FACILITATORS' ROLE IN LESSON STUDY: ADAPTING A THEORETICAL FRAMEWORK

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Facilitators seem important for the effect of lesson study, yet research on their role is scarce and there is a lack of theoretical approaches to examine this role. In this paper, we adapt a theoretical framework, the knowledge quartet, that focuses on how teachers' knowledge of mathematics and its teaching and learning play out at the classroom level. We use a lifting strategy to adapt the quartet to the facilitator level and apply it to analyse the facilitators' role in a Norwegian lesson study that targeted primary teachers' development of inquiry-based teaching. We conclude that the adapted framework appears as a promising theoretical approach that can provide deep insight into the facilitator role and potentially serve to develop it. However, more research beyond this single case is needed to further develop the framework.

INTRODUCTION

In countries with a long-lasting system of lesson study such as Japan and China, the role of facilitators (or knowledgeable other, koshi, expert teacher etc.) are well-defined although the roles can vary depending on the types of lesson study (Seino & Foster, 2021; Takahashi, 2014). However, in countries unaccustomed with lesson study, the facilitators' role is more blurred. Often the facilitator guides the lesson study process (Seino & Foster, 2021) (therefore we use the term facilitators), and in many cases, no facilitators are included, particularly when the adaptation of lesson study is more mature (Skott, 2024). However, research stresses the importance of including a facilitator also at mature stages (Skott, 2024), and Takahashi (2014) even claims that lack of effectiveness of lesson study outside East Asia is "likely to be due to a lack of effective support from outside the lesson study team" (p. 2).

In this area, the research is limited, especially on how facilitators best support teacher learning during lesson-study interactions (Clivaz et al., 2023). There is thus a need for theoretical approaches that focus on what a facilitator believes and knows of mathematics and its teaching and learning and how this influence teachers' learning in a lesson-study context. At the classroom level, Turner and Rowland (2011) developed such a framework, *the knowledge quartet*, that focused on how teachers' content knowledge influenced their classroom teaching. Inspired by Karsenty (2020), we aim to adapt this framework to the facilitator level and apply it to examine how facilitators' knowledge and experiences play out in a Norwegian lesson study targeted primary teachers' development of inquiry-based teaching (IBT). We address the question:

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How to adapt the knowledge quartet to the facilitator level to gain insights into the facilitator role in a Norwegian lesson study on inquiry-based teaching?

First, we present theoretical approaches used in the scarce research on the facilitator role. We then theoretically adapt the knowledge quartet to the facilitator level and test it empirically on the Norwegian lesson-study data. Finally, we discuss our results.

THEORETICAL APPROACHES IN RESEARCH ON FACILITATORS

Research on facilitators' role in lesson study applies a variety of theoretical approaches. However, some studies conduct inductive analyses without a theoretical lens, such as Seino and Foster (2021) and Takahashi (2014), which both examined the final comments of Japanese knowledgeable others. Clivaz et al. (2023) used a mixed-methods approach to explore a group of Swiss primary teachers' development of 'mathematical knowledge for teaching problem solving' in a lesson study with a focus on two facilitators' role (a knowledgeable other and an expert teacher). The facilitators' levels of knowledge were analysed quantitatively and their dialogic interactions qualitatively. The authors developed the framework, *Lesson study dialogue analysis*, to qualitatively analyse the dialogue at three levels of which the micro level included participants' utterances, such as expressing or inviting new ideas. Clivaz et al. (2023) found that the knowledgeable other took an expert perspective, proposed consensus and synthesised ideas more often than the expert teacher, while she aroused more reasoning and participated in the dialogue in ways similar with the teachers. Also using a dialogic approach, Skott and Psycharis (in press) examined how a Greek and a Danish facilitator supported teachers' development of core practices in a lesson-study context. Based on dialogic interactions, they examined the extent to which the facilitators succeed in creating dialogical spaces, that provided such opportunities for the teachers.

In a Chinese context, Gu and Gu (2016) developed a framework to analyse facilitators' roles in post-lesson sessions. The framework consists of both four mentoring strategies to capture the dynamics between teachers and facilitators, and the knowledge that facilitators pay attention to (practical, mathematical and pedagogical knowledge). Gu and Gu (2016) found that most facilitators used authoritative conversation (i.e., they provided general comments or comments on anticipated problems) and focused on practical knowledge. Inspired by Gu and Gu (2016), Skott and Ding (2022) combined these strategies with the original knowledge quartet to examine and compare how facilitators talked with teachers and about what in a Chinese and Danish lesson study. They added new strategies (i.e., building relationships and using teachers' ideas) and found that the Danish facilitators engaged in relational talk with teachers, while the Chinese facilitator talked in an authoritative way.

To summarize, these studies focus primarily on dialogical aspects of the facilitator role, often combined with a static perception of knowledge. They provide valuable insights into how facilitators interact dialogically with teachers in different contexts and the knowledge involved, but none of them consider theoretically, how facilitators'

knowledge of mathematics and its teaching and learning come into play in lesson-study interactions and is shaped by and shape these. To develop such a tool for reflecting on lesson-study interactions and facilitator knowledge – and to advance both – we adapted the knowledge quartet to the facilitator level.

ADAPTING THE KNOWLEDGE QUARTET

Karsenty (2020) focused on adapting frameworks on mathematics teachers' knowledge and practices at the classroom level to the level of mathematics educators who support teachers' professional development (i.e., facilitators). She suggested using one of two strategies: *lifting* or *nesting*. When lifting a framework, its constructs are transferred or adapted to the facilitator level – an analogy between the two frameworks is created – while nesting means to use a self-similar structure at the facilitator level and include the original framework as a component in this structure (Karsenty, 2020). Use of these strategies is based on two assumptions: 1) a connection exists between what a teacher needs to know and what a facilitator needs to know; 2) the adaptation is a worthwhile endeavour. Both assumptions apply in our case. We decided to use the lifting instead of the nesting strategy as it seemed more suitable for our purpose and less complicated.

At the classroom level, the knowledge quartet consists of four categories and associated codes (Turner & Rowland, 2011). The category *foundation* differs from the three other categories as it is about knowledge possessed by teachers, such as knowledge, beliefs and theoretical background acquired through education (codes ex.: awareness of purpose; theoretical under-pinning of pedagogy). The other categories concern how teachers' knowledge plays out in actions. *Transformation* is about choices teachers make when transforming their own content knowledge into pedagogical forms target students (code ex.: choice of representation and examples). *Connections* are about teachers' choices when establishing coherences in student learning across lessons and class level (code ex.: making connections between concepts; anticipation of complexity). The last, *Contigency*, is about how teachers respond to unexpected classroom events (code ex.: responding to students' ideas; deviation from agenda).

To lift the quartet to the facilitator level within a lesson-study context focused on IBT, we made categories analogue to the four above and constructed initial codes through a preliminary data analysis. Consequently, in the lifted quartet, *foundation* refers to facilitators' knowledge, theoretical background and beliefs acquired through academic work, such as writing and reading research articles about IBT (codes ex.: awareness of IBT goals; use of terminology; overt subject knowledge). *Transformation* concerns facilitators' choices, when transforming their knowledge and experiences (e.g., about IBT) into pedagogical forms targeted teachers' learning in a lesson-study context (codes ex.: use of examples, observations and the lesson plan; suggest IBT tasks). *Connections* concern facilitators' choices about establishing coherence in teachers' learning of IBT across lesson-study activities (codes ex.: focusing on connections between tasks, lesson goals and student mathematical thinking; focusing on student difficulties and on scaffolding their learning). The last category, *Contingency*, is about

how facilitators respond to unexpected events in a lesson-study context (codes: responding to teachers' uncertainty about lesson study; deviation from the lesson plan).

METHODOLOGICAL APPROACH

Context of the study

The third author conducted the lesson-study project together with several university teacher educators (acting as facilitators), teachers and principals at two schools in the middle of Norway (2016-2023). The goal was to support the teachers' development of IBT in science and mathematics. The project's approach to IBT was inspired by the definition used in the European project, *PRIMAS*, which consists of five components (Maaß & Reitz-Koncebovski, 2013): 1) Valued outcomes that include fostering inquiring minds, preparing individuals for uncertain future and lifelong learning, and enhancing the understanding of science and mathematics. 2) A classroom culture that fosters a shared sense of ownership and purpose, values mistakes and student input, and encourages dialogue. 3) Learning environment that includes open problems with multiple solution strategies, access to tools and resources, and a focus on moving from problems to explanations. 4) Teachers must foster, value and scaffold students' reasoning, and relate to their experiences. 5) Students must pose questions, inquire into problems, and collaborate. The project used the four stages of lesson study described by Lewis et al. (2019): study a specific mathematical topic, plan a research lesson, teach the lesson and observe students' activities, reflect on the enacted lesson based on observations. Each lesson plan was enacted by two teachers with a reflection meeting in between, and both teachers and facilitators participated in all lesson-study activities.

The lesson study reported in this paper (fall 2016) included six teachers: TP (school principal), T11 and T12 (first grade), T21 and T22 (second grade), TS (special education, supporting the teachers), and three facilitators: FM (mathematics), FS and FZ (science). Previously, the school had participated in two projects focused on IBT, but of the teachers only TP had participated in those. Before the first planning meeting, the teachers suggested functional relationships as a goal of the lesson, which related to a goal in the national syllabus about "Recognize, talk about and continue structures in simple number patterns" (Utdanningsdirektoratet, 2006). The lesson plan was taught by T11 and T12 in their first-grade classrooms (students aged 5–6 years).

Data collection and analytical strategy

The data for this paper consists of audio recordings of two planning (116 and 104 min., respectively) and two reflection meetings (97 and 98 min.) and video recordings of two research lessons (each 60 min.). Moreover, the teacher carried an audio recorder around the neck, and three audio recorders were placed at student tables. All audio and video recordings were transcribed and selected parts translated into English. The authors jointly adapted the knowledge quartet and developed its initial codes to foster a shared understanding of the framework. Since the last two authors were familiar with the data,

they conducted the empirical analysis, whereafter we all discussed and refined it. In the analysis, the adapted quartet's categories and codes were used as analytical lens.

RESULTS OF OUR ANALYSIS WITH THE ADAPTED FRAMEWORK

We present our results by illustrating how each category of the adapted quartet gave insights into how the facilitators interacted and what knowledge they drew on.

Foundation

There were several examples, where the facilitators' foundation surfaced as regarding both IBT and mathematics. An example of the latter was FM's response to a teacher's use of the terms digit and number (the tasks included integers up to 20):

T22: Digit is the same as number. They [students] grasp that quickly (…)

FM: But it is important, that it is not the same, as here there will be more than one digit. Here we will have five and ten and fifteen and twenty.

FS: But it says last number.

FM: But it is not correct mathematical language (planning meeting 2).

Here, FM used his overt subject knowledge to clarify the difference between digit and number, which T22 had misunderstood. Moreover, FM also overtly drew on his foundation to emphasise use of correct mathematical terminology.

Transformation

The teachers suggested functions as the focus of the lesson study, partly because they were inexperienced with teaching this topic in the early grades. Hence, the facilitators supported them in developing ideas about how this topic could look like and how to teach it inquiry based. This is illustrated in the next extract, where FM suggested both one way to interpret the topic in these grades and relevant functional relationships:

T21: We were talking about students' initial encounter with functions. (…)

FM: The issue concerns identifying patterns and connections. Like a triangle has three edges, and there is a relationship between the number of vertices and the number of edges in a triangle. And what about a quadrilateral? A quadrilateral has four edges and four vertices. These are the type of words, concepts and figures that can be applied also in first grade [suggests further examples, such as the relationship between the numbers of hands and fingers, the numbers of dogs and their feet] (planning meeting 2).

Here, FM transformed his knowledge of functions and functional relationship by choosing examples of relationships between objects that were familiar to the teachers and their students, such as them in simple geometric figures. By giving these examples, FM conveyed images to the teachers about what teaching functions in the early grades can look like and encouraged them to reflect on similar kinds of relationships which would be relevant for first graders. In this transformation, FM's knowledge-in-action about both functions and IBT played out in terms of which functional relationships can

qualify as open problems with multiple solution strategies and, at the same time, allow first-grade students to explore mathematical relationships and reason about them.

Connections

The analysis showed that the facilitators frequently made connections to support coherence in teachers' learning across the lesson-study activities. Typically, the facilitators initiated a focus on the connections between students' mathematical thinking, lesson goals and tasks and did so in one lesson-study activity with a focus on the next. One facilitator initiated for example a discussion of potential difficulties students might face in the planning meeting and of strategies the teachers could use in the research lesson to respond to these challenges:

> FM: We should probably discuss what can be difficult with these tasks. How to meet the difficulties? What can be typical answers from students, typical mistakes or misconceptions? What can be difficult to understand? So that we have a plan for how to meet it (planning meeting 2).

Here, FM's knowledge-in-action of IBT played out. For instance, when he encouraged teachers to value students' answers including mistaken ones and supported them in building on these answers during the research lesson. Moreover, FM initiated a discussion about how to scaffold students ("how to meet it"), especially those who were challenged. Thus, rather than telling teachers about IBT practices, FM initiated such practices based on his own knowledge and experiences and tried to engage teachers in them, first during the planning and later in the reflection meeting. By creating such connections, FM tried to support coherence in teachers' learning of IBT.

Contingency

The observed instances of contingency at the facilitator level concerned unexpected events in the lesson-study context and teachers' uncertainty about lesson study as a new way to collaborate. We give examples of both. In a research lesson, T11 gathered all students in a classroom corner and launched the task as planned. In the subsequent reflection, T11 expressed uncertainty about whether the students had understood the task, and several observers confirmed that most students had not. This event was unexpected for the facilitators since the students were expected to understand their collective planned launch of the task. FM reacted by suggesting: "Would it have been possible to ask one or two students to explain the task by using their own words to see if they had understood?" (reflection meeting 1). In this response, FM's knowledge-in-action of IBT surfaced as regards the importance of creating a shared ownership and purpose of the inquiry among students and of encouraging dialogue and collaboration. Again, FM formulated his response as a proposal to be discussed with the teachers – hereby acknowledging their professionalism – and not as something they must do.

Occasionally, the teachers expressed uncertainty about being part of a lesson-study group, where one of them taught and was observed by the others. Here is one example of how the facilitators responded to this in-the-situation unexpected event:

FM: We cannot say it often enough: that it is not the specific teacher we are observing or how this teacher behaves in the classroom. We study the lesson plan that we have made together to consider, whether there are any points of improvement (reflection meeting 2).

Here, FM's knowledge-in-action about lesson study and the challenges with adapting it outside East Asia came into play. He focused on the group's joint responsibility of improving the plan, stressing that the aim was not to assess the teacher's performance. Moreover, FM's knowledge-in-action about IBT played out in his attempt to cultivate an inquiring mind among the teachers as regards their classroom teaching. Such an inquiry stance composes a new approach to professional development in Norway. To react to teachers' uncertainty about lesson study (e.g., how to enact it and its purpose) is a crucial part of a facilitator's role, at least in countries unaccustomed to lesson study.

DISCUSSION AND CONCLUDING REMARKS

We addressed our research question by using the lifting strategy to theoretically adapt the knowledge quartet to the facilitator level within a lesson-study context focused on primary teachers' development of IBT. We then tested the adapted quartet using data from a Norwegian lesson study. Based on our adaptation and analysis, we conclude that our initial lifting of the knowledge quartet seems promising both theoretically and empirically. Theoretically, the adapted categories seem to align largely with the meta-instructional role of the facilitators in supporting teachers' development of IBT. Empirically, all four categories proved productive in analysing this role in terms of how facilitators' knowledge-in-action – about mathematics, IBT and lesson study – played out in lesson-study interactions and were shaped by (and shaped) these.

Compared with other theoretical approaches, the adapted quartet is not based on the assumption, that knowledge is "located in the minds of [people]" (Turner & Rowland, 2011, p. 196), as is the case in Clivaz et al. (2023) and Gu and Gu (2016). Rather, the adapted quartet focuses on what facilitators does know and believe about mathematics and its teaching and learning (as opposed to ought to know), and how it is realised through lesson-study interactions and influenced by these dynamic contexts. Although, there are similarities with Skott and Ding's (2022) use of the original quartet, their approach did not focus explicitly on the facilitator's role in supporting teachers' learning or on how their knowledge-in-action influenced their interactions. Compared with the dialogic approaches applied by Clivaz et al. (2023) and Skott and Psycharis (in press), the adapted quartet did not fully capture facilitators' dialogical interactions with teachers, such as synthesising ideas or creating dialogic spaces. But the adapted quartet stressed other important roles, that related more closely to the lesson-study goals, such as transforming their knowledge about IBT and mathematics into pedagogical forms target teachers' learning (e.g., suggesting functional relationships that can be explored by first graders) and supporting coherence in teacher's learning (e.g., by focusing on students' mathematical thinking across lesson-study activities).

With this initial adaptation of the knowledge quartet, we wanted to contribute to developing a future tool, that facilitators can use to plan, evaluate, and strengthen their role in lesson-study interactions. As our study is limited by its focus on a single lesson-study case and the facilitator role, we suggest to further develop the framework with more lesson-study cases and examinations of links to teachers' learning opportunities. Future research could also assess the quartet's practical value for reflecting on lesson-study interactions and facilitators' knowledge, with a view to developing both.

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