implemented a research

lesson and reflected on his own practice. These activities resonate with Widjaja et al.'s (2017) findings that enactment and reflection were crucial in facilitating teachers' professional learning.

As the study progressed, emerging understanding of LS processes became evident. For example, Kini was able to focus his comments on the students' learning rather than the teacher in PLDs. This resonates with one of the challenges Fujii (2014) highlighted, stating that foreign implementers should be wary of focussing on the teacher during PLD. Kini did not follow the lesson plan as a 'recipe' and navigated his lesson by his students' responses and the classroom situation. His professional learning took place over a period of 18 months during which he actively participated in all the processes.

The challenges identified by Kini (see above) were quite different from those stated by Lewis et al. (2019). For example, contrary to Lewis et al.'s concern that a "culture of politeness" regarding critique can undermine inquiry, Kini was quite critical during reflective post-lesson discussions as well as critical of his own lesson.

Conclusion

In summary, Kini was introduced to SPSA through LS. In this study, at the end of the project, Kini had a good understating of SPSA and LS processes and demonstrated a willingness to learn. Through his active participation, Kini was able to integrate many of the elements of SPSA in his research lesson and at the same time made valuable contributions towards collaborative lesson planning and post-lesson discussions, embracing strengths of the research lessons and focusing on teaching and student thinking during the post-lesson discussions. He valued highly the collaborative lesson planning processes and the outcomes of engaging with the team to solve problems and anticipate student solutions. Kini was open to accept suggestions from his team members and researchers who assumed the role of knowledgeable others. He embraced the shift in the approach to teaching and learning of mathematics and professional learning that was situated in the classrooms. In the process, he decided to test a research lesson in his class. He brought about several changes in his practice regarding classroom organisation, his teaching approach, student activities and teacher activities. For example, normally he would pick a textbook, discuss an example to explain how to solve a problem, ask students to attempt similar exercises, have the teacher or students show their working on the board while students copied correct solutions as corrections. In this new approach, Kini's role as teacher shifted drastically. For example, in the *neriage* phase, he discussed student solutions on the board with students expected to explain their thinking and reasoning. Using LS and exploring SPSA in their classrooms resulted in challenges, such as time constraints, difficulties related to collaborative planning, and lessons being scrutinised. Teachers may be reluctant to modify how they teach, but when immersed in a new strategy that they find effective, their teaching habits begin to transform. "Leaving behind the lecture method requires a sophisticated pedagogical approach, which takes time to learn" (Takahashi, 2021, p. 5). Consequently, this study has shown glimpses of the effectiveness of LS as a PL model and SPSA as a teaching pedagogy with potential and relevance to the Pacific region.

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