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► To cite this version:

Mercy Kazima, Janne Fauskanger, Arne Jakobsen. From instrumental to relational – Malawi mathematics teacher educators’ research lessons. Eleventh Congress of the European Society for Research in Mathematics Education, Utrecht University, Feb 2019, Utrecht, Netherlands. hal-02422565

HAL Id: hal-02422565

<https://hal.science/hal-02422565>

Submitted on 22 Dec 2019

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From instrumental to relational – Malawi mathematics teacher educators’ research lessons

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This paper discusses the type of research lesson planned by mathematics teacher educators participating in a lesson study cycle. An earlier study found that mathematics teacher educators’ research questions were not clearly formulated and as a reason, their initial lesson plans for research lessons did not make student teachers’ learning visible. This follow up study analysed the lesson plans further before and after comments from knowledgeable others and looked into the type of lesson planned to be conducted, with the hypothesis that the type of lesson would determine the type of student teacher learning made visible. Data in form of lesson plans were collected from five teacher education colleges. Theory driven content analyses was used and Skemp’s (1976) categories of instrumental and relational teaching were the point of departure. The findings include that the initial lesson plans were mostly presenting instrumental type of lessons, but after comments from the knowledgeable others, the revised lesson plans were presenting a more relational type of lessons with student teachers’ learning more visible.

Keywords: Malawi, mathematics teacher education, lesson study, type of research lesson.

Introduction and background

Lesson study is a new concept in Malawi teacher education and it is also relatively new in Malawi education as a whole. Lesson study was introduced to mathematics teacher educators in all public primary teacher education colleges as a form professional development and as part of a five year project which aims at improving the quality of mathematics teacher education in Malawi (Kazima & Jakobsen, 2018). The project is wide and professional development of mathematics teacher educators is one out of five components. In the project, we decided on using lesson study as a model for professional development because lesson study offers the opportunity for the teacher educators to work together and to study and learn from their own teaching. Since it was the first experience of lesson study in Malawi teacher education, we developed a research project, alongside the professional development, to study the teacher educators’ understanding of lesson study. The research was informed by previous studies of lesson study outside Japan as discussed below. The findings from our first study (Fauskanger, Jakobsen & Kazima, 2018) prompted us to do this follow up study where we ask the following research question: Which type of research lesson do Malawi teacher educators plan in their first experience with lesson study? Details are discussed in the

following sections. First, we situate our study by discussing relevant previous research on the use of lesson study in new contexts outside Japan.

Lesson study originated from Japan where it has been practiced for more than a hundred years. It is so much part of the teaching profession that it is like air to teachers in Japan (Fujii, 2014). Studying own teaching and learning from students' learning is key to lesson study in Japan, thus having a clear research question and carefully planning a research lesson that reveals students' learning are important aspects of Japanese lesson study (Takahashi, 2013). Due to its success in Japan, lesson study has been introduced to many other contexts outside Japan and many report on benefits that are experienced by teachers or student teachers that participated in the lesson studies (da Ponte, 2017). However, many also report on challenges that participants experience when implementing lesson study for the first time. There are at least four related challenges that inexperienced participants face. First, they do not always see the importance of a research question as a starting point for planning their research lessons (Bjuland & Mosvold, 2015; Fujii, 2016). Second, they often overlook the importance of predicting students' responses (Lewis, Perry, & Murata, 2006). Third, they do not emphasise on planning focused observation of students' learning (Bjuland & Mosvold, 2015, Fujii, 2016). Fourth, they do not plan for teaching activities in order to make students' learning visible (Bjuland & Mosvold, 2015).

Lesson study in Africa has been reported used in a few countries including Malawi, Uganda and Zambia (Fujii, 2016, Ono & Ferreira, 2009). In these three countries, the reported lesson study was initiated by some Japan related initiatives supported by the Japan International Consultative Agency as part of aid towards the education sector. Fujii (2014) studied the lesson study in Malawi and Uganda schools and revealed a number of misconceptions among the teachers implementing the lesson study. Some of the misconceptions were that the teachers did not distinguish lesson study from workshop. The after teaching discussion often focused on the teacher and how the teacher can improve and not necessarily on students' learning. He also found that re-teaching of the research lesson was taken as necessary regardless of the outcomes of the first teaching. These misconceptions illustrate further the challenges of introducing lesson study to new context outside Japan.

In more recent years, there has been growing use of lesson study in teacher education. Larssen et al. (2018) report from a review of lesson study in teacher education where they found that there were variations in the way lesson study was adapted to new contexts, for instance, how observations were conducted. This emphasizes the challenges of lesson study when introduced to inexperienced participants in new contexts.

Methodology

Data were collected within the professional development that was designed for the Malawi mathematics teacher educators by the wider project. For the purpose of this paper, the lesson plans analysed are produced by all mathematics teacher educators at five teacher education colleges. Two teacher education colleges participated in the first year, and three participated in the second year. The professional development started with a three day workshop that introduced the teacher educators to lesson study. The teacher educators were also introduced to concept study of

multiplication and fractions, the two concepts which the teacher educators suggested they find most difficult to teach and would like to research on. During the three days, the teacher educators also worked in groups and started designing their research lesson. The three authors of this paper facilitated the workshop and acted as knowledgeable others in discussing the planned lesson study. After the workshop teacher educators from each teacher college continued working together drafting their initial lesson plan, before it was sent to the knowledgeable others for comments. The knowledgeable others provided comments and encouraged the teacher educators to revise and improve their lesson plans. The process from the introductory workshop to final lesson plan took at least about four months (May-September). In this study, we collected all initial draft lesson plans and final lesson plans after revisions.

The lesson plans were analysed using theory driven content analysis (Hsieh & Shannon, 2005). The first study drew from literature and focused on three aspects of research question, prediction and observation (Fauskanger, Jakobsen & Kazima, 2018). In this follow up study, we draw on Skemp (1976) and use the two categories of teaching mathematics (i) instrumental and (ii) relational as the point of departure. Skemp (1976) divided teachers' mathematical understanding into two divergent categories: (i) Instrumental understanding—a lower version of understanding—for example rote memorization of algorithms and (ii) Relational understanding, which encompasses a deep, conceptual understanding. When relating his framework to teaching, Skemp (1976) suggests that a teacher who teaches from an instrumental paradigm cannot produce students who learn mathematics relationally. More recent studies confirm that conceptual and connected mathematical knowledge is a premise for conceptual teaching (Tchoshanov, 2011). This highlights the importance of studying whether Malawi teacher educators' research lessons tend to be of 'the type' instrumental or 'the type' relational.

Results and discussion of findings

Teacher College A

The research lesson plan from Teacher College A focused on multiplication of two-digit numbers using different strategies. In their initial lesson plan draft, the teacher educators planned that student teachers would be asked to use as many strategies for multiplying two-digit numbers as possible, and then later share their strategies with the rest of the class. Then student teachers would work in groups to critique the different strategies that were presented. The research lesson was planned to be an instrumental understanding type of lesson (Skemp, 1976) because the emphasis was on the strategies or algorithms and on how to perform the algorithms. There was no explicit emphasis on understanding why the strategies would work, thus the research lesson focused on what to do and not the reasoning behind the strategies. In Skemp's (1976) words, the lesson seemed to be about 'rules without reason'. However, there were opportunities for relational understanding (Skemp, 1976) where the lesson plan suggested that student teachers should present their work on the chalkboard. The interaction that could go on between the student teachers presenting their work and the rest of the class could include explaining how as well as why their strategies work. Another opportunity was where the student teachers were going to be asked to critique the different strategies presented for multiplying two-digit numbers. This could include discussions of the

mathematical reasoning behind each strategy. The lesson plan was silent on this and therefore in the enactment of the plan the teacher educators could easily miss the opportunity.

Comments from the knowledgeable others were explicit in pointing out that explanations of reasons why the strategies work should be included in the plan. For example they commented:

(...) one important point is not only to ask them [student teachers] to demonstrate how to solve [the tasks] using their own strategy, but to explain WHY their strategy/algorithm work – this is important. For example, many of the algorithms use the [distributive] property that $67 \times 28 = (60 + 7) \times (20 + 8)$ and then different ways of multiplying the parenthesis is behind the algorithm. (...) So we propose to ask them [student teachers] to demonstrate and explain why the algorithm work.

After revision, Teacher College A's lesson plan included suggestions from the knowledgeable others in that it was explicit that student teachers will be required to give reasons for why their strategies would work. As an example, the teacher educators added to the goals of the lesson the statement: "student [teachers] will explain why different strategies work." The lesson structure also changed from focusing on student teachers practicing different strategies of multiplying two-digit numbers to student teachers' understanding of, and reasoning behind, the different strategies of multiplying two-digit numbers. The teacher educators wrote in the revised plan that they "want students to understand and appreciate that there are a variety of strategies when multiplying numbers and reasons why these algorithms work." In relation to evaluation, the teacher educators wrote "[a]re student [teacher]s able to justify their strategies" as one of their criteria for evaluating their research lesson. This indicates that the revised lesson plan was not only focusing on the 'what' to do when multiplying two-digit numbers, but also on the 'why', thus a movement towards a relational understanding (Skemp, 1976) type of lesson.

Teacher College B

The first research lesson plan from Teacher College B, started with a demonstration by the teacher educator on how to represent multiplication of mixed numbers using paper as a resource. This was followed by the teacher educator asking the student teachers to work in groups and come up with other resources they can use for modelling the same multiplication and finally for the groups to demonstrate their representations to the rest of class. The lesson had the potential to be relational if the groups' demonstrations and discussions of their representations included justifying why their representations would work. However, the lesson plan did not indicate that such discussions would take place. Without the justification and mathematical explanations of why the representations work, then the lesson would be only for instrumental understanding with student teachers copying what the teacher educator did without much understanding. Comments on this first draft of the lesson plan from the knowledgeable others were explicit in suggesting that the teacher educator should not demonstrate and let student teachers copy their procedure, but rather should ask student teachers to do the task as a problem solving activity. The knowledgeable others wrote:

... before demonstrating, you are recommended to invite the students to solve the problem. Only if you invite them to find solutions by themselves, you will be able to learn about their strategies.

It would also be interesting if you started the lesson with a more open problem for the students to solve. Problem solving makes it easier for you to observe students' strategies and their learning.

This change in focus has the opportunity to make the research lesson become a relational understanding type of lesson (Skemp, 1976). The knowledgeable others also commented that the lesson should not only focus on modelling and how to do the different representations using various resources but should also emphasise why each of the representations works. The teacher educators at College B revised their research lesson plan and implemented the suggestions from the knowledgeable others. The revised lesson plan started with the teacher educators presenting a mixed number multiplication problem and asking the student teachers to work in groups and to investigate possible resources they can use to model the mixed number multiplication. This change from demonstrating for the student teachers to asking them to investigate in a problem solving manner, made the lesson shift from the instrumental lesson it was at first to a relational type of lesson. The rest of lesson plan, however, was still not explicit on soliciting justifications and mathematical explanations for the resources and modelling presented by the student teachers. Thus, the research lesson could still miss opportunities for more relational understanding by student teachers.

Teacher College C

The initial draft lesson plan from Teacher College C was for a research lesson that started by asking student teachers to model addition of two fractions with the same denominator. According to the lesson plan, this was something that the student teachers had done in the previous lessons. The lesson proceeded to group activity of modelling of addition of fractions with different denominators with step by step instructions from the teacher educator. The lesson was an instrumental understanding (Skemp, 1976) type of lesson because the student teachers could have easily completed all the tasks by following the instructions without understating the mathematical reasoning behind the procedures. Comments from the knowledgeable others suggested changes that could lead to a more relational type of lesson, but were not explicit on this. For example, where teacher educators wrote that they intended to invite the student teachers "to model addition of $2\frac{3}{5} + 1\frac{1}{2}$ using papers ... [using] the following procedure – model whole's i.e. 2 and 1 by ensuring that the size [of the whole] is the same." The knowledgeable others commented that: "you can let the student teachers reflect on this and not tell them immediately that the size (area) has to be the same - so this can also be a point of observation. Do the student teachers understand that the size has to be the same?"

Although not explicit, the knowledgeable others suggested that student teachers should not be told immediately what to do but should be left to first think for themselves and find their own strategies of solving the problems presented. This was important because it could shift the instrumental lesson to a relational lesson, and it could also offer opportunities for teacher educator to observe student teachers' learning.

The revised research lesson plan by Teacher College C took the advice of the knowledgeable others. The revised lesson plan was a relational type of lesson because the teacher educator posed the questions to the student teachers and allowed them to find solutions without giving the step by step instructions. The lesson plan also included prompts for asking the student teachers to explain their

solutions. For example, the teacher educators wrote that they would ask the student teachers to “explain their solution strategies to the class” and to “facilitate student [teacher]s’ discussion on their solutions in order to understand ideas behind the solutions.” These changes have the potential to bring out student teachers’ reasoning and justifications for their solutions into the lesson, and might result in a relational understanding type of lesson (Skemp, 1976).

Teacher College D

Teacher College D’s research lesson plan was on division of fractions. Their initial lesson plan started with a demonstration by the teacher educator modelling division of two fractions using the number line. This was followed by an activity for student teachers to do in groups. The activity was another example of division of two fractions and student teachers were to model using number line in the same way as demonstrated by the teacher educator. Finally, there were more exercises for the student teachers to practice. The student teachers could do these activities by copying the teacher educator’s example without much understanding. This was a typical instrumental type of lesson where the teacher educator demonstrates an example and the student teachers observe and later imitate and copy the process on other examples. Comments from the knowledgeable others suggested that the teacher educators should not demonstrate how to model the division of fractions on the number line, instead should just pose the question to the student teachers and let them think and come up with their own ways of modelling the division; “This might be a nice way to start the lesson ... if you start with a more open approach, it is easier to observe students’ thinking”. The teacher educators were also challenged to think more carefully about the pairs of fractions they use as examples or tasks in the division of fractions lesson because some pairs of division are easier to model than others. For example the knowledgeable others wrote: “This [referring to $1\frac{1}{5} \div 1\frac{1}{6}$] is really difficult to model. Why have you chosen these fractions for the students to model on the number line? You are recommended to think carefully about which fractions to use and in what order”.

In reaction to these comments, the teacher educators revised the research lesson plan to a more relational type of lesson. The revised lesson plan started with easier fractions to model and posed the question to student teachers to work in groups and find ways of modelling the division of given fractions. The group activity was followed by individual work where student teachers were asked to model more division of fractions tasks. This lesson had the opportunity to be a relational type of lesson because the student teachers would not be told what to do and copy, instead they would be invited to think, discuss and to find ways of solving the problems. However, the lesson plan did not emphasise on student teachers justifying their solutions or explaining their reasons, therefore these could be missed and that would make the lesson less relational than it could be.

Teacher College E

The research lesson by Teacher College E was on modelling multiplication of mixed numbers. The initial draft lesson plan was the only one of the five initial lesson plans that presented a relational understanding type of lesson. The lesson plan started by posing a problem; to model of $3 \times \frac{1}{2}$, for student teachers to do without giving them steps of procedure to follow. The lesson plan also included asking questions that would seek student teachers’ understanding of mathematical

reasoning behind the tasks. For example, they wrote: “Ask student [teacher]s to explain the meaning of $3 \times \frac{1}{2}$ ” and “Encourage student [teacher]s to demonstrate and explain their solutions.” The whole research lesson was structured in four parts as follows: (i) introduction, (ii) posing the problem, (iii) individual problem solving and (iv) discussing student teachers’ solutions. This might result in relational understanding lesson because students would be made to ‘problem solve’ and discuss their solutions, thus they would understand the strategies as well as the mathematical reasoning behind the strategies.

Comments from the knowledgeable others further encouraged the relational understanding type of lesson although not explicitly. For example in response to the lesson plan’s point of evaluation that stated “Do students understand the meaning of $3 \times \frac{1}{2}$ ”, the knowledgeable others wrote: “How will the observers observe if the students understand? Through listening to discussions? Through analysing their written work?” This was suggesting that the teacher educators should be more specific in the activities that would display student teachers’ relational understanding. However, there was no revised lesson plan from Teacher College E.

Summary and conclusion

Table 1 summarises the type of lessons from the five teacher education colleges.

Initial draft plan	Final plan
4 (out of 5) research lesson plans mostly instrumental types of lessons and following the common general format: <ul style="list-style-type: none"> - Teacher educator demonstrating example - Similar activity for student teachers - Class discussion - Conclusion 	All 4 lesson plans more relational types of lessons more focused on student teachers and their learning. General format changed towards: <ul style="list-style-type: none"> - Teacher educator posing problem - Student teachers use their own methods to solve problems - Teacher educator observing student teachers - Student teachers discussing their solutions to problems
One lesson plan of relational type of lesson: <ul style="list-style-type: none"> - Problem solving approach 	Lesson plan not revised

Table 1: Summary of type of lessons by the 5 teacher colleges

Looking at all five teacher colleges, our analysis indicates that four of the five colleges initially had instrumental type of research lesson in their plans for the research lesson while only one college had a research lesson plan indicating a relational type of lesson. After comments and encouragement from the knowledgeable others to think about student teachers’ learning and about how to make this learning visible in the research lesson, all the four lesson plans improved and became more relational type of lessons. This suggests that focusing on how to make student teachers’ learning visible when planning research lessons can shift a lesson plan from an instrumental type to more relational type of research lesson. A relational type of lesson, which allows problem solving by the

student teachers, enables student teachers' learning to be visible and therefore more appropriate for observation of student teachers' learning in lesson study. To plan such a lesson is however, challenging (Bjuland & Mosvold, 2015). The finding that the type of research lesson improved to make student teachers' learning visible suggests that lesson study has the potential to be a useful model for teacher educators' professional development in Malawi. . The study informs further work and other researchers in the field of lesson study the important role of knowledgeable others (Takahashi, 2013) for newcomers to lesson study and one important implication for future research would be to learn more about this role.

Acknowledgment

The study was kindly funded by the Norwegian Programme for Capacity Building in Higher Education and Research for Development (NORHED).

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