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Task-Design Lesson Study – A methodological tool for exploring mathematics teachers’ task-design principles and pedagogic practices

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The primary function of lesson study is to enable teacher professional learning. Accordingly, much of the existing research literature that involves lesson study, reports the professional learning outcomes for the participating teachers. However, research that reports scientific knowledge from studies in which the lesson study constitutes the research design is scarce. This paper proposes a new model of lesson study called Task-Design Lesson Study (TDLS) developed as a methodological tool for a recent study in England, with which to explore in-service teachers’ design principles and accompanying pedagogical practices. By theorizing TDLS as a community of inquiry, this paper argues that TDLS can provide: i) a space for teachers’ professional inquiry activity; and ii) a methodological tool from which to construct scientific knowledge.

Keywords: Lesson Study, teacher collaboration, mathematics task design.

Background and introduction

This paper originates from a recently completed study, set against the background of mathematics pedagogical reform in England, where I explored in-service primary teachers’ design principles and their accompanying pedagogical practices associated with a novel form of mathematical task (Jacques, 2023). Much of the literature on task design for mathematics learning is reported from the perspective of academic experts in the field. In this paper, I theorize lesson study as a *community of inquiry* (Jaworski, 2006), but claim that much of the literature associated with lesson study, unsurprisingly, reports professional learning outcomes for participating teachers rather than scientific knowledge arising from studies where lesson study constitutes the research design. Thereafter, I propose a model of lesson study that I developed as a *methodological tool* for the aforementioned study, with which to explore teachers’ mathematical task design principles and accompanying pedagogical practices. I conclude by reflecting on how the proposed model of lesson study took account of the research study’s inquiry needs.

Communities of inquiry

A community of inquiry is a collaborative space for teacher professional learning. Jaworski (2006, 2019) argues that, in the context of mathematics teacher education, inquiry is a tool used by students, their teachers, and didacticians (or teacher educators) thus constituting three nested layers of inquiry, modelled in Figure 1. The centre of this model Figure 1 represents the classroom setting where teachers and students interact through mathematical inquiry, the middle layer (white area) represents a space where teachers collaborate to inquire about mathematics teaching and learning and the outer layer represents the researchers’ (or didacticians’) inquiry about the other two layers from which, “observations and reflections of all participants lead to data which is analyzed rigorously, ... , to provide insights into the entire developmental process” (Jaworski, 2019, p. 277).

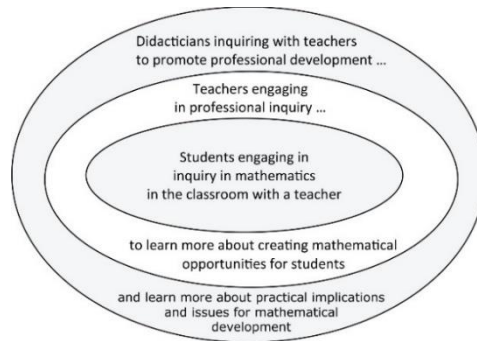


Figure 1: Inquiry in three layers (Jaworski, 2019, p. 278)

Central to this model is that participating teachers engage in *critical alignment* (Wenger, 1998) to address *issues in practice*, such as designing mathematical tasks and developing approaches to mathematics teaching (Jaworski, 2006). This includes teachers “critiquing and trying to develop, improve or enhance the status quo” (Jaworski, 2006, p. 191) and this experience conceptualises individual teacher’s professional learning. However, I consider critical alignment to also characterize the collective knowledge constructed from the teachers’ and students’ collaborative inquiry activity. I propose that this knowledge is evident in the *objects of collaborative inquiry* produced during the inquiry process. These objects provide the source material for a researchers’ inquiry (represented by the outer layer in Figure 1), giving insight into, for instance, teachers’ task design principles and accompanying pedagogical practices that they construct during their inquiry activity.

It is no surprise, given its primary purpose, that research involving communities of inquiry in mathematics teacher education largely reports findings related to teachers’ professional learning or students’ learning and that little is reported about the collective knowledge arising from critical alignment. In the next section, I consider how lesson study as a space for professional learning, can be theorized as a community of inquiry, from which objects of collaborative inquiry can be produced.

Lesson Study as a community of inquiry

Lesson study has been described as “a practice-based, research oriented, collaborative mode of professional development” (Huang & Shimizu, 2016, p. 393), involving students, teachers and teacher-educators (didacticians). Its origins lie in East Asian education cultures such as China and Japan (e.g., Huang et al., 2017; Yoshida, 1999). Participating in Japanese lesson study (JLS) involves four distinct stages of inquiry: developing a lesson goal and research question; designing a research lesson including a detailed plan informed by researching teaching materials; observing a research lesson and reflecting on the research questions in a post-lesson discussion to consolidate participants’ learning (Murata, 2011). The focus for inquiry is on developing students’ mathematical learning. In Chinese Lesson Study (CLS), teachers at different levels of expertise collaborate to design an excellent lesson. Teachers design and conduct a research lesson and reflect on its success and redesign the lesson, thereby the focus of inquiry in CLS is on developing teaching practices leading to successful learning.

Since Stigler and Heibert (1999) drew attention to JLS, cultural adaptations have been made to this model such as *learning study* (LS) in Hong Kong and Sweden (Marton & Pang, 2006); *research lesson study* (RLS) in England (Dudley, 2014) and *micro-teaching lesson study* (MLS) in the US

(Fernández, 2005). Each of these adapted models includes common elements which are typically coordinated by a lesson study facilitator/teacher educator and include: i) collaborative planning of a research lesson based on research questions identified by the participating teachers (i.e. an issue in practice); ii) observation of a live or video-recorded research lesson, and iii) participation in a post-lesson discussion to reflect on the observed research lesson and the lesson study research questions (i.e. critical inquiry). These elements of lesson study can be theorized as a community of inquiry (Doig & Groves, 2011).

Additional elements are culturally or purposefully included and distinguish the different interpretations of lesson study. For instance, in LS, variation theory of learning (Marton & Pang, 2006) is a guiding principle for the research lesson design and includes pre- and post-assessments of students' learning. In RLS, three focal students in a whole class are observed during the research lesson and interviewed afterwards, enabling "forensic visibility" (Dudley, 2014, p. 4) of the students' experience of the lesson goal. MLS (Fernández, 2005) is an adaptation of lesson study for pre-service teachers where the teacher-educator identifies the focus for a short lesson *episode* which the pre-service teachers design and teach to small groups of peers (rather than school students). Unlike JLS (Yoshida, 1999), LS, RLS and MLS include iterative cycles of redesign and reteach. When the lesson goal also involves students' mathematical inquiry, these models of lesson study can also be thought of as communities of inquiry. Whilst, the adaptations apparent in these models accommodate the local inquiry needs of the participating teachers and the learning needs of their students (the middle layer and central layer of Figure 1, respectively), little is reported about how lesson study is adapted to accommodate the inquiry needs of researchers (the outer layer of Figure 1). In the next section, I propose a model of lesson study, developed for this purpose.

Task-Design Lesson Study as a community of inquiry

To explore in-service primary teachers' design principles and accompanying pedagogical practices in the aforementioned study, I developed Task-Design Lesson Study (TDLS). This served two deliberate purposes. Firstly, it offered an authentic community of inquiry within which teachers, supported by me as teacher-educator¹, could collaboratively inquire about their own professional practices associated with a type of task that promoted students' mathematical inquiry. Secondly, it was designed to accommodate my inquiry needs as researcher. That is, it was also my *methodological tool* for my research design, used to gather objects of collaborative inquiry. It is this latter purpose on which I focus for this paper. Drawing from the layers of inquiry in Figure 1, Figure 2 conceptualizes TDLS as a community of inquiry by illustrating the nested layers of inquiry questions in the context of the aforementioned research study: the dark grey area represents the outer layer of Figure 1: the researchers' inquiry; the white area represents the second layer of Figure 1: the teachers' inquiry; and the light grey area represents the central layer of Figure 1: the students' mathematical inquiry.

¹ In the study mentioned in this paper I was both teacher-educator and researcher

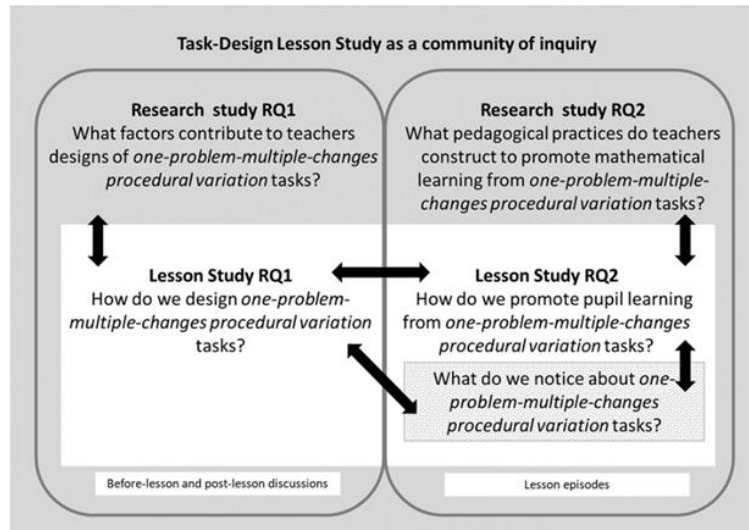


Figure 2: Task-Design Lesson Study as a community of inquiry, showing the nested inquiry questions for the researcher (dark grey), teachers (white) and students (light grey) and the reflexive relationships between the different inquiry questions as well as the stages of TDLS from which objects of collaborative inquiry were collected for each RQ.

The left-hand side of Figure 2, is concerned with collaborative discussions and the right-hand side is concerned with research lessons. As teacher-educator, I constructed the two lesson study research questions (RQ1 and RQ2 in the white area), informed by and mapped to my already identified research study's research questions (RQ1 and RQ2 in the dark grey area in Figure 2). The white area represents the space where the objects of collaborative inquiry would be produced. Thus, generating the data for analysis to gain insight into the teachers' task design principles and pedagogical practices. Arrows in Figure 2 indicate three reflexive relationships. Firstly, between the pairs of lesson study and research study research questions. Secondly, the right-hand side of Figure 2 includes the students' inquiry question during the research lesson (light grey area). The two arrows from this area indicate the reflexive relationship between the students' experiences of mathematical inquiry on each lesson study research questions. Finally, the model also indicates a reflexive relationship between the two lesson study research questions that arise from iterative stages of TDLS. These stages are described in more detail below.

The stages of Task-Design Lesson Study

There were several local considerations to accommodate when designing TDLS. Firstly, in some lesson study models (e.g., JLS or LS), the stages can extend over several weeks or months. In England however, teacher attrition on extended professional learning activities is often high and therefore there was a risk that few teachers would be able to participate to that level of commitment. Furthermore, since the focus of inquiry was the design and use of a short task, the research lesson need only be a lesson *episode*, as in MLS (Fernández, 2005). This could reduce the amount of time needed for the collaborative design, teaching the research lesson and reflecting on the inquiry questions. I designed the lesson study model so that all stages could take place in a single event, over two and a half to three hours. This meant that the teachers in attendance were able to participate in all stages of the lesson study process in this single session.

TDLS involves three iterative cycles of inquiry (Figure 3). I incorporated an iterative structure, borrowed from LS, RLS and MLS to enable the teachers to respond to the students' experience of the task in each lesson episode so that they could adapt it and reflect on how these changes provoked different student experiences involving three iterations of the task.

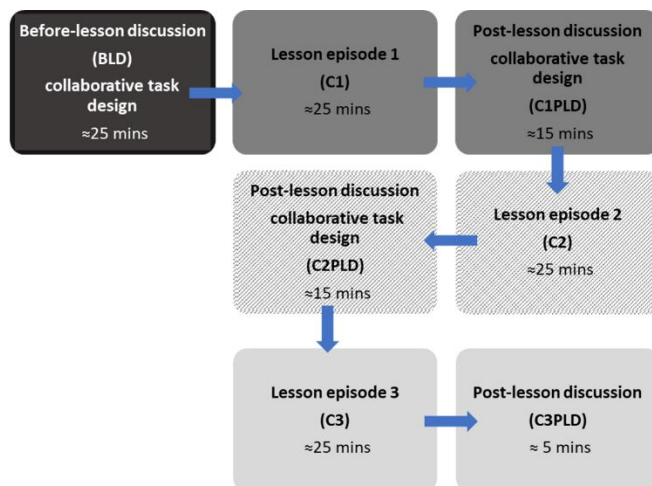


Figure 3: Task-design lesson study (TDLS) showing the three iterative cycles of inquiry conducted in a single session

Additional time for transition from one stage to another is not accounted for in the model but equated to approximately 15 minutes in total. Before describing the detail of each stage of the cycle, I explain how the teachers came to be involved in the study and their roles within the community of inquiry.

I designed the lesson study research questions prior to recruiting the participating teachers. These questions informed the professional learning initiative which was promoted to primary teachers in southeast London. Teachers elected to participate because they were interested in the focus of the inquiry. Whilst the teachers' individual professional learning was not a focus for the research study, it remained so in my role as the teacher-educator in the initiative. Eight teachers from different schools participated. They attended an orientation day and three TDLSs on three separate occasions over a span of three months. The launch event was designed to introduce them to one another, to explore their knowledge of the task type that was to be the focus of their inquiry and to familiarize the teachers with the stages of the lesson study model. Three teachers hosted a TDLS at their own school. This required them to provide a room in which the participating teachers could discuss the task design and conduct the lesson episodes. Each teacher chose a mathematical focus for the design of the task. The host teachers also identified three groups of 6–8 students to form a 'class' for each lesson episode, affording 'forensic visibility' of the students' experiences (Dudley, 2014). To enable the three groups to be broadly homogenous, the host teacher selected the group of students from their own class to be representative of the whole class in terms of prior mathematical attainment.

The model involves three stages beginning with a *before-lesson discussion* (BLD). The purpose of the BLD is to set the scene for the lesson study (introduced by the host teacher) and for the teachers to collaboratively design the first iteration of the task. In the BLD the host teacher introduces the mathematical focus and provides information about their students' prior learning. Based on this information, the teachers contribute and discuss their ideas for the design of the task, giving reasons

for their choices and/or comment on and critique others' choices. The teacher-educator's role in the BLD is to facilitate the discussion, prompting and probing as a *knowledgeable other*, but at the same time maintaining an equitable role as co-participant in this layer of inquiry.

After the BLD, the host teacher collects the first group of students for the first *lesson episode*. During this transition, the other teachers prepare the equipment needed for the task. The first lesson episode is taught by the teacher-educator. This is a specific characteristic of TDLS which allows the teacher-educator's practices to be exposed and critiqued first. During a lesson episode the observing teachers attend to the lesson episode teachers' use of the task and the students' experiences. The second lesson episode is taught by another teacher, identified in the BLD and the final lesson episode is taught by the host teacher. This enables them to use the third iterated task with a group of their own students.

When each lesson episode is complete, the students return to their normal class. The teacher-educator facilitates a *post-lesson discussion* (PLD) to interpret the students' experiences and to consider how those interpretations might inform modifications to the design of the task or its use with the students in the next iteration. Once the next iteration of the task is agreed, the host teacher gathers the next group of students, and the next cycle begins. The second lesson episode is followed by a second post-lesson discussion where reflections inform a final iteration of the task design and its use in the final lesson episode. After the third cycle, the post-lesson discussion involves the teachers briefly reflecting on the whole session.

Using Task-Design Lesson Study as a methodological tool

In the preceding section, I described TDLS as a community of inquiry in which teachers and teacher-educators inquire about the design of mathematics tasks and the accompanying pedagogical practices. TDLS could be used for this sole purpose. However, TDLS was also designed to accommodate the study's research questions (dark grey area of Figure 2). In this final section, I discuss characteristics of TDLS that distinguish it from lesson study as purely a model for teachers' professional inquiry. Furthermore, I consider issues that arose when using it as a methodological tool².

By considering TDLS as a community of inquiry, it was possible to identify layers of inquiry for the researcher/teacher-educator, teachers and students (Figure 2). There were two points of departure from established models of lesson study (e.g. JLS). Firstly, the *research study* questions informed the *lesson study* research questions, and I defined these before recruiting the teachers. TDLS arose from considering how best I could gain insight into teachers' design principles and pedagogical practices associated with a novel type of mathematics task. Whilst the teachers did not have agency to influence the inquiry questions, they elected to participate because they were interested in inquiring about this predetermined focus. Secondly, TDLS was designed to produce objects of collaborative inquiry to explore teachers' task design and pedagogical practices. In contrast to JLS but similar to LS (Kullberg et al., 2020), the focus of inquiry was also on the teachers' practices - although the students' experiences influenced these practices as part of the inquiry process (Figure 2).

2 By methodological tool, I mean a tool that forms part of research design for constructing scientific knowledge.

To harness the objects of collaborative inquiry for rigorous analysis (Jaworski, 2019), all stages of the TDLS were video-recorded. Transcripts of the BLDs and PLDs formed the units of analysis to investigate factors influencing the teachers' design of the tasks. The lesson episode transcripts, screenshots and flipcharts were analysed to explore the teachers' pedagogical practices when using the tasks with students. If used just as a space for collaborative inquiry, video recording would be an unnecessary element of TDLS. Since these were only used by the researcher.

In TDLS, I participated as researcher and teacher-educator in the two outer layers of the community of inquiry (Figure 1 and Figure 2). This reflexive position required me to make explicit, in the study's research methods and the study's findings how these two positions influenced the outcomes of the research study. As teacher-educator and researcher, I was simultaneously managing the needs of the teachers' and students' inquiry activities and 'caretaking' my own research study. These two positions also led to possible implications in terms of the power relationships between me and the teachers. The teachers were aware that they were being researched by me and they also perceived me as a 'knowledgeable other' as teacher-educator. Therefore, I made efforts to enable the teachers to feel empowered to fully engage and to avoid them withholding participation for fear of being judged.

Lastly, TDLS was designed to produce ecologically valid results. That is, the results of the study could be generalized to the every-day work of teachers. I have shown that TDLS can offer an authentic space for collaborative professional inquiry as well as a methodological tool. One limitation of its ecological validity was the number of students in the lesson episode. To manage this, the small groups were chosen to be representative of the whole class in terms of prior mathematical attainment and therefore enabled forensic visibility of the range and type of student responses that might arise in a whole class situation. For analysis of the objects of collaborative inquiry, these groups in each cycle of a TDLS were treated homogeneously. Furthermore, whilst TDLS involves a reduced amount of time for teacher reflection and design, when compared to other models of lesson study, this mirrors the conditions under which teachers work in their day-to-day practice.

Conclusion

In this paper, I have described how TDLS constituted the research design for a study exploring teachers' mathematical task design principles and accompanying pedagogical practices. TDLS, as a community of inquiry, served as a *methodological tool* to accommodate the study's research questions whilst providing a space for collaborative professional activity. I observed that in TDLS, the layers of inquiry questions were reflexively related (Figure 2) and proposed that *objects of collaborative inquiry* could represent the collective knowledge arising from the inquiry activity. Consequently, these objects of collaborative inquiry served as the source material for my analysis. My development and use of TDLS suggests that it has the potential to produce ecologically valid outcomes for research studies wishing to explore teachers' mathematics task design principles and pedagogical practices, as well as providing a space for teacher professional inquiry.

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