Lesson Study

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Short Author Biography

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Abstract

In this chapter Lesson Study (LS) is introduced as a model of professional development, which provides teachers with opportunity to research their own practice with a view to improving students' learning. LS is growing in prominence worldwide, particularly in STEM education. In this research a group of post-primary Mathematics teachers participated in LS during their implementation of a revised curriculum. Their work was analysed utilising a framework of Mathematical Knowledge for Teaching (Ball, Thames, & Phelps, 2008) and findings demonstrate a prominence of knowledge specific to teaching mathematical content (i.e. specialised and pedagogical content knowledge) employed by teachers during LS.

Introduction to Lesson Study

Lesson Study is a practice-based, research-oriented, student-focused form of professional development, where teachers collaborate with a view to improving teaching and learning (Huang, Takahashi, & Ponte, 2019). It has been growing in popularity since coming to prominence with Stigler and Hiebert's seminal work 'The Teaching Gap', which contrasted the teaching and learning of Mathematics in three countries (1999/2009). As a finding of their research, Stigler and Hiebert attributed the positive outcomes of learning in classrooms in Japan, such as students' problem solving and critical thinking skills, to teachers' participation in a collaborative model of teacher education entitled Lesson Study (LS) (1999/2009). LS has since been introduced in many educational systems, from Dublin to Doha, across a variety of subjects and levels of education (Stigler & Hiebert, 2016). While teachers participating in LS may focus on any subject it has gained particular prominence in STEM, perhaps due to the focus of the earliest English-language articles documenting LS in science and mathematics classrooms in Japan (see Lewis and Tsuchida (1997)).

At a fundamental level LS is a mode of professional development which involves a group of teachers participating in a cycle of successive phases of planning, conducting, and reflecting on a research lesson (see Figure 1) (Lewis, Perry, & Hurd, 2009). It is not a formulaic

procedure that prescribes a specific routine, but rather a set of principles that can be adopted to different subjects and settings (Stigler & Hiebert, 2016). <Insert Figure 1 here>

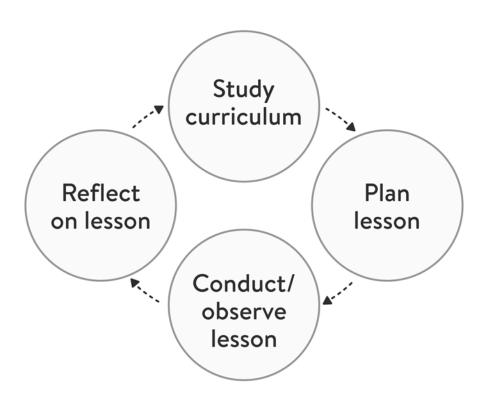


Figure 1 Lesson Study Cycle

Research over the past two decades has demonstrated how LS contributes to: transforming teaching (Lewis & Tsuchida, 1997; Ni Shuilleabhain & Seery, 2018), improving students' learning (Lewis & Perry, 2017), developing teacher knowledge (Ni Shuilleabhain, 2016), developing teacher community (Lewanowski-Breen, Ni Shuilleabhain, & Meehan, 2021), and building connections between research and practice (Huang & Shimizu, 2016). For the purposes of this chapter, where readers may consider working with teachers engaging in LS for their own research, LS can be thought of as layered activity where teachers research their own practice and the researcher(s) working with them can focus on a same or separate research question. In this form LS has been widely utilised in a way typical of matryoshka dolls, where the research work of the LS group is in itself part of a broader research project and where each research focus is connected by the common theme of improving teaching and learning.

How does Lesson Study work in practice?

A LS group typically consists of 3-6 teachers and can often include others interested in the work of teaching, such as an experienced educator (i.e. a 'koshi' or knowledgeable other (Takahashi, 2014)) and/or a LS facilitator who guides the work and research of the group

(Lewis & Hurd, 2011). The LS group should operate as a community of practice, where all participants engage equally in the work of creating, conducting, and reflecting on a research lesson. In Phase 1 of the cycle (see Figure 1), at the convening meeting(s) or first meeting of the academic year, participants agree on a common goal. This is usually a long-term aim that will not necessarily be achieved through one cycle of LS, but rather is intended to provide the group with a foundational vision for the work they will undertake (Lewis et al., 2009). This activity provides teachers with opportunity to consider and articulate their teaching philosophies and personal aspirations for their roles as educators.

Sample goal: "For pupils to find purpose and meaning in their mathematics which leads to their enjoyment of the subject." (Ni Shuilleabhain & Seery, 2018)

Phase 1 then continues with an agreed-upon focus on a particular element of content, where teachers partake in 'kyozai kenkyu' or research around various curriculum materials, textbooks, and academic literature (Takahashi & McDougal, 2016). This activity provides an important bridge between research and teachers' enactment of new or unfamiliar pedagogies (Huang & Shimizu, 2016). Based on this activity, teachers consider an aspect of their own practice or of their students' learning that they wish to learn more about. They construct a research question which they hope to answer through teaching and observing a 'research lesson'.

Sample research question: "How can we support learners visualising three dimensional shapes using their current knowledge of trigonometry?" (Ni Shuilleabhain & Bjuland, 2019)

In Phase 2, employing the lenses of curriculum, student-thinking, and research (Fernandez, Cannon, & Chokshi, 2003), the group collaboratively plans the research lesson to be taught as a live activity. Utilising the educative materials sourced or developed from Phase 1, they map out the research lesson paying particular attention to the work and thinking that students will undertake. Careful consideration is given to the activities students will engage in, the challenges students may experience, the questions students may ask, and how the teacher may guide the classroom conversations throughout the lesson. The dialogic space required for this collaborative work of planning provides teachers with a chance to share and build ideas, making their often-implicit knowledge explicit (Warwick, Vrikki, Vermunt, Mercer, & van Halem, 2016). It is important to note here that, where possible, all members of the group should attend all meetings and that the majority of the work should occur in meetings rather than as homework.

As part of their planning, the group decides on the teacher to conduct the lesson (Phase 3) and the information to be collected by the observing members of the group. It is important, however, that the research lesson remains a shared entity rather than the conducting teacher's responsibility. In addition, during the research lesson, it is important that the observers' roles mirror the stance of laboratory scientists, carefully observing an experiment and collecting information, and not as additional teachers in the classroom. Finally, in Phase 4, teachers collectively discuss the lesson and reflect on and record the learnings gained from the cycle, with reference to their research question and long-term goal.

A cycle is typically conducted over a number of weeks, often totalling 6-8 hours of meetings. Teachers may wish to revise and reteach the research lesson, with a subsequent reflection discussion, to a different group of students if they feel they have not answered their research question or learned enough about students' thinking. This is, however, not always a necessary step (Fujii, 2014).

Researching with Lesson Study: A case study

In this research we consider a case-study of five Mathematics teachers in one post-primary school. These teachers participated in LS with a view to improving their teaching and students' learning and, simultaneously, their modes of collaboration as a subject department grappling with curriculum reform. Working with the author, who acted as a facilitator of LS and was a participant observer in the research (Bogdan & Biklen, 2007), teachers took part in multiple cycles of LS over the course of one academic year. For the purposes of this chapter we focus on one particular cycle of LS, where teachers wanted to explore new ways of introducing quadratic patterns to their students. The research investigated the knowledge utilised by teachers during the cycle and asked:

What elements of teachers' mathematical knowledge for teaching (MKT) are employed in the planning and reflection of the research lesson?

The research question refers to the Mathematical Knowledge for Teaching (MKT) framework, as defined by Ball et al. (2008), which is split into two sections: Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge (PCK). SMK is outlined as the disciplinary knowledge required by Mathematics teachers and is broken into three categories of: Common Content Knowledge (CCK), Horizon Content Knowledge (HCK) and Specialised Content Knowledge (SCK). CCK refers to mathematical knowledge that is used outside of teaching, such as knowing odd or even numbers, while SCK identifies the knowledge that is unique to teaching, such as understanding and assessing different techniques of answering a particular problem. On the other side of the MKT framework, PCK is outlined as the knowledge which distinguishes the understanding of an educator from that of a content specialist. PCK is delineated into the three categories of: Knowledge of Content & Students (KCS), Knowledge of Content & Teaching (KCT) and Knowledge of Content & Curriculum (KCC). These categories attempt to classify the types of knowledge utilised in the work of teaching where, for example, a teacher might select appropriate mathematical language, analogies, and metaphors in their planning (KCT) or may choose an example that students will find interesting and motivating (KCS).

In an attempt to answer the research question, multiple forms of data were generated. As explored earlier, much of the work of LS occurs during teachers' planning and reflection conversations. These opportunities for 'interthinking' (Bjuland & Helgevold, 2018) were therefore an important part of the generated data for this research. All conversations of the group throughout Phases 1, 2 and 4 were audio-recorded and materials from all meetings, such as planning notes, the research lesson plan, and reflection report, were collected. In addition, teachers' observation notes from the research lesson (Phase 3) were also included.

Generated Data	Format
Teachers' conversations in Phases 1, 2 and 4 of the LS cycle	Audio-recorded and transcribed.
Teachers' planning and reflection notes	Collected in hard-copy and photo-copied/scanned.
Teachers' collective research lesson plan and reflection report	Collected in soft copy
Observation notes from teachers	Collected in hard-copy and photo- copied/scanned

Participating teachers had identified a shared lack of confidence in teaching through structured problem solving (Takahashi, 2021) and wanted to explore how they could introduce a topic without exposition. Focusing on algebra they asked:

How can we introduce students to quadratic expressions without explicitly demonstrating what they are?

As part of their 'kyozai-kenkyu' they shared how they usually taught the topic, read articles (sourced by the LS facilitator/author) on teaching the topic, and compared textbook and online exercises. Over a number of meetings (Phase 2) they agreed on a problem to pose to students, decided who would teach the lesson, and planned the questions the conducting teacher would ask in order to guide students' thinking. The information they decided to record during the research lesson (Phase 3) included:

- Questions asked by students during the lesson
- Elements of students' group-work conversations
- Copies of students' work

Teachers observing the lesson were each assigned to a group of students and all of the collected data, including samples of students' work, was reviewed by the group in the reflection meeting (Phase 4).

What did the data look like and how did I analyse it?

With audio-recorded conversations it is important to be familiar with the data (Bogdan & Biklen, 2007), therefore the first phase of analysis involved listening carefully to the conversational data while reading the transcriptions and checking for accuracy. This first phase provided the author with an outline of features of teachers' MKT that were present in the data. The transcriptions and associated documents were then uploaded to NVivo, which provides a way to manually code the qualitative data according to a researcher-defined or

automatically generated framework. In this instance, the framework of teachers' MKT, with sub-categories outlined by Clivaz and Ni Shuilleabhain (2019), was input to the programme and the data was manually coded. While manual coding could have been completed using paper and pen, the software programme provides a way to easily record and calculate the occurrences of each sub-category of knowledge and to compare these across the phases of LS.

In the analysis of the transcribed conversations, chunks of conversations (or utterances) pertaining to a single topic were designated as a unit of code. As an example, the following section of conversation from Phase 2 was analysed as one unit of code of KCS, with the subcategory of 'identifying students' knowledge or learning' (all names are pseudonyms):

Fiona: Just, before we even do this, what have they done in algebra up until this? Or does it matter?

Walter: I would have it here [referencing year plan records]. They've done standard linear equations, they've done expressions.

Fiona: So, we would have done kind of, you know, work from a practical context and brought that into linear. We would have done simplifying expressions, so they have done a little bit already.

Walter: Hmm mm.

Fiona: Because if the variables aren't, things are just going to come out of the blue to them...

Walter: They've done substitution, they've done -

Fiona: They've come across the variables in linear patterns already

Walter: They've done some multi-graphing. That sort of stuff.

Fiona: Yeah, they would have done substitution.

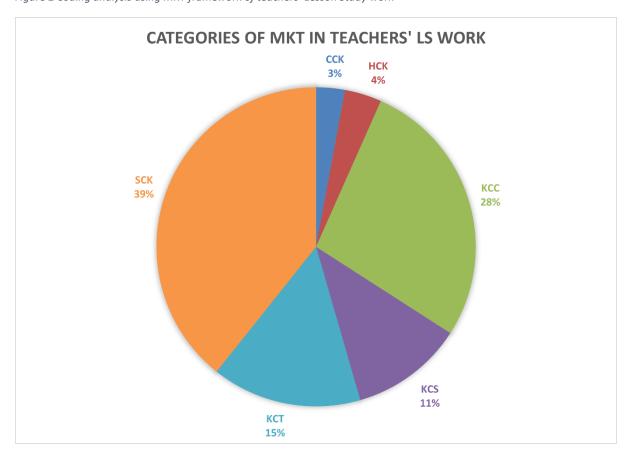
Walter: And they've done tables and graphs of linear patterns.

Each unit of teachers' conversations relevant to the planning or reflection of the research lesson was coded, as were teachers' observation notes, lesson plan, and lesson reflection. The completed coding from each of the data sources was recorded and graphed according to each category of MKT (see Figure 2).

What did the method allow me to see and how well did it show me?

The phases of a LS cycle, where teachers have time and space to think carefully and deeply about their teaching and students' learning, provide a window into the complex work of teaching. In this case study, analysis of the qualitative data demonstrated a prominence of SCK (39%) and KCC (28%) in teachers' work (see Figure 2). <Insert Figure 2 here.>

Figure 2 Coding analysis using MKT framework of teachers' Lesson Study work



The sub-categories of SCK present in the data revealed the fine-grained conversations teachers held around the mathematical content and their own understanding of the topic of algebraic expressions. It also recorded teachers' explanations and justifications of their mathematical ideas with one another, providing moments of learning for the group where, for example, teachers shared, compared, and contrasted various ways of factorising a quadratic expression.

Fiona: Because if I was factorizing that I wouldn't go straight into brackets, I would

put another two or three lines in between...

Walter: You do that even with the 'a' as 1?

Fiona: Any old thing.

Dave: Everything squiggles.

Fiona: Yeah. Go for squiggles every time... Eileen: What do you mean squiggles?

Teachers also talked explicitly about the mathematical language which would be used in class, focusing on the wording that would make most sense to students. These opportunities to discuss and share such knowledge, unique to the repertoire of Mathematics teachers, contributed to the depth of the content discussions and supported teachers in considering the lesson through a student lens (Fernandez et al., 2003). This detail in planning was mirrored in the Phase 4 reflection conversations, where teachers were interested in how the anticipated student responses were realised within the research lesson. It is interesting to note that teachers' KCC (Knowledge of Content & Curriculum) was more prominent in

these planning and reflection conversations, when compared to other similar analyses of teachers' LS work (Clivaz & Ni Shuilleabhain, 2019; Ni Shuilleabhain & Clivaz, 2017). This may relate to the fact that this cycle was undertaken during the implementation of a revised post-primary curriculum, where teachers paid particular attention to the wording and progression of content in the syllabus. This finding further highlights the important role LS can play in the implementation of new curricula (Ni Shuilleabhain, 2018). Furthermore, as the prevalence of MKT has been demonstrated to increase in teachers' conversations over successive cycles of LS (Ni Shuilleabhain, 2016), this finding highlights the specific learning LS can support through teachers' sustained participation.

What are the key considerations in using this approach?

LS can provide a useful structure within which teachers can test and trial new ideas, with the support of their colleagues. In parallel, teachers' collaborative conversations can provide the researcher with rich data on the detailed knowledge and skills required in the planning, conduction, and reflection of lessons. However, while LS can provide a window on the workings of teaching, it is difficult to capture the impact on students' learning. As a LS cycle includes only one research lesson, the benefit to students can be difficult to record without sustained data generation over a specified number of cycles which pertain to one specific topic (see Curran (2020) or Lewis and Perry (2017) as examples of such work).

Introducing teachers to LS does not necessarily lead to them successfully participate in a cycle. Deliberate work needs to be undertaken to ensure any participants, including the researchers, fully understand the philosophy and practices underpinning LS. Indeed, where this has not taken place, LS has not been effective in influencing teachers' or students' learning (Bjuland & Mosvold, 2015; Fujii, 2014; Seleznyov, 2019). The following is therefore important to keep in mind when undertaking research with LS:

- 1. A core tenet of LS is for teachers to research their own practice for the benefit of their learners.
- 2. Conducting LS means conducting all four phases of the LS cycle in their entirety, with all (or as many as is feasible) members of the LS group participating.
- 3. The work of the LS cycle should occur within the LS meetings and over a number of weeks.
- 4. Participation in the LS group should be voluntary and not directed by school leadership or the researcher team.
- 5. The goal of LS is not to produce a research lesson plan, but rather to engage in collaborative, deep and detailed discussions around teaching and learning.

It is also useful to keep in mind that in order to fully embrace the work of LS, teachers need to be comfortable articulating not only their knowledge, but also the gaps in their knowledge. Sharing vulnerability, be it in confidence with content or pedagogical approaches, requires a level of trust and community between teachers. In this regard, it is important to remember that participating in LS is, in itself, an activity which can generate teacher community (Lewanowski-Breen et al., 2021). Researchers should be mindful, therefore, of the length of time or number of cycles which may be required to uncover changes in teachers' or students' learning.

Where would I direct people to learn more about this approach?

For further reading and resources, the following may be useful:

- o Lewis, C. & Hurd, J. (2011), Lesson Study Step by Step: How Teacher Learning Communities Improve Instruction. USA: Hienemann.
- World Association of Lesson Study https://www.walsnet.org/
- The Lesson Study Group at Mills College https://lessonresearch.net/
- Professional Development Service for Teachers sample mathematics lessons from lesson study - https://www.projectmaths.ie/for-teachers/lesson-study-library/

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