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Malawi mathematics teacher educators' understanding of Lesson Study

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Abstract

Purpose – The purpose of this paper is to better understand the challenges involved in introducing Lesson Study (LS) into teacher education in Malawi by studying mathematics teacher educators' (TEs') understanding of planning for LS.
Design/methodology/approach – This study is a part of a wider ongoing project designed to improve the quality and capacity of mathematics teacher education in Malawi. One of its components is professional development of all mathematics TEs in Malawi using an LS model. The units being analyzed comprise of the TEs' written lesson plans and qualitative content analysis is the chosen analytical approach.
Findings – Based on the analyzed research lesson plans, the TEs have difficulty in focusing on their own learning parallel to the student teachers' (STs') learning, and struggle with predicting STs' responses to tasks. In addition, there is a pervasive lack of emphasis on planned and focused observation of STs' learning, as evidenced by a review of the research lesson plans.
Research limitations/implications – This is a small-scale study due to LS being introduced to Malawi teacher education for the first time and the need to test before possible upscaling.
Practical implications – The paper includes a description of mathematics TEs' understanding of LS in an African context, which can be a valuable information for TEs who are attempting to use LS.
Originality/value – This paper fulfills an identified need to learn more about TEs' understanding of LS worldwide.

Keywords Malawi, Lesson Study, Teacher education, Mathematics, Lesson plans

Paper type Research paper

Introduction

Originating in Japan, Lesson Study (LS) as a vehicle for teachers' professional development (PD) has been implemented in many countries around the world (e.g. Lewis *et al.*, 2006). The LS traditionally focused on how teachers can deepen their understanding of students' learning and on how this understanding can positively affect the quality of their teaching (e.g. Dudley, 2014; Lewis and Hurd, 2011). In the last few decades, LS has been introduced in mathematics teacher education (e.g. Suh and Fulginiti, 2012). As the use of LS outside of Japan becomes more common, it is evident that some central components are not easily transferred into the new contexts (e.g. Cheung and Wong, 2014; daPonte, 2017; Fujii, 2014; Xu and Pedder, 2014). As such, exploring implementations of LS in contexts outside Japan is important.

At the heart of LS are the two processes of learning and observation (Dudley, 2014). Larssen *et al.*'s (2018) literature review of LS in teacher education revealed that LS changes and adaptations to different contexts are present in the conduct of LS cycles (Wood, 2018) as well as in the discourse of researchers within the field. As an example, they found that there was no universally held understanding of the process of observation, how it should be conducted, and who or what should be the principal focus of attention. Larssen *et al.* (2018) highlighted the need to be rigorous in how LS adaptations for use in teacher education are described and discussed. Based on another review of research on LS in secondary teacher education, daPonte (2017) concluded that, in order to better understand adaptations of LS in new contexts, future research needs to have a critical perspective on LS. This is also a conclusion from Cheung and

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Wong's (2014) review. The studies reviewed by these authors showed positive effects of LS on teaching, learning or both. However, due to insufficient evidence used when answering the questions "Does Lesson Study work?" and "How does it work?" further studies of participants' understanding of important aspects of LS are warranted.

According to Xu and Pedder (2014), only two studies conducted in the African context were published between 2001 and 2013. Our review, however, found studies of LS used in schools in some African countries (e.g. Coe *et al.*, 2010; Ono and Ferreira, 2009), and more research has been published since 2013 (e.g. Fujii 2014, 2016; Msonde and Msonde, 2017). Similar to Xu and Pedder (2014), we found that the focus of attention is not teacher education, but rather PD for in-service teachers. Thus, conducting further research on LS in teacher education in African countries is important. In addition, research on LS as a vehicle for mathematics teacher educators' (TEs') PD is scarce (see the next section), not only in Africa, but all around the world. Motivated by these gaps, in this paper, we set out to answer the following research question:

RQ1. How do mathematics TEs in Malawi understand LS and intend to conduct their research lessons in their teacher training colleges (TTCs)?

We discuss the findings of a study that explored how TEs in Malawi understand LS and how they intend to implement the LS in their teaching at TTCs. Before we present and discuss our findings, we will situate our study in the context of extant literature in the field and will present our methodological approach.

LS – affordances and challenges

In the USA, LS seems to be implemented without a deep understanding of the method (Lewis *et al.*, 2006). This might relate to misconceptions about LS in contexts outside of Japan (e.g. Fujii, 2014). The processes of learning and observation are important in LS cycles (e.g. Dudley, 2014), and it seems that certain aspects of these two processes are particularly challenging for those new to the LS (Larssen *et al.*, 2018). Some recent studies point to challenges in implementing LS in schools as well as in teacher education. For instance, based on his investigation of implementing LS in Malawi and Uganda, Fujii (2014) concluded that teachers have several misconceptions about LS. One misconception – resulting in a lack of focus on the improvement of teaching – is that the teachers do not distinguish LS from a workshop. Another challenge relates to the writing of a lesson plan – an important part of LS, necessary for scaffolding teachers to maintain focus on teaching and not on the teacher – not being fully understood in these contexts. The third challenge relates to the concepts in focus. Fujii (2014) contends that a careful study of the topic should enable teachers to distinguish between concepts that are more or less significant. The African teachers included in his research, however, seemed to treat all concepts included in structured problem-solving lessons as equally important. These findings reported by Fujii (2014) confirm the need to further explore planning for LS.

In a more recent study, Fujii (2016) finds that teachers' collaborative work on developing lesson plans is under-appreciated when LS is adopted outside Japan. Fujii (2016) suggests that a possible reason behind this outcome is that the effort involved in creating lesson plans for a research lesson is invisible to the outsiders. He identified some key features of the planning process important for educators seeking to improve LS outside Japan. The most important features are task design and the flow of the research lesson. In correspondence with findings pertaining to the Norwegian context (Bjuland and Mosvold, 2015), Fujii (2016) asserts that a research question is not always a point of departure when inexperienced LS participants develop a research lesson. Absence of research question results in lack of emphasis on planned and focused observation of students' learning. Another challenge resulting in lack of observation of students' learning, found by Bjuland and Mosvold (2015), is that the mathematics research lesson is not implemented in order to make students' learning visible.

According to Fujii (2014), the challenges of adapting LS to new contexts might be related to differences in what is valued in different educational contexts, due to which LS is interpreted according to the new context. Lack of focus on the written research lesson plan including, for instance, a research question and carefully selected tasks and examples. This is also highlighted by Grimsæth and Hallås (2015), who noted that it is difficult for Norwegian teachers to provide constructive critique during colleagues' teaching. As a result, the teachers' discussions tend to be descriptive, rather than analytical. Skott and Møller (2017) report on similar results obtained in the Danish school context. These researchers argue that their results relate to the Danish teachers' culture, where teachers tend to work individually.

Prediction of students' responses is regarded as a crucial element of LS. In a study by Munthe *et al.* (2016), the TEs assumed that the student teachers (STs) would have very little experience on which to base their predictions, and they incorporated STs' interviews of mentor teachers about the students before the ST started planning a lesson. To gain more knowledge about students, the STs also interviewed one student each after they had taught the first lesson. However, prediction was still challenging for the STs.

Chassels and Melville (2009) studied affordances and challenges by implementing LS in the Canadian teacher education context. They concluded that LS stimulates STs' awareness of students' needs, teaching strategies important to meet the students' needs, and that it is important to work collaboratively with colleagues on improving teaching. The challenges found in this study relate to time and administrative structures of importance for teachers' collaborative work. The challenges found in the Canadian teacher education context seem to partly overlap with those noted in the Norwegian context (Bjuland and Mosvold, 2015).

Research on LS as a vehicle for higher education mathematics teachers' PD is scarce. One exception is Becker *et al.*'s (2008) study, based on the authors' involvement in an LS focusing on students' understanding of mathematics concepts, such as the Mean Value Theorem. These researchers highlight LS as important for TEs' learning about college students' learning. Similarly, Alvine *et al.* (2007) concluded that, by improving the content of the lessons and by developing teaching skills, LS might have a positive impact on undergraduate education. In addition, they highlighted LS as having the potential of "becoming a powerful professional development tool to improve teaching and learning in undergraduate education" (p. 111). A third study in this field focused on an undergraduate statistics course (Roback *et al.*, 2006). Through their LS process, these researchers highlighted that they "gained insight and awareness into effective statistical pedagogy and how students develop statistical thinking" and, by focusing on one single lesson, they were provided with "an achievable and generalizable means for examining the course as a whole" (p. 18). Roback *et al.* (2006) also identified some challenges of using LS, such as difficulty to maintain a focus on student thinking and to embrace the research lens throughout the LS process.

From our review, we learned that research on LS as a vehicle for mathematics TEs' PD is lacking. Hence, there is an urgent need to elucidate how mathematics TEs understand LS. In addition, explorations of planning for research lessons (Fujii, 2016) are called for, and studying how TEs plan their research lessons in their TTC contributes to this call. In this paper, we discuss findings of a study that explored different aspects of how TEs in Malawi understand and intend to implement LS by researching their own teaching at TTCs. The focus on intended object of learning (i.e. the lesson plans only) is based on the work of Fujii (2016), who highlighted that the development of lesson plans is under-appreciated in contexts outside Japan. Preliminary findings suggest that, while there are some general understandings of LS that are common among the TTCs, there are also some different understandings by the TEs from different colleges (Kazima *et al.*, 2017). Furthermore, implementation of LS varies across the TTCs. In general, the TEs seem to struggle with some of the aspects of LS that are found in research on STs and teachers worldwide (Bjuland and Mosvold, 2015; Fujii, 2014). Although this might not be

surprising, it raises the question of how best to implement LS in a way that will be useful and beneficial among TEs in Malawi.

In Malawi, teacher education for primary school is offered by TTCs, which fall under the auspices of the Ministry of Education. The two-year program is called Initial Primary Teacher Education and has a common curriculum for all colleges. Each year contains three terms – two terms full time taught course at the TTC and one term teaching practice in primary schools. Teacher education for secondary school is offered at university level and is a four-year full-time taught program plus a term (10–12 weeks) of teaching practice in schools. Our study focuses on primary teacher education offered by the TTCs and specifically on mathematics TEs.

Methodological approach

The present study is a part of a wider ongoing project designed to improve the quality and capacity of mathematics teacher education in Malawi. One component of the wider project is PD of all mathematics TEs in Malawi ($n = 89$) – a seven-month-long process that starts and ends with a three-day workshop. The PD uses an LS model where mathematics TEs at each TTC implement one LS cycle in mathematics. Each TTC has 8–12 mathematics TEs working together in their LS cycle. Within the first three-day workshop in May, an introduction to LS is provided for the TEs and they start to discuss and write lesson plans for their research lessons with guidance from the workshop instructors. The focus of this activity is an aspect related to multiplication or fractions. Based on the findings obtained by Fujii (2014), who contended that a careful study of the topic should enable teachers to distinguish between significant and non-significant concepts, this workshop also invited the TEs to study these concepts in-depth. Affordances and challenges involved in LS implementation (see the previous section) are also presented and discussed. After three days of working together with the authors of this paper, as knowledgeable others or external experts (Takahashi, 2013) on planning for a research lesson, the TEs spend ten weeks finishing the first lesson plan draft for their research lessons and send the draft to the external experts by mail. The lesson plans are commented on by the external experts, and the TEs are invited to revise their plans according to the feedback received. Based on the revised plan, they conduct their research lesson at their own TTC. In the November workshop, the TEs are invited to present their overall LS process, as well as answer(s) to their research question(s).

For this paper, and in order to conduct an in-depth analysis of the gathered information, data were collected from four out of eight TTCs in Malawi and comprised of the lesson plans for their research lessons before and after the revision (i.e. two plans from each TTC). Videos of the TEs planning research lessons, teaching research lessons and discussing the research lessons after teaching, were also available. However, only the intended object of learning is explored. This is important because the research lesson plans are under-appreciated when LS is adopted outside Japan and because key features of the planning process are important for educators seeking to improve LS outside Japan (Fujii, 2016). Consequently, for the purpose of this paper, the unit of analysis is the TEs' written lesson plans only and includes both the first draft as well as the revised versions of the lesson plans (i.e. eight lesson plans).

In this study, we assume that TEs' research lesson plans can provide a glimpse into their understanding of LS. To answer the research question guiding the study, qualitative content analysis was adopted. We have chosen an iterative strategy, weaving back and forth between the empirical material and previous research, and we conducted both conventional and theory-driven content analysis. In conventional content analysis, researchers immerse themselves into the data material in order to gain new insights. This approach is regarded as a flexible way of analyzing textual data, and a systematic approach to classify and identify themes or patterns (Hsieh and Shannon, 2005). In theory-driven content analysis, coding categories are used deductively. Previous research on LS in contexts outside

Japan – including challenges and affordances (see the previous section) – informs the theory-driven content analysis. These analytical approaches resulted in the categories presented in Table I.

Findings

From our analysis of the TEs' lesson plans, we learned that the focus of attention was as presented in Table II.

Research question in TEs' lesson plans

At TTC-A, the TEs planned a research lesson for their STs to understand and appreciate a variety of multiplication strategies. In their first draft, they had the following lesson plan title: "Exploring strategies students use when multiplying two-digit numbers by three-digit numbers." The external experts commented that this indicated an interesting research question for the lesson, but also that it is important to formulate a research question focused on what they as TEs would like to learn from the research lesson. The TEs at this TTC also had a "lesson question" for their research lesson. In the first draft, as well as in the final lesson plan, this question read: "How do different multiplication strategies work when solving the problem: $676 \times 28 = ?$" The external experts commented on this question in the first draft, asking if this was their research question and if they wanted to learn how different strategies work or "something about your student teachers' understanding." The external experts also highlighted that, in LS, there are two relevant questions to ask: what the STs are expected to learn from the lesson; and what they as TEs want to learn about STs' learning from the research lesson (i.e. research question). In the final draft, the TEs presented the following lesson title: "What strategies do students use when multiplying two-digit numbers by

Category	Example extract from the research lesson plans
Research question	Exploring strategies students use when multiplying two-digit numbers by three-digit numbers (TTC-A)
	How to teach modeling of multiplication of mixed numbers using different resources? (TTC-B)
Prediction	We assume students will have a variety of multiplication strategies, e.g. traditional (long multiplication), distributive, expanded notation, repeated addition, lattice and multiplying starting with tens (TTC-A)
Process of observation	Are students able to solve 67×28 with regrouping using different strategies? (TTC-A)
	Are all students able to model mixed numbers with the same denominators? (TTC-C)

Table I.
Categories and examples from the research lesson plans

TTC	Focus in research lesson
TTC-A	Multiplication of two-digit numbers, where the student teachers would first be asked to solve some multiplication problems individually using their own strategies
TTC-B	How to represent multiplication of mixed numbers using paper as a resource followed by the TE asking student teachers to work in groups and to come up with other resources they can use for modeling the same multiplication
TTC-C	Asking the student teachers to model addition of mixed numbers with fraction part having the same denominator followed by asking them to model addition of mixed numbers with fraction part having different denominators
TTC-D	Division of proper fractions using a number line. First, an example would be given and discussed with the whole class, then student teachers would be asked to work on similar tasks in groups

Table II.
Focus in TEs' research lessons

two-digit numbers?" However, "research question" was not presented in the plan. The research question was also retained as the lesson title, but the TEs at TTC-A seemed to be interested in learning more about their STs' two-digit multiplication strategies.

In the first lesson plan draft from TTC-B, the following question was presented as a "Lesson question": "How to teach modelling of multiplication of mixed numbers using different resources?" When commenting on the draft, the external experts highlighted the topic as interesting, but also wrote that a research question was lacking. They further noted that, in designing a research lesson, "you want to research something, so you have to make a question about what it is about the teaching of multiplication of mixed numbers you want to learn through your teaching of the lesson. Is [there] something your student [teachers] perhaps struggle with, or [are there] misconceptions they might have?" In their final research lesson plan, the TEs presented the following research question: "Do teaching learning and assessment resources have an impact on the teaching of mixed numbers?" This question indicates that the TEs would like to learn more about if and how teaching and learning resources might affect teaching of multiplying mixed numbers. It is, however, not clear from the revised plan what exactly the TEs would like to learn from the research lesson.

In their lesson plan for a research lesson focusing on modeling addition of mixed numbers, the TEs at TTC-C did not present a research question in their first research lesson plan draft. They instead provided two questions related to what their STs should be able to do after the lesson: "Are all students able to model mixed numbers with the same denominators?" and "Are students able to model addition of mixed numbers with different denominators?" These two questions were presented under the heading "Points to notice (evaluation)" and relate to observation rather than a research question. When commenting on the first draft, the external experts highlighted the learning by the TEs themselves as important in LS "and as a reason the teachers' research question for the research lesson is of importance." The TEs were thus advised to read an appendix in the book by Lewis and Hurd (2011, p. 129) in order to be provided with an example of how a research theme might be chosen. In their final plan for the research lesson, a research question was still lacking. However, questions related to STs' learning were provided and focused on what they are able to do and what they understand. Based on this, it is not clear what the TEs would like to study and to learn more about from this research lesson.

An explicitly presented research question was not present in the first research lesson plan draft from TTC-D. When presenting the "success criteria" for their research lesson, the TEs wrote what STs should be able to, while failing to mention the TEs' learning. When commenting on the lesson plan draft, the external experts highlighted the success criteria present as a nice way to specify the core element of the lesson, i.e. what the STs are learning from the lesson. They also noted that, in LS, a research question for the TEs is important and asked "What would you like to learn (about your students' learning) from the lesson? […] What is it you want to research?" The TEs were encouraged to add success criteria focusing on their own learning in and from the research lesson: "If you should list success criteria for your research lesson that would be that you have managed to find answer to what you – the teacher educators – have found out through teaching of the lesson plan you have made." In their revised lesson plan, the TEs at TTC-D still presented success criteria for STs only. As a result, it is unclear what the TEs intended to study and to learn from this research lesson.

Based on the analysis of the research lesson plans from these four TTCs, we can conclude that it is difficult for the TEs to focus on their own learning parallel to the STs' learning. This is true, even if the external experts provide explicit feedback related to the importance of research question as a point of departure for a research lesson in LS. These findings coincide with those yielded by previous research in other contexts (Bjuland and Mosvold, 2015; Fujii, 2016), making it difficult to embrace the research lens throughout the LS process (e.g. Roback *et al.*, 2006).

Prediction in TEs' lesson plans

In their draft for the research lesson, the TEs from TTC-A wrote that they assumed that the STs would know a variety of multiplication strategies, but also that the STs in primary as well as in secondary schools were exposed to the Malawi long multiplication strategy and might prioritize this approach. When commenting on the first draft, the external experts challenged the TEs to predict which strategies the STs would utilize. Based on this challenge, the TEs in their final draft wrote the following: "We assume students will have a variety of multiplication strategies, e.g. traditional (long multiplication), distributive, expanded notation, repeated addition, lattice and multiplying starting with tens." In their lesson plan, the TEs also wrote that they would encourage the STs to explain why the strategies they used work, and to critique different strategies by "focusing on advantages, disadvantages, simplicity, and complexity."

At TTC-B, there were no signs of prediction in any of the lesson plans. Prediction was also not commented on explicitly by the external experts. The external experts highlighted that it is important for TEs to think about how they expect all STs to approach a particular task (multiplying mixed numbers using local resources), and challenged them to perhaps "do it without converting the whole numbers to fractions" and by highlighting that the tasks "can be solved in different ways and some might be easier than the one [the solution method] proposed." However, prediction was not explicitly in focus either in the written plans from the TEs or in the comments from the external experts.

When describing the current skill level of the STs, the TEs at TTC-C wrote that their experience from previous groups of STs has shown that many STs are uncomfortable when dealing with fractions. The TEs continued by stating that the STs "can ably handle structural questions on addition of mixed numbers with different denominators, but found it very difficult to model the same. These phenomena could be attributed to the silence existing across the primary school and teacher training college curricula on modeling addition of mixed numbers with different denominators; hence the gap." In the first lesson plan draft, the external experts did not comment on this explanation. Similarly, they did not comment on prediction either implicitly or explicitly. Consequently, the prediction remains the same in the final version of the research lesson plan.

At TTC-D, there were no signs of prediction in the first lesson plan draft. Prediction was also not commented on explicitly by the external experts and is not present in the final lesson plan.

Based on the assessment of the research lesson plans from these four TTCs, we can conclude that it is difficult for the TEs to predict how their STs will solve a given task. Prediction was thus difficult for TEs as well as for their STs (Munthe *et al.*, 2016). When the external experts commented on prediction, it was included in the revised lesson plan from TTC-A. Based on the fact that the external experts did not provide explicit feedback related to the importance of prediction in LS, it is not surprising that the final research lesson drafts from the other TTCs did not focus on prediction.

Process of observation in plans for research lessons

In the initial lesson plan draft for TTC-A, three different types of observations of STs' strategies for multiplying two-digit numbers were mentioned. The plan included two questions – "Are students able to solve? [the problems]" and "Are students presenting different algorithms?" – without indicating if this would be evaluated through direct observation of STs' individual work in class, or by evaluating their written work. The superficial nature of what aspects would be observed seemed to be related to the research question, which was unclear, but indicated that the goal was to have students explore different strategies and learn more about their understanding of these strategies. This became clearer in the third type of observation when they wrote, "Are students

showing understanding of different algorithms?" which implied their interest in STs' understanding of different algorithms/strategies for multiplication of two-digit numbers. In the feedback given by the external experts, the TTCs were challenged by the question of how they would evaluate whether the STs were able to solve the problems and to evaluate their understanding. They were also asked to be more explicit in their planned process of observation. After revision, the new plan contained five additional explicit points of observation. There was a shift toward looking for more explicit evidence of ST understanding, as they looked for STs being able to justify and communicate their choices. Examples from points of observation in the revised lesson plan are "Are students able to solve 67×28 with regrouping using different strategies?" and "Are students able to justify their methods?"

The lesson plans for TTC-B started with TEs using papers demonstrating $\left(5\frac{1}{3} \times 3\frac{2}{5}\right)$. This was followed by the TEs asking STs to work in groups and to come up with other resources for modeling the same multiplication and to demonstrate their approach to the rest of the class. In the initial plan, the group indicated that they wanted to observe whether STs were able to use different resources and whether they were able to understand the skills involved in this work. They also planned to observe if the STs were able to use different resources when working on a different number problem $\left(2\frac{1}{3} \times 3\frac{3}{4}\right)$. The external experts instructed the group to explicate how they would observe the level of understanding and the skills, and the difference in skills involved in solving a problem and skills involved in using different resources in solving a problem. They were also advised to move away from yes/no observation questions (i.e. "Are students able to solve the problem using different resources?") and more toward observational question like "How do the students use the different resources?" In the revised plan, the group had moved toward more explicit observational questions – although still rather vague – such as "Are students able to employ a variety of methods using resources?" and "Are students able to show an understanding of the methods?"

The lesson plans for TTC-C asked the STs to model addition of mixed numbers, something the STs, according to the lesson plan, had done in previous lessons. This was followed by asking them to model addition of mixed numbers with the fraction part having different denominators. This activity was to be done as group work, and with step-by-step instructions from the TE. In this initial plan, only two types of observation were pointed out: "Are all students able to model mixed numbers with the same denominators?" and "Are students able to model addition of mixed numbers with different denominators?" These observational points are superficial as they do not focus on evaluating STs' understanding, but rather focus on what they are able to do. This was also highlighted by the external experts in writing. In the revised lesson plan, the TEs had made a list of 13 observational points. The list starts with observation of what STs were able to do with previous knowledge (addition of whole numbers and fractions with the same denominators) and then moving gradually to addition of more complex numbers (improper fractions, mixed numbers, whole numbers and fractions), before focusing on whether STs were able to model addition of whole numbers, fractions and mixed numbers with the fraction part having a different denominator.

Only one of the four TTCs, TTC-D, failed to mention anything related to observation, either in the original lesson plan, or in the revised plan. It should be noted this was also not pointed out by the external experts who reviewed the plan. For the three remaining TTCs, observation is related to evaluation and the focus is on the student, with the observation questions in the form "Are the students able to […]" or "Do students understand […]." During the review, the external experts raised questions like "What are the observers going to observe in the lesson you have planned? Are you observing one student or several students? What might anticipated student

responses be?" While these were directed specifically at the TTC-C, for some TTCs, more specific questions related to how they would observe students' learning were suggested. Three of the colleges included a more detailed list of "points of evaluation" after revising the plan. The changes were more detailed in terms of more explicit relation to content, but the types of questions were mostly the same. Hence, it seems that a common understanding of what should be the principal focus of attention when observing is what the STs are able to do. However, our analyses indicated lack of emphasis on planned and focused observation of STs' learning in the research lesson (Bjuland and Mosvold, 2015; Larssen *et al.*, 2018).

Concluding discussion

When studying how mathematics TEs in Malawi understand LS by analyzing how they intend to conduct their research lessons, our findings support earlier research stating that LS in new contexts with inexperienced participants can be challenging. First, our findings support the results obtained by Bjuland and Mosvold (2015) and Fujii (2016) in that developing a research question for the LS research lesson is challenging. When inexperienced LS participants develop a research lesson, a research question is not always the point of departure. In the present study, the external experts gave explicit feedback related to the importance of research question as a point of departure for a research lesson in LS. However, based on the research lesson plans analyzed, it is clear that it is difficult for the TEs to focus on their own learning parallel to the STs' learning. These findings coincide with those yielded by previous research in other contexts, such as initial teacher education (Bjuland and Mosvold, 2015) and in African schools (Fujii, 2016), making it difficult to embrace the research lens throughout the LS process (cf. Roback *et al.*, 2006). As this might result in lack of emphasis on planned and focused observation of students' learning in the research lesson (cf. Larssen *et al.*, 2018), it is important that a research question is present in plans for research lessons.

Prediction is an important part of the development of plans for research lessons (cf. Fujii, 2016) and is regarded as a crucial element in LS. From our analyses of research lesson plans, a second conclusion is that predicting STs' responses to tasks is as challenging for TEs as it is for STs (cf. Chassels and Melville, 2009; Munthe *et al.*, 2016).

A third conclusion is that the process of observation in LS is challenging for the TEs. Larssen *et al.* (2018) found that there was no common understanding of the process of observation, how it should be conducted, and who or what should be the principal focus of attention. This might be related to research question not always being the point of departure when inexperienced LS participants develop a research lesson (e.g. Bjuland and Mosvold, 2015) and can result in lack of emphasis on planned and focused observation of students' learning in the research lesson.

Comparing the four TTCs' lesson plans, we observe some similarities and some differences in the three aspects (research question, prediction and observation). The similarities relate to how they phrased their points of observation as evaluating whether or not STs are able to do something, e.g. "Are students able to multiply mixed numbers?" Such phrasing would produce a yes/no answer and would not offer the TEs the opportunity to learn about their STs' learning. These similarities are not surprising because the TTCs have similar contexts; they follow the same curriculum and use the same curriculum materials, including a handbook for the initial teacher education program (Malawi Institute of Education, 2006). The handbook suggests evaluating lessons using what they call "success criteria" that are presented in the form "by the end of this unit, students should be able to […]." Most importantly, these criteria can usually be answered with a "yes" or "no." This context seems to influence the TEs' understanding of observation in LS (Fujii, 2014); thus, shifting from the "success criteria" they are

familiar with to the observation points as required in LS presented a challenge for them. General comparison across the colleges also shows that there was a substantial improvement in the number and phrasing of observation points between the first drafts and the final lesson plans. This emphasizes the important role of external experts in LS (Takahashi, 2013).

Differences across the TTCs' lesson plans were especially pronounced in the presentation of a research question. Although they all seemed to understand that the research lesson is for them to learn about their STs' learning, the TEs from the different TTCs seemed to have different understandings of research questions, as evident in their phrasing and naming. Some did not use the term "research question" but "lesson title." These differences are intriguing because the TEs from all TTCs attended the same introductory workshop to LS and had the same external experts commenting on their draft lesson plans. This highlights the complexity of LS to newcomers in new contexts.

The role of external experts (Takahashi, 2013) seems to be crucial for the LS success. As the findings from this study show, where there was no explicit advice (e.g. about observations to TTC-D) there was no improvement in the final lesson plan. This highlights the importance of advice from external experts in developing capacity in LS among TEs.

Looking at these findings in light of the overall objectives of the wider project, we consider the improvements from drafts to final lesson plans as an indication that LS can be used as a model for capacity building in teacher education in Malawi. We note that one cycle is insufficient to develop common understanding of LS in teacher education. We thus expect that additional cycles with continued advice from external experts would improve the TEs' understanding and implementation of LS.

Implications

Implications of the findings from this study include both positive and challenging effects of the different understandings and implementations of LS on the desired goal of improving quality of mathematics teacher education in Malawi. One implication relates to the importance of the research lesson plans. Future research on the key features of the planning process will be of importance for educators seeking to improve LS outside Japan (Fujii, 2016). The second implication relates to the role of external experts. Based on his investigation of the role of the external expert in Japan, Takahashi (2013) concluded that participating in LS with colleagues is the best way to develop the ability to serve as an external expert. Outside the Japanese context, where a systematic use of LS is lacking, this may be difficult. In the context of this study – where the external experts were available by mail only, except for the initial planning phase and the closing discussion phase – the role of the external expert might be one reason why the lesson plans were challenging to write for the TEs. Studying TEs' LS cycles where external experts are present during the process would thus be a valuable avenue for future LS research in the Malawi context.

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Further reading

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