



Lesson Study in Initial Teacher Education: Affordances and Constraints in Teaching Mathematics through Inquiry

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Abstract

Pre-service teachers, reading for the Master in Teaching and Learning (MTL) degree at the Faculty of Education (University of Malta), are offered an 18-hour course on how to use inquiry as a pedagogical tool to teach mathematics to secondary school students. To teach this course, a mathematics teacher educator – referred to as ‘the lecturer’ – used lesson study as a teaching methodology with pre-service teachers enrolled in the MTL during the 2022-2023 academic year. This paper will focus on the affordances and constraints that lesson study, used for the first time as a teaching and learning methodology, offered to both the lecturer and his two students. Using the theory of affordances and constraints, data analysis sheds light on how lesson study was applied and experienced by pre-service teachers, and to what extent it provided them with learning opportunities. The aim of this paper is to critically analyse outcomes that could prompt a discussion around why lesson study might be a useful and promising approach in initial teacher education (ITE). This paper will delve into the lesson study model adopted by ‘the lecturer’, the existing knowledge of pre-service teachers and their disposition towards lesson study and inquiry teaching, and the influence of the course and the school context on their enactment of lesson study and inquiry teaching.

Keywords: *Initial teacher education; inquiry teaching; lesson study; mathematics education; pre-service teacher education; teacher professional development*

1. Introduction

As lesson study gains popularity [1], this paper explores the benefits and challenges of using it as a methodological tool in an initial teacher education (ITE) course and its potential to enable pre-service teachers in learning to teach mathematics through inquiry. The paper focuses on learning experiences of two pre-service secondary school teachers. Their experiences and learning about inquiry teaching is understood to depend on the potential for action that lesson study has as a teaching methodology, pre-service teachers’ dispositions for collaboration and learning, and the affordances and constraints that the course and the school contexts have on these teachers’ enactment of lesson study.

2. Lesson study

Lesson study, a professional development model that has its roots in Japan, is a collaborative approach whereby teachers work together to develop their knowledge about teaching [2]. It typically involves a lesson study team which is made up of a small group of teachers (2 to 6), from the same or from different schools, and who are led by a lesson study facilitator – a person who is knowledgeable about the lesson study process. Following the lesson study team’s identification of an issue with teaching, the lesson study process would typically include four main phases – studying, planning, doing and reflecting [3].

For teachers of mathematics, the prominence within lesson study is teaching through problem solving (TTPS) [4]. In TTPS, teachers typically present students with a challenging problem and provide opportunities for students to solve the problem through discussion and to come up with possible solution strategies that are then shared and discussed with the whole class.

As [5] argues, there is more to lesson study than just planning a lesson and observing it. Lesson study involves team members in posing a research question, doing research and reflecting along the process. Hence, while identifying a common and desirable lesson objective is crucial, for the lesson study team the central focus should be student learning [3].



3. Teaching mathematics through inquiry

Across the literature, inquiry is a contested term used in different ways and contexts to describe student-centred teaching [6] which includes active, problem-based and investigative approaches to learning mathematics. An essential feature of student-centred approaches to teaching mathematics is the use of cognitively demanding tasks [7]. Student-centred teaching typically involves the teacher presenting a task at the beginning of the lesson. This is often followed by some student exploration of the task, and ending with a whole-class presentation and discussion of student-generated solutions. Inquiry is a multifaceted activity based on student-centred and collaborative learning for the development of students' higher-order reasoning. Teaching mathematics through inquiry, hence, requires that teachers involve students in problem solving with others [7] and, through this process, provide students with thoughtful support and scaffolding at different stages of the inquiry process [7].

4. The theory of affordances and constraints

Within a system (which, for pre-service teachers, can be a course and/or their school context), affordances provided by the environment are preconditions for activity and opportunities for action. In other words, affordances delineate what the environment offers, what it provides, furnishes and invites for interaction, behaviour, action and learning to take place. Affordances describe the environment (e.g. a lecture setting or a secondary school classroom) in terms of behaviours that are possible at a given moment under a given set of environmental conditions. Conditions within the environment are seen as limitations to allowable actions. [8] uses the term constraints on affordances arguing that constraints do not infer negative connotations. Constraints, which refer to a boundary or guide, are complementary and necessary for action to take place. Generally speaking, members of a community (e.g. of a course or a school) carry their own perception of potential for action. This perception, which is relative to the setting and conditions within that environment, depends on their knowledge, skills and dispositions.

5. Research context

5.1 Initial teacher education at the University of Malta

Since 2016 the Faculty of Education at the University of Malta, which is one of the main providers of ITE, offers a two-year full-time Master in Teaching and Learning (MTL) course or a three-year part-time MTL course. These MTL courses can be pursued only after a candidate has obtained a first-cycle degree in a subject area or a related area of the curriculum.

5.2 Lesson study in Malta

Similar to countries outside Japan (e.g.: Portugal and the UK), in Malta lesson study is initiated at university level [9], through the Collaborative Lesson Study Malta (CLeStuM – www.clestum.eu) programme. While members of CLeStuM usually take the role of lesson study facilitators, other academic members from the Faculty of Education are usually invited to act as knowledgeable others. The lesson study process adopted in Malta, which can vary according to the context in which lesson study is enacted, usually involves five key stages – (1) the lesson study team first identifies a research problem; (2) the team plans a detailed lesson which addresses the research problem; (3) the lesson is taught by one of the teachers and observed by the rest of the team members who collect data about the research problem; (4) a post-lesson discussion, which includes reflections on the observed lesson and an analysis of the data collected, is held; and (5) finally, the team prepares a report of their lesson study journey to share the findings with members of the school community and beyond [9]. The lesson study process usually takes between 6 to 8 weeks and typically involves participants in weekly face-to-face meetings with their lesson study facilitator (in most cases, a role undertaken by one of the CLeStuM team members).

5.3 Lesson study and the MSM5002 course

Lesson study has been used for the first time in academic year 2022-2023 as a methodology in teaching the 'Inquiry and Assessment in the Mathematics Classroom' (MSM5002) course (see <https://www.um.edu.mt/courses/studyunit/MSM5002>) with pre-service secondary school teachers of mathematics. Lesson study was intended to serve as a tool which could provide pre-service teachers with a bridge between theory and practice through a practice-based experience of inquiry teaching.



The MSM5002 course, scheduled in the first semester (November 2022 to January 2023) of the first year of the MTL, is taught over a period of nine two-hour lectures held weekly. It adopts a blended practice-based approach of face-to-face and online lectures. Learning for these pre-service teachers takes place both at University and at their school placement. Hence, at their school, pre-service teachers hold meetings with a team of mathematics educators to plan their lesson study. The lesson study model, adopted in this MSM5002 course, requires pre-service teachers to work within a team made up of: (1) 'the lecturer' (a mathematics educator acting as the lesson study facilitator); (2) a teacher mentor who assists pre-service teachers in their planning, teaching and evaluation of a mathematics inquiry lesson; and (3) a teacher colleague and/or a school leadership team member.

6. Methodology

A case study approach [10] was considered appropriate to bring forth the experiences and insights of the two pre-service teachers (Beth and Pam, both pseudonyms). At their present schools, Beth and Pam were supply teachers as they had neither a teaching qualification nor experience. At the University of Malta, they had just started their first year of the MTL in mathematics on a part-time basis. The analysis, drawing on the course participants' lesson study journey in learning about inquiry teaching, involved qualitative data collection methods. These methods included a *personal journal* in which they wrote down reflections about the experiences, achievements, challenges and dilemmas they faced. They also participated in an end-of-course online *survey* and a one-hour online *focus group* discussion. Data was analysed through inductive coding and using a thematic approach to generate emergent themes [11]. Three main themes, related to the affordances and constraints on pre-service teachers' implementation of lesson study, emerged from the data analysis.

7. Findings

Prior to the MSM5002 course, Beth and Pam were unaware of lesson study and what it would involve. Also, for them, inquiry was a novel approach to teaching mathematics and MSM5002 happened to be the first course which required them to design resources (for example, a mathematical task and a detailed lesson plan) which they then would need to put into practice. Notwithstanding the challenges, they felt that, 'unless teachers try it out' (Beth, survey, February 2023) they cannot realise the benefits of collaboration, detailed planning and teaching through inquiry.

7.1 Collaboration supported lesson planning for inquiry teaching

For Beth and Pam, the support received from the lecturer, their mentors and school colleagues were essential, not only in terms of their learning about lesson study but, more importantly, about inquiry teaching. Discussions with the lesson study team members provided the pre-service teachers with opportunities 'to learn from more experienced colleagues (Pam, survey, February 2023) through 'feedback on the lesson plan and suggestions for improving the teaching' (Beth, survey, February 2023). The two pre-service teachers commented that, since they started teaching, they had 'planned many lesson but never got any feedback' (Beth, personal journal, January 2023). In this regard, the mentors, with whom both 'had built a strong relationship' (Pam, personal journal, December 2022), played an essential role. For Beth, who initially felt that doing a lesson study was going to be an overwhelming task, ongoing discussions with the mentor provided her with 'guidance and teaching ideas' (survey, February 2023) that, eventually, facilitated her lesson planning.

Pam, who was unsure what planning a lesson in lesson study involved, felt that the planning phase required more work than when planning one of her usual lessons. In her words, 'the lesson plan in lesson study involved an in-depth study of a lot of things' (Pam, focus group, January 2023) and 'required a lengthy process ... like you are forming a story where one thing leads to another' (Pam, survey, February 2023). Beth, on the other hand, reflected on the benefits of lesson study and felt that doing a lesson study, so early in her career, was beneficial as it gave her insights about what to keep in mind for future lesson planning.

7.2 Inquiry as a teaching approach to stimulate student learning

Pam realised that, through inquiry, she could engage her students more actively in learning mathematics. According to her, 'instilling curiosity at the start of a lesson' (focus group, January 2023) is imperative. For example, she thought that 'presenting a scenario and getting students hooked' could



stimulate them to think (focus group, January 2023) and, within small groups, help them explain and discuss ideas. Similarly, Beth said that what she has learned is to 'start the lesson by encouraging and eliciting students' ideas ... engage them also in thinking and sharing ideas' (focus group, January 2023). As teachers, the lesson study methodology helped them shift from giving answers and instead 'learn how to question students and allow them with time to think' (Beth, survey, February 2023). Lesson study, hence, got her 'to experience a different style of teaching ... to move out of the comfort zone and see student learning differently' (Pam, survey, February 2023). Also, studying a lesson from students' point of view helped Beth to 'identify possible stumbling blocks' (survey, February 2023).

From the start of the course, even Beth felt that inquiry was an important teaching approach to help students make mathematical connections and, hence, develop a deeper understanding of mathematics. She mentioned how in her observations she 'could see that the class with whom she did the lesson study could make a clear link between the equation of the line and the sketching of the graph and provide justifications, when compared to her other classes' (Beth, focus group, January 2023). For her, this connection on the part of students made her happy as she could see that her efforts to plan an inquiry lesson generated a positive learning outcome for her students. Moreover, these students eventually requested more of the inquiry type lessons. She also discovered how through inquiry a teacher may cover less content which students would, however, understand better.

Their main challenges revolved around orchestrating the final whole-class discussion, during which students present their work and, then, the teacher summarizes the main points arising from the discussion [7]. For Beth, responding to students' ideas was challenging as she still needed 'to learn how to lead a discussion' (focus group, January 2023). Pam agreed that the whole-class discussion was a crucial part of the lesson and she needed 'to get it right' (focus group, January 2023).

7.3 Unpreparedness for lesson study and perceived limitations

Lesson study and its process were new to Beth and Pam. Initially, lesson study looked 'a big thing and pretentious' (Beth, focus group, January 2023), particularly because these two pre-service teachers were new supply teachers with no experience of teaching and no teacher education. Both mentioned that initially they were sceptic about how lesson study could work and perceived many limitations.

A main challenge for both was choosing a topic which they could teach through inquiry. For Pam, who planned to do her lesson study with a Year 7 class (12-year olds) who had just started secondary school, the issue was the limited mathematical content covered. Besides, she also envisioned to encounter classroom management issues related to this being her first time using group work with her students. Due to her perceived lack of control resulting from the more collaborative classroom setting, she feared students would be 'distracted by the surrounding environment, being noisy and misbehaving' (focus group, January 2023). Moreover, she struggled to include creativity 'in such a way to make the lesson fun' and feared that she 'might not be able to come up with open-ended inquiry questions' and then 'to direct students to the lesson objectives' (personal journal, December 2022).

Following this experience, pre-service teachers made suggestions for improving the course. For example, they suggested a lesson study time-frame that was longer than the set 9-week period in semester one. According to them, the lesson study process could be carried out over more weeks and possibly in semester two where they felt they could be more prepared for it and when their 'course exams would be over' (Pam, focus group, January 2023).

Also, while they found the resources (literature on inquiry teaching and lesson study and the videos of groups of mathematics teachers engaged in a lesson study) useful, they still felt that some of the lesson study phase (e.g., the teaching and the lesson observation parts) were new to them and posed challenges. For example, they suggested having two teaching trials of the lesson – in the first trial pre-service teachers could 'observe a more experienced teacher doing the teaching' (Beth, survey, February 2023) and then they would be the ones doing the teaching. Pam also suggested to 'include an observation of a lesson prior to planning a lesson study'. According to her, this 'would allow pre-service teachers to observe both the teacher carrying out the lesson study and the students and this, in turn, would then 'help them understand better how they should plan their lesson' (survey, February 2023).



8. Discussion and conclusion

For the two participants, lesson study and inquiry teaching were novel approaches. Acknowledging that lesson study is a robust, yet complex, process for teacher learning [9] [12], this study sought to investigate the affordance and constraints that lesson study, which was used for the first time as a methodological approach to teaching an ITE course, had when used within a pre-service teacher education course about inquiry teaching.

The lesson study model, which involved 'the lecturer' as the facilitator and the pre-service teachers working closely with their mentors and a school colleague, offered both learning opportunities as well as challenges. Learning was mostly generated from the ongoing collaboration and discussions that the two pre-service teachers had with members of their lesson study teams, but especially their mentors. Also, although identified as challenging, the planning and teaching of an inquiry lesson supported pre-service teachers' understanding of inquiry teaching. Being their first ever experience doing a lesson study and teaching an inquiry lesson, a main challenge was pre-service teachers' lack of knowledge about these two methodological tools and their roles in lesson study (namely choosing a topic for the lesson, planning, teaching and observing the lesson). Hence, these pre-service teachers suggested that modelling experiences of, for example, observing an inquiry lesson prior to their involvement in it, would serve to provide knowledge and overcome their initial fears of engaging with 'the unknown' (lesson study and inquiry teaching). The implication is that, when novel approaches to teaching are introduced, these need to be accompanied with ongoing, targeted and just-in-time support [13].

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