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Inexperienced teachers and knowledgeable others in lesson study: what lessons are drawn from the new practice?

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Abstract
This study explored how Malawian teachers who participated in an adapted lesson study (LS) professional development (PD) for the first time understood teacher collaboration, and the lessons learnt by the inexperienced knowledgeable other (KOs) through facilitating the new practice. The study was conducted qualitatively using data from lesson plans, lesson planning and lesson reflection sessions. The findings revealed shifts in teachers' understanding of teacher collaboration from as only meaning division of roles to also including individual and group ownership and mutual support in all phases of LS. The findings further revealed that inexperienced KOs' challenges in facilitating LS in contexts where LS is not a known practice are greater, probably resulting into gradualness in teachers' understanding of the LS process and improvement in their teaching. Therefore, while LS is an effective PD for teachers' learning about improving their teaching, the inexperienced teachers and inexperienced KOs' understanding of conducting and facilitating this practice may develop over time and with frequent practice. Further research is required to understand how inexperienced KOs can effectively handle different LS issues including teacher resistance.

Keywords Lesson study · Teacher collaboration · Knowledgeable others · Professional development

1 Introduction

After functioning for over 100 years in Japan as an effective professional development (PD) for improving teaching, lesson study (LS) has been adopted, adapted and spread widely across the world as an effective model for teacher professional learning [1]. LS is a teacher-led professional learning approach in which teachers work collaboratively with their colleagues to plan, observe, and reflect on their practice with guidance from the knowledgeable other [1–3]. Four stages of LS are reported in most literature; study, plan, do, and reflect [4–6]. Study stage involve studying of the curriculum and relevant documents to search a goal or research problem. During planning stage teachers collaboratively plan a research lesson which is implemented by one teacher in the classroom at the doing stage while other participating teachers observe and collect data. This is followed by collaborative reflection by the participating teachers to discuss effective aspects of the observed lesson and to suggest how the lesson can be improved. For effective learning from LS, teachers are expected to develop core principles of teacher ownership of the lesson, collaboration, and inquiry into teaching and student learning in a chosen topic [6, 7]. When each teacher exercises ownership of the LS, they work collaboratively to achieve their goal [8].

LS is relatively a new practice in Malawi and has mainly been conducted in primary mathematics education, with confirmed reports in improvement in lesson planning, lesson delivery, lesson reflection and teacher collaboration [9, 10]. We initiated LS with experienced secondary level mathematics teachers from two schools in Malawi with an aim of

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improving their knowledge for teaching geometry, a field reported as challenging in both teaching and learning [11]. Literature on LS recommends the use of theory informed frameworks when introducing LS in new contexts to structure discussions and guide research [1]. We have responded to the recommendation by conducting the LS using the mathematics teaching framework (MTF) that was developed and used to guide LS in South African secondary schools with similar contexts to most Malawian secondary schools [12]. The MTF is rooted in sociocultural theory opined to an orientation to mathematics as a network of scientific concepts [13], and to mathematics teaching and learning as goal directed with mediation towards increasing sophistication and coherence in disciplinary knowledge and ways of knowing. It is comprised of three recognisable and inter-connected teaching practices: exemplification (examples, tasks and representations), explanatory communication (word use and justifications) and learner participation (doing and talking mathematics).

In our research on LS with the Malawian secondary level mathematics teachers, we have mainly focused on teachers' learning of the teaching practices of MTF including exemplification and explanatory communication [14]. Regarding the LS itself, we have only reported on how the role of the knowledgeable other (KO) was very crucial in focusing teachers' attention from their usual/normal planning, which only focused on achieving lesson objectives, to also focus on improving their teaching [10]. Although teacher collaboration is a powerful tool for teachers' learning during LS [15, 16] and also challenging for teachers [2, 3] we have not attended to it in our research. Furthermore, our research only used data from one group of teachers that regarded their lessons throughout the LS cycle as successful because they were conducted according to their plan. We have not reported on data from the group of teachers that regarded one of the lessons as unsuccessful because it was not implemented according to their plan. Dudley et al. [17] argues that a lesson that deviates from the planned lesson can also provide rich ground for teachers' learning to improve their practice. Therefore, it was necessary to study what the teachers learnt from conducting a LS cycle which had unsuccessful lesson.

Several challenges of adapting LS in new contexts have been reported, including in African countries such as Malawi. These include teachers' lack of understanding of key aspects of LS, such as planning lessons in relation to an identified research problem, lack of understanding of different stages of lesson planning, and constraints of time in particular in resource-constrained contexts [1, 3, 9]. These challenges point to the critical role of the knowledgeable other (KO) when adapting LS in a critical context [18]. Lewis et al. [16] argue that in a country where LS is a new practice for both KO and teachers, the KOs lack prior experience to draw upon for facilitation, so they must learn to contend with several issues including teachers' resistance and balancing between directing teachers and teacher autonomy. They call for research on how KOs work with practicing teachers in contexts where LS is a new practice to develop their own professional knowledge and skills as they mentor teachers. In the Malawian LS, both teachers and the facilitating KO were inexperienced in LS, as such, it was indeed necessary to conduct a qualitative exploration of how KOs mentored the practicing teachers and the lessons they learnt during the mentoring process. Therefore, in this paper I explore two research questions, (1) how do teachers interpret collaboration when conducting lesson study for the first time? (2) As KOs, what do we learn from conducting LS with teachers in a context where the practice is new to both the facilitating KO and the teachers?

Studying teachers' interpretation of collaboration in contexts like Malawi where teachers have been used to working alone to plan and teach lessons is important in learning about their uptake of the collaboration aspect of LS as well as in contributing to the development of research from such contexts. As Huang et al. [18, 19] observes, despite the increase in adoption, adaptation and research in mathematics teacher PD across contexts, including in resource-constrained contexts, research linked with LS in such resource constrained contexts is still under-developed and under-reported in international research collections and surveys. Furthermore, studying what we as novice KOs learn about conducting LS with fellow novice teachers in LS is an opportunity of advancing our understanding of LS and the role of KO through self-reflection, examining of our experiences and practices when engaging the teachers in LS [6].

2 Review of related literature

2.1 Lesson study and collaborative learning

Benefits of LS include provision of collaborative learning opportunities for teachers to improve their lessons, learn new teaching pedagogies, deepen their subject matter knowledge, and become self-reflective practitioners [3, 20, 21]. Within mathematics education, LS's power is largely derived from teachers' collaborative efforts to understand the richness and complexity of mathematical ideas and practices for supporting students' engagement with these [7]. These learning opportunities are created through collaborative LS activities such as lesson planning and post-lesson reflection where

comprehensive planning and in-depth analyses about the quality of teaching and learning is conducted [22, 23]. There is evidence worldwide and including in Malawi that when teachers do LS in their schools, they do not only learn much about improving their teaching, but their collaboration skills are also enhanced [3, 10, 15].

Collaboration provides teachers with opportunities for professional growth through encouragement, empathy, mutual support and sharing knowledge when designing research lessons aimed at improving teaching [20, 24]. Teachers find these collaborative moments outside their classrooms beneficial because they provide less stressful and more thoughtful intellectual settings suitable for their learning about making good instructional decisions than when they are alone in the classroom [20]. It is therefore through teachers' collaboration that ideas of 'learning from teaching', develop, hence LS creates a good environment for development of professional learning communities [24]. This agrees with a study on improving mathematics teacher educators' collaboration in a LS in Malawi which revealed that LS offered mathematics teacher educators opportunities to develop their professional growth through working together and sharing knowledge for addressing different mathematics education challenges within and between their colleges [10].

Teacher collaboration can take different patterns. Gräsel et al. [25] in Muckenthaler et al. [24] propose three patterns of collaboration. The first is collaboration through exchanging information and materials with colleagues without necessarily meeting physically. In this case, there is little communication and few financial expenses. Another type of collaboration is through sharing tasks and then teachers work independently to meet an agreed goal by completing their respective parts. In this pattern the teachers do communicate or meet when need arises, for example, to check if they have a common understanding of their goal and to monitor each other's progress, hence the expenses are higher. The third is, collaboration through co-construction, where group members work together physically to develop common knowledge and common solutions to problems through dialogue. Although this type of collaboration is the most expensive, it is effective in contributing to teachers' professional growth [25]. Being a new practice framed from social cultural theoretical perspective, the LS with Malawian secondary school teachers was planned to mainly use co-construction pattern of collaboration where teachers were expected to come together physically to plan, teach and reflect on the lesson [17].

Despite being a critical element of LS, several challenges of collaboration are reported just as with other aspects of LS [2]. Sekao and Engelbrecht [26] reveal that South African teachers who taught the lesson during LS reported of disliking lesson evaluation because their counterparts were over criticising their lessons. Other challenges of collaboration during LS include teachers' lack of mutual support, encouragement and sense of ownership [8, 27]. Some ways of promoting collaboration during LS have also been suggested, including valuing individual input and support, and not deciding the teacher of the lesson before finalising lesson preparation [7, 8]. Peterson et al. [7] report that although pre-service teachers made progress in shifting their discussions towards understanding the mathematics content of the lesson and students' thinking during LS, their sense of lesson ownership began to drop. This is because when they knew the teacher of the lesson in advance, they left the final preparations to him/her. To promote sense of ownership, the LS facilitators therefore decided not to select the teacher of the lesson until all lesson preparations were conducted, a strategy that worked in their context. Burroughs and Luebeck [8] report similar findings from a LS with pre-service teachers in mathematics education whereby when a teacher was assigned to the lesson too early, the rest of the team withdrew from group ownership of the lesson. What is not clear from these studies are the consequences of the type of collaboration whereby final lesson preparations are left to the lesson teacher.

2.2 Role of the knowledgeable other in lesson study

The involvement of a KO is one of the central aspects of LS as traditionally practised in Japan. There is well documented literature on the importance of involvement of the KO in LS [e.g., 7, 19, 28]. Takahashi and McDougal [21] regard KO as an important component of LS and define her/him as "someone from outside the school's planning team who has content expertise, often has teaching expertise, and is well-versed in Lesson Study" (p. 267). In mathematics education, the KO can be someone experienced in both mathematics content and pedagogy; for example, an experienced in-service mathematics teacher or university mathematics educator [29]. Literature documents that KOs are critical in increasing the success of school-based LS as they play very important roles of contributing insights at every phase of LS cycle [eg. 19, 28, 30]. In LS, the role of the KO includes initiating discussions and drawing attention to key issues of the lesson, supporting teachers to develop proper sequencing of the lesson tasks, and providing immediate feedback to the teachers soon after the lesson to help improve the lesson [1, 23]. The KOs do this by "(1) bringing new knowledge from research and the curriculum; (2) showing the connection between the theory and the practice; and (3) helping others learn how to reflect on teaching and learning" [30, p. 10].

In the study by Peterson et al. [7], the role of the KO was essential in different ways. These included conducting conversations that would redirect the pre-service teachers' thinking and talking about how to teach mathematics for conceptual understanding, and modelling questions to be asked in the reflection meetings to keep their conversations focused on the mathematics of the lesson and student thinking. During lesson reflection sessions, therefore, KOs and participating teachers collaboratively work together to critically analyse the observed research lessons and construct suggestions for improving the lesson [23].

While it is emphasised that for LS to be effective in providing necessary support, the KO should be someone who is well experienced, there is no formal training for KOs even in Japan, continued participating in LS with colleagues is regarded as best way of learning to perform the roles effectively [21, 23, 29, 30]. Baldry and Foster [29] suggest that when working outside Japan where teachers are not experienced in LS, in addition to knowledge for advising on how to improve instruction, the KO needs to possess some expertise about how to conduct LS to help the teachers understand the LS process and its importance. The authors therefore suggest that in addition to providing feedback after the lesson, the KO should be present during lesson planning sessions to help the teachers who are inexperienced in LS raise their planning level beyond their routine lesson planning practices. This implies that if the KO who is introducing LS in a new context is not experienced in either participating or facilitating LS, they should be trained to build their capacity for mentoring the teachers during lesson planning. In the Malawian adapted LS, the KO who facilitated the LS had not yet participated in or facilitated LS, she was being mentored by other two KOs who had experience in facilitating LS, hence the motivation to explore lessons learnt during facilitating LS for the first time.

3 Methodology

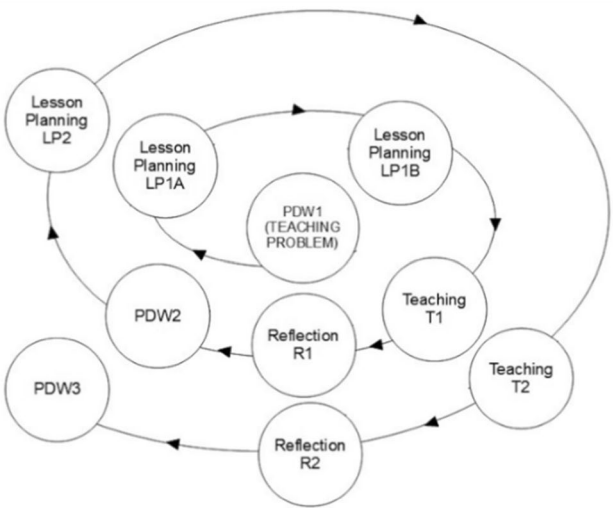
3.1 The lesson study

The Japanese LS model contains four phases: study, plan, teach, and reflect [21, 31]. As Fujii [9] suggested, to ensure effectiveness in teacher learning from LS, context must be considered when adapting the Japanese LS in a new country. Considering that Malawian teachers challenges in teaching mathematics are both in geometry content and teaching [11], we incorporated PD workshops in our LS model. We started the LS with the teachers with a 2-days PD workshop at the university where two of the four KOs (including the author of this paper) work. During the workshop, (labelled PDW1 in Fig. 1), we introduced the teachers to: (1) activities for promoting geometric reasoning using the MTF, and (2) the purpose and process of LS as shown in Fig. 1.

Towards the end of the PDW1, we asked the teachers to decide on a topic and a problem that they wanted to conduct LS. The problem decided by teachers from one school was that Form 1 (Grade 9) learners experienced challenges in understanding the properties of lines and angles. For example, the learners applied properties of angles formed by parallel lines and a transversal on non-parallel lines. The aim for the teachers was to improve learners' understanding of properties of lines and angles through engaging them in several interactive geometric activities during the LS. This was in line with what they learnt in PD1 in relation to the MTF as well the Malawi government's call on improving education quality and promoting learner centred education [11]. After the workshop, the teachers planned a research lesson and conducted LS whose stages are shown in Fig. 1. PDW1 was followed by two initial planning sessions (LP1A and LP1B), then teaching 1 and reflection. This was followed by another PDW2 where teachers reflected more on teaching 1 and started planning for teaching 2. After PDW2, the teachers continued with lesson planning 2 in their school and conducted teaching 2 which was followed by reflection 2. A third lesson planning session was done during PDW3 were the teachers conducted in-depth reflection of teaching 2 and suggested improvements.

It was deliberately planned that in LP1A session, there should be minimal input from KO with an aim of starting from what the teachers know or learnt from PDW1 and deciding how to help them. For this particular school, the lesson planning that was done in PWD3 led into teaching 3, a decision made by the teachers themselves upon noticing that teaching 2 was not implemented according to their plan. Unlike in Japanese LS where the lesson is taught by the class teacher [22], in the Malawian adapted LS model, we made a deliberate choice that teaching would be done by any of the participating teachers because they were all learning to do LS. Since individualised teaching was routine for these teachers, it was necessary that the teacher of the lesson be unknown when they were learning to motivate them to work together. This decision also helped us to avoid some challenges including where a teacher would resist to open up their classroom for LS upon knowing that they would be expected to teach the lesson as observed by Skott and Møller [32]. The aim of this study is not to validate whether the teachers achieved their aim of enhancing learners' understanding of

Fig. 1 Lesson study cycle



properties of lines and angles, but on what the teachers as well as the KOs respectively learnt about collaboration and facilitation while conducting the LS.

The content of the PD workshops was mostly planned online by four KOs, two from the Malawian University where the PD workshops were being conducted (KO1 and KO3), and two from a South African University (KO2 and KO4). KO1 (author of this paper) and KO4 were postdoctoral fellows under the supervision of KO2 who is a mathematics education professor at a South African University and is experienced in facilitating LS. KO3 was a mathematics education professor at the Malawian university and had facilitated LS with primary teacher educators and teachers. KO3 facilitated the PD sessions together with KO1 who had no practical experience in conducting LS. The lesson study project was part of KO1's fellowship, as such, only KO1 participated physically in all stages of the LS cycle to provide guidance to the teachers and to collect data. KO2 and KO3 who had practical experience in conducting LS acted as trainers to KO1 and KO4 (who was also planning to do LS in her country). Most of the meetings for planning the PD and discussing the teachers' lesson plans and lessons were held online because KO2 and KO4 could not travel to Malawi due to COVID 19 international travel restrictions. As we will see in the findings sections, the remote mentoring of KO1 had some implications on the teachers' learning during the LS.

3.2 Data collection and analysis

3.2.1 Data collection

KO1 collected data through video recording of the PD sessions and LS sessions with the help of two research assistance who were mathematics education doctoral students at the university. In addition to video recording sessions, KO1 also wrote field notes and took pictures of the teaching and learning materials and lesson plans that were used during teaching. For this study, data included the lesson plans for Teaching 1 and 2, lesson planning sessions for Teaching 1 and 2, as well as lesson reflection session for Teaching 2.

3.2.2 Study participants

As already explained, the LS was conducted with 10 teachers from two public secondary school in Malawi (five teachers from each school). The two schools are national secondary schools, characterised by high performing students, low teacher to student ratio of 1 to 40 as recommended by the MoEST, and qualified teachers usually with more than three years of teaching experience. Therefore all the ten teachers were qualified to teach secondary school mathematics as they had a bachelor of education degree with mathematics as an area of specialisation. In addition, they also had more than five years' experience of teaching mathematics. This is unlike other types of secondary schools where the teachers who teach mathematics might either be underqualified to teach at a secondary school because they only have a primary school teaching certificate, or they might be qualified to teach other secondary school subjects but not mathematics. We deliberately planned to engage with teachers qualified to teach mathematics because although secondary mathematics

content knowledge is an issue for most secondary school teachers [11], there was no enough time and resources to fully develop the unqualified teachers' content knowledge. Each lesson was taught in a different form 1 class. There were 40 students in each class. Out of the five teachers being focused on in this study, two were female teachers and three were male teachers. Their school is located in one of the cities in Malawi. Teaching 1 was done by a male teacher, Teaching 2 was done by a female teacher and Teaching 3 was done by a male teacher.

3.2.3 Data analysis

The qualitative exploration followed a grounded theory approach to data analysis by using inductive thematic analysis data analysis strategies to generate theory form the data [33]. The video recorded data was transcribed by the research assistants who assisted in collecting data. Both the video recorded and the transcribed data were made available to all 4 KOs for further analysis depending on research interests. However, it was mainly two KOs (KO1 and KO2) who conducted in-depth analysis of the data as they had interest in doing research on the LS. We (KO1 and KO2) began the analysis by reading the transcribed data individually several times and conducting open coding which generated many codes. After comparing the codes, discussing our differences and reaching consensus, we classified the codes to generate main themes which were used for grouping the data for further interpretation [33]. Several major themes were generated from all data, but the focus of this study was on two themes which are collaboration and KO intervention. Collaboration theme was generated from the instances where the teachers deliberated LS issues that could be related to or inferred to working together. KO intervention themes were generated from instances where the KO made some input or suggestions. Most of the discussions that focused on collaboration and KO intervention were in lesson planning and lesson reflection sessions data, as such, these sessions formed the main data that was analysed for this study.

Through further analysis of the data under the themes of 'collaboration', and 'KO intervention', I was able to examine how the teachers' talked about collaboration, so as to interpret how they understood it. Through analysis of how the teachers responded to the KO's suggestions, I was able to draw lessons for KOs. In some instances, the teachers' discussions required referring to other sources of data such as lesson plans and KO1's journal, therefore data triangulation was conducted for in-depth analysis and interpretation of the data.

3.3 Compliance with ethical standards

Considering that data for research was going to be generated at each phase of the LS, we observed several school-based research ethical principles as proposed by Bryman [33]. To gain access into the schools, we sought permission from the Education Divisional Office which manages secondary education in the region. The Education Division Manager granted us permission and introduced us to the head teachers of the schools. We sought verbal informed consent for data collection and publication from each teacher upon explaining to them the purpose of the LS and how we were going to collect data. Before each lesson, we sought consent from the learners by informing them that we were conducting a study and asking them if we could video record the lessons. Both the teachers and students were assured of anonymity and confidentiality, and this is evidenced through the use of pseudonyms in reporting the findings.

4 Findings

The findings are presented using 3 major themes that were further generated from analysing the data that was being focused on: teachers' take up of advice enhanced through KO's clarity and justification, teachers' interpretation of collaboration as division of labour, and teachers' interpretation of collaboration as mutual support and lesson ownership.

4.1 Teachers' take up of advice enhanced through KO's clarity and justification

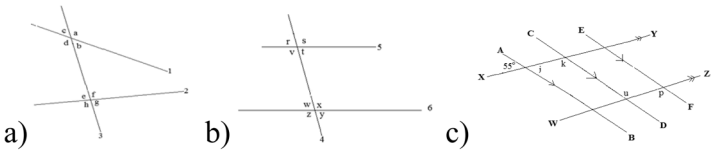
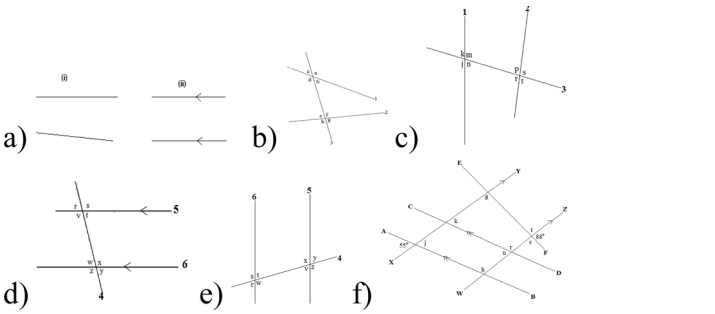
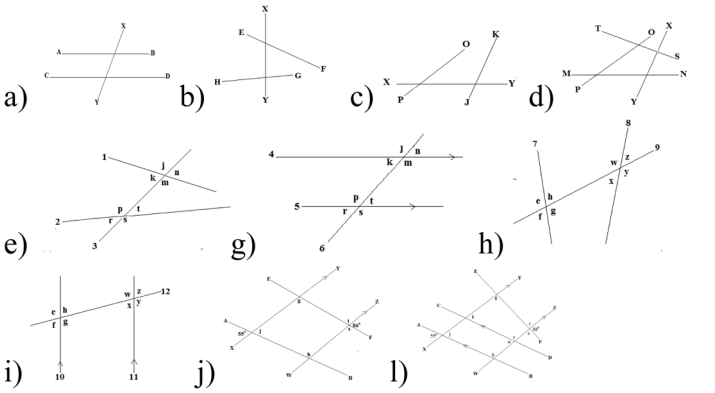
During their initial lesson planning (LP1A) session, which took place at their schools, all teachers were present throughout the planning session. There was no discussion on who would teach the lesson as was recommended during the PD workshop that the one to teach the lesson (called lesson teacher hereafter) should be nominated after completing all lesson preparation activities. The teachers agreed to engage learners in different tasks using examples presented in Table 1 in LP1A (a product of LP1A planning session) column.

In LP1A in Table 1, examples a and b were for the learners' task of measuring angles and inducing properties of angles formed between the transversal and both parallel and non-parallel lines. Example c was for the learners' task of applying the angle properties to calculate values of the lettered angles. During discussion of LP1A by all KOs, we noticed that the teachers varied the orientation of the examples and their complexity and used a counterexample of non-parallel lines. We attributed this to what they learnt from the PD workshop where the MTF was discussed with emphasis on varying of orientation and complexity of geometric examples (also called diagrams). We, however noticed that the teachers only planned one example for deducing each property, these we thought would not help the teachers to achieve their aim of promoting learners understanding of properties of lines and angles because of lack of other aspects of exemplification such as variation in terms of contrast. Therefore we agreed that KO1 should advise the teachers to consider revising the examples by (1) using at least two examples for inducing properties of lines and angles formed between the transversal and parallel and non-parallel lines to avoid generalising the properties from one case, (2) include examples for defining parallel lines. Part of the discussion between KO1 and the teachers focusing on revising the examples during LP1B planning session is presented in extract 1. Note that T is for teacher.

4.1.1 Extract 1: KO1 suggesting revision of examples

93. KO1 Remember that during the workshop, we discussed the MathematicsTeaching Framework where we were talking about examples and tasks for helping our learners to generalise. For example to say that if the lines are parallel, the angles formed by the transversal and the parallel lines, thecorresponding angles, alternate angles are equal and vice versa… Will these examples help you to make that generalisation? Remember, we talked about using varied examples to generalise.

Table 1 Example sets developed by teachers for the whole LS cycle

Lesson plan	Examples
LP1A	 a) b) c)
LP1B	 a) b) c) d) e) f)
LP2	 a) b) c) d) e) g) h) i) j) l)

94. T1 I think, for a start we can use the same variation where we just have two lines and a transversal. In the second lesson, that's where we can now have possibly two or three parallel lines as well as two or three transversals going in different directions.
95. KO1 ... We are teaching them to generalise that it is only when lines are parallel that corresponding and alternate angles are equal. We don't want the students to generalise from one example only. In this case we have one example where students are measuring angles on non-parallel lines and one example where they are measuring angles on parallel lines. So, what I wanted to suggest is that it would be better if we had at least two different examples of different orientations of parallel and non-parallel lines.
96. T1 The idea of bringing in two different examples, the variation that you are talking about is a good thing. They already know the alternate and corresponding angles, but the challenge is to understand the properties. So there should be examples or activities that will really assist the learners to make that final conclusion to say okay, if we say parallel, it can appear like this, it can also appear like this one.
97. T2 Maybe a suggestion here, in the first diagram on the non-parallel lines, the transversal is somehow vertical, probably, another diagram can be with lines, which are running somehow vertical but the transversal can be horizontal, changing the orientation (scribbles a diagram on paper).
98. T2 So that they should not only stick to the fact that for a transversal, it means the lines start from top to bottom. But emphasise that these are non-parallel lines, even if the transversal goes the other way round, still, if the lines are not parallel, the alternate angles cannot be equal.

As extract 1 shows, at first, T1 understood me (KO1) as suggesting that they should add a complex diagram with more than two parallel lines and one transversal (94) and he resisted that this being a first lesson, the examples for inducing the properties should not be more complex. When I clarified that I was only suggesting variation of the orientation of the diagrams but not their complexity to avoid generalising from a single example (95), they took up my suggestion (96, 97) and revised the examples as shown in LP1B in Table 1. This confirms that the role of the KO was crucial in helping the teachers to improve the quality of their examples, especially in clarifying pertinent issues that are not clear. A lesson for the KOs in this regard is that when their suggestions are clarified and justified, they can be taken up by the teachers with less resistance.

4.2 Teachers' interpretation of collaboration as division of labour

During LP1B planning session, four out of the five teachers were present at the beginning of the planning session. The teachers spent more time discussing the teaching and learning materials to be used during teaching 1. They decided to draw all examples for inducing and applying the properties of lines and angles (example b to f in LP1B in Table 1) on A4 papers with one example on each paper (called worksheets hereafter) and make a set of eight copies of each example for their eight groups of students in the classroom which had 40 learners in total. They agreed to distribute the worksheets to all groups of learners at once and ask them to first measure angles of examples b and c then induce some properties of pairs of angles formed by transversal and non-parallel lines. This would be followed by measuring of angles in examples d and e to also induce properties of pairs of angles formed between a transversal and parallel lines. The teachers also agreed that after the planning session, the lesson teacher would be responsible for printing the lesson plan and the worksheets and bringing them to classroom. Towards the end of the planning session while discussing how they would conclude the lesson, one teacher (T1) left. After agreeing on the conclusion task, the three remaining teachers started debating on nominating the lesson teacher. Extract 2 present part of the debate. Note that the lesson was to be taught in the form 1 class whose mathematics teachers was T1 (Note that T stands for teacher).

4.2.1 Extract 2: nominating the teacher for teaching 1

675. T2 I think it is necessary that we agree on who will teach the lesson?
676. T3 (nominated T2)
677. KO1 Is it possible to wait until Thursday morning so that you can nominate the teacher after preparing all lesson materials together.
678. T3 We will all assist in finalising the materials and lesson plan, but we stillneed to identify someone who will teach the lesson so that he/she can be prepared psychologically, I nominate …. (nominated T2)

679. T2 Not me, I have already done much work here with … (mentioned T4). We have been writing the corrections when we were discussing. A different teacher should now teach the lesson to show that all of us are participating in this lesson study, probably one of the form 1 teachers.
680. KO1 Do we have the form one teachers here? Because it should be someone who has participated in this planning session up to the end.
681. T2 & T4 Yes.
682. T4: We do have a form one teacher, she will teach although she is not here today, she still needs to take part in this activity as a group member so thatwe all have roles.
683. KO1 Oh, is it the madam who is not here?
684. T2 Yes, she is the one but she already suggested that we should nominate a different teacher as this lesson will be taught in her class, she suggested… (mentioned T1).
685. T3 Did you tell him before he left?
686. T2 No, I did not tell him, but since we have made the corrections together here, he will be able to follow.
687. KO1 I suggest that it should be someone who is here up to the end of the discussions because we have discussed some other revisions including how to assess learners understanding when concluding the lesson.
688. T3 But he left after we almost finished discussing the teaching tasks, so he should be able follow the lesson plan when it is developed and he will be briefed about the evaluation tasks. We can also come in to help him to prepare the materials if need arises.

As extract 2 shows, KO1 was advising the teachers on two issues, (1) pending nominating of the teacher of the lesson until lesson preparation was complete (677), and (2) nominating a teacher who participated in the whole planning session to teach the lesson (680, 687). Both suggestions were resisted by the teachers. The teachers went on to nominate a teacher who left towards the end of LP1B planning session (T1) to teach the lesson (686,688). Their rationale for each nominee revealed that at this stage of LS cycle, collaboration was understood as division of labour and not as mutual support (679). After performing a certain role, for example being a moderator during the planning session (T3) or recording proceedings of discussions, revising the lesson plan and drawing diagrams (T2 and T4), the three teachers thought that they were not supposed to participate in the final lesson preparation activities. As such T2 suggested that the lesson be taught by form 1 teachers, these were either T5 who was not present during the whole planning session (679) or T1 who left toward the end of the planning session and was neither the moderator nor the secretary. Although the KO did not clarify why the teachers should pend nomination of the lesson teacher until lesson planning is completed, T3 understood or probably recalled from the PD that they were all expected to support the lesson preparation and promised to do so (678). This is different from T3's view of offering help if there was need (688), which implies complete shifting of lesson preparation and teaching ownership to T1. The challenge for KO1 in this case was lack of knowledge and negotiating skills for helping the teachers to understand the importance of nominating a teacher who was present throughout the planning session to teach the lesson pending nomination of the teacher of the lesson until completion of lesson preparation. Here, a lesson to KOs is that it is difficult for teachers to pick up suggestions raised by KO when these are not clarified and justified, especially when the suggestions concern a new practice for them, which in this case is collaboration. Therefore Teaching 1 was taught by T1.

Teaching 1 was delayed for about 30 min because T1 who was the lesson teacher was finalising typing the lesson plan, printing and photocopying worksheets with the school secretary. I and the other four teachers waited for him outside the administration block. When he finished photocopying the worksheets we went to class. This meant that T1 worked alone to finalise the lesson preparations. During the lesson, he distributed copies of all examples to each group of students. He used examples a, b and d that are shown in LP1B in Table 1 for recalling the definition of parallel lines and naming angles formed between transversal and parallel and non-parallel lines. Examples b and d were also used to induce properties of angles formed between transversal and non-parallel lines. Although example e was not marked with arrow heads in LP1B, the teacher told the students to mark the lines with arrow heads on their worksheets to show that they are parallel lines.

After teaching 1, the teachers convened to reflect on the lesson. They were generally happy that the lesson went according to their plan and pointed out several good aspects of the lesson. They agreed that students participated actively in measuring angles and were able to generalise that corresponding and alternate angles are equal and co-interior angles are supplementary only if they are formed by parallel lines. The teachers however observed that learners spent more time on drawing the diagrams and measuring each of the angles and that some of the definitions given by the learners were not mathematically complete. Generally, the teachers agreed that T1 implemented the lesson tasks

as planned, confirming their argument that T1 was going to manage the lesson because he was present when critical decisions about the tasks and examples for inducing and applying the angle properties were decided.

On our part as KOs, when we convened to discuss the lesson after watching the video recording, we also agreed that the lesson was conducted according to plan and that the learners indeed took long to draw diagrams. In addition, we noted that the teacher mainly stressed on assisting learners to identify parallel lines using arrow heads but not necessarily to help them to understand parallel lines as being equidistant from each other. He only elaborated this point towards the end of the lesson when a learner drew two lines which were not equidistant but had arrowheads and asked if they were parallel lines. We therefore agreed that in PD2, I would suggest to the teachers to consider including examples that would help them elaborate on the point of parallel lines being equidistant. However, we did not discuss the issue of how we could convince the teachers to pend selection of lesson teacher before completing lesson preparations. This issue might have been overlooked probably indeed because the lesson was implemented as planned.

During LP2 planning session which started in PDW2, the teachers were watching the video recording of teaching 1 when revising their plans to observe areas requiring improvement. They agreed to add more examples to illustrate several points including the equidistance property of parallel lines as shown in LP2 in Table 1 as I suggested to them. We noted that the teachers might have agreed to the suggestion of adding more examples because they already experienced the need for elaborating the definition of parallel lines, so the importance of improving on examples was clear to them. As the aim of the lesson was not to improve the learners' drawing skills, but to increase their interaction with the diagrams through measuring and inducing properties, the teachers agreed that they would draw the diagrams for inducing properties on worksheets in advance. Like in LP1B planning session, towards the end of LP2 planning session, the teachers nominated T4 who was also not present to teach the lesson as a way of ensuring equal distribution of roles. Part of conversation on nominating the lesson teacher and KO1's suggestions are presented in extract 3 below.

4.2.2 Extract 3: nominating teacher for teaching 2

516.	T1	So, who will teach the lesson this time?
517.	T3	Madam… (Mentioned T4) volunteered that she will teach because she was not going to be part of the planning session.
518.	T2	Let her teach as part of her being part of the team, we will brief her on the changes. If she will have any challenges with the preparation we will helpher.
519.	KO1	I would like to repeat that it is better that the teacher of the lesson be nominated after all lesson preparation activities. Let me also repeat that it is also recommended that the teacher of the lesson be nominated from the team of teachers who are present during the planning session to ensure that they understand the tasks to be done in the classroom.
520.	T5	Yes, madam we agree. But we have not made many changes, more over she was present when we were discussing the flaws of previous lesson. Most of the changes that we have made were already agreed upon during lesson 1 reflection.
521.	T3	I agree, she will be able to understand the changes and handle the changes accordingly.

As with the case in extract 3, I also failed to convince the teachers on when to nominate the person to teach the lesson and who should be the teacher of the lesson (519–521). This is still attributed to my inability to clarify why the teachers needed to pend nominating of lesson teacher until finalising lesson preparation. The teachers therefore agreed that the lesson be taught by T4 who was absent during the planning session but volunteered to teach the lesson as a sign of her commitment to performing a specific role in the LS activity (517, 518, 520, 521). T2 pledged that they would explain to her the changes agreed and help her if needed (518), as also by pledged T3 during LP1B planning session. Meaning that at this stage of LS, the teachers still interpreted collaboration as division of labour and continued to shift ownership of the lesson preparations to the nominated lesson teacher who did not take part in lesson planning.

4.3 Teachers' interpretation of collaboration as mutual support and lesson ownership

Teaching 2 started on time, it was however surprising that T4 started the lesson by drawing examples for recalling meanings of parallel and non-parallel lines (examples a, b, c and d in LP2) on the board instead of distributing worksheets containing such diagrams for learners to analyse and answer questions as agreed during LP2 planning session. This had effects in terms of time as well as accuracy. Later on, it was evident that the worksheets that T4 brought to class were not enough as they were only distributed to three out of the eight groups of students for the activity of measuring angles to induce properties. Consequently, only the students from the three groups participated in discussing with the teacher the angle measurements and inducing the angle properties, implying minimal learner participation. In trying to increase learner participation during the task of applying angle properties to calculate values of angles, the teacher decided to group all students in the classroom into 3 large groups of about 13 students per group and asked them to do tasks on the worksheets.

In their initial discussions while reflecting on teaching 2, four teachers agreed that the lesson was a bit successful because T4 clarified the definition of parallel lines by emphasising equidistance of lines, an aspects of the lesson that the teachers aimed at improving. They however noted that their aim of promoting learner interaction with the geometric tasks was a challenge. T4 was quick to point out that the lesson was not successful because she did not have enough worksheets for the learners as she forgot to photocopy them. She further explained that she noticed while in the classroom that she had only three worksheets and these were for different activities (recalling knowledge, inducing lines and angle properties and applying the properties). So she decided to distribute these to three groups of learners for each group to do a single task. Although the other 4 teachers agreed with T4 about the lack of worksheets, they could not figure out the cause of the challenge until I enquired if T4's absence during LP2 planning session impacted on her lesson preparation and delivery as shown in extract 4 below:

4.3.1 Extract 4: causes of lack of teaching and learning materials during teaching 2

27. KO1 May be she can comment if her absence during lesson planning affected the lesson delivery. I mean although most of the changes were made and agreed in her presence during reflection on the first lesson, she was not present during second planning session where clear instructions and guidelines fordoing the tasks were agreed and some other changes were made.
28. T4 I would say that may be it is because I was also in a rush when going through the lesson plan that my colleagues developed. After the secretary printed the lesson plan and the worksheets, I only concentrated on understanding the planned activities. I did not check if the teaching materials were enough, so I think I was not well organised.
29. T5 I think we should not completely just look at her but I think it should be allof us. Because I think it is like when we sit and plan, even when someone may be was not there, but we must know that it is all of us who are doingthe teaching.
30. KO1 Yes.
31. T5: I feel like it is the actual team work that is some how lagging behind. Because regardless that she was not there, I think we are all to blame because we did not help her to assemble the teaching and learning materials. I feel like we could have produced the materials together and even checked with her before going to class. Furthermore, when the secretary completed typing the lesson plan and drawing the diagrams on the worksheets, madam here (meaning T4) presented them on our whatsApp group for commenting, but no one of us commented.
32. KO1 Okay.
33. T3 I agree, I think we could have done better, after the lesson plan and worksheets were finalised, we could again maybe briefly meet for twenty or thirty minutes, actually just to look at them together and maybe even polish them up. Through this we could have checked if the worksheets were correct and enough.
34. T2 This being a lesson study, it is supposed to be a team work activity. So, whenever we are planning together, we should take it that anyone can teach the lesson. So, that is the sense of togetherness… Even if we say, this one will lead us in the teaching, but everyone should be available to check the electronic lesson plan and

activity sheets. After the lesson plan and worksheets are printed, it is also necessary that we all meet for short time as my colleagues have suggested, to scrutinise them and ensure that we have all materials that we need for the lesson. So I agree, we need to accept the blame that we did not check if our colleague had all materials ready with her. It is like after planning or agreeing that this is what we should do and these are the examples and tasks to use, we leave everything to one person to complete the planning.

As noted in extract 4, although the teachers did not think that T4's absence during LP2 planning session contributed to the quality of the lesson, there was a shift in the teachers' interpretation of collaboration (29, 31, 33, 34). KO1's question provoked opportunities for the teachers to think of the causes of lack of enough worksheets, which in turn led to shifting the viewing of collaboration from only as meaning division of labour to also mean owning the lesson and working together until lesson preparation is completed and teaching is done. The teachers did not view T4's absence during LP2 planning session as the cause of the lack of teaching resources, but their own withdrawal of support or shifting of lesson to the lesson teacher. It is interesting to note that the teachers realised that their withdrawal of support implied lack of empathy, lesson ownership and mutual support (34, 29). Considering that teaching 1 was implemented according to plan although the teachers also withdrew support, of course probably because T1 was present up to almost the end of LP1B planning session, it can still be argued that T4's total absence from LP2 planning session might have affected the remaining lesson preparation process and consequently the lesson delivery.

The teachers agreed to do teaching 3 in another class using the same LP2 tasks and examples but revised how they would involve learners in doing these as well as the questions that they would ask the learners. They revised and prepared the worksheets together before nominating T2 to teach the lesson. When the teachers gathered to reflect on teaching 3 after the lesson, they were happy with the teaching, especially because all learners were actively involved in measuring angles, inducing the line and angle properties and applying them to calculate values of angles, thus an achievement of their aim of the LS. They mainly attributed the success of the lesson to their working together and owning of the lesson during lesson preparation which lead to implementation of the lesson according to their plan, hence a shift in their interpretation of teacher collaboration from division of labour to mutual support and lesson ownership throughout the LS process.

5 Discussion

Both teaching 1 and 2 were done by teachers who were nominated in their absence. The difference was that while T5 participated in most of the LP1B planning session for Teaching 1, T1 did not participate in LP2 planning session for teaching 2. Three interesting issues arise from the findings in relation to teachers' interpretation of collaboration and KOs' learning from the LS (1) whether teacher's absence from the lesson planning session can affect lesson implementation, (2) whether nominating a teacher before finalising lesson preparation can affect lesson implementation, and (3) whether KO's lack of facilitation skills influence teachers' take up of his/her suggestions. The first two issues relate to how teachers interpret collaboration in LS while the third issue relates to what KOs can learn from conducting LS with teachers inexperienced in LS. I discuss these issues in detail in the following sub-sections.

5.1 Teachers' interpretation of collaboration as division of labour

When teachers build their own professional learning communities, they take both individual and mutual ownership in learning how to improve their teaching practices [16, 17]. As the findings have shown, through co-construction pattern of collaboration [24, 25], the teachers met physically and socially constructed their knowledge together through planning, observing and reflecting on the lessons in line with Dudley et al. [17]. However, there were moments where the pattern of collaboration shifted to working individually with the aim of ensuring that every member contributed to the LS. This shift is attributed to the teachers' understanding of collaboration as fair division of labour and it led them to nominate a teacher who was either not playing any role, for example, of being a scriber during the lesson planning sessions (such as T5) or was not present during the planning session (for example T4). The division of labour understanding of collaboration by the teachers might have been influenced by their routine individualistic practices of planning and teaching lessons. While this approach made each teacher feel responsible for playing a noticeable role and having a fair share of the tasks, it led to individual working by the lesson teacher and to lack of ownership of the lesson by the other teachers, confirming findings from Peterson et al. [7] that when a teacher was chosen in advance, lesson ownership

began to drop. I argue here that although sharing of tasks for independent working is a type of collaboration that is also widely practiced in Japan and other countries during LS, in the Malawian case where the teachers are not experienced in doing LS, this pattern of collaboration still needed to be blended with mutual support as also suggested by one of the teachers during reflection for teaching 2.

There were different outcomes from the delivery of Teaching 1 and Teaching 2. According to the teachers, Teaching 1 was successfully implemented as planned. I agree with the teachers that since the lesson teacher was present during LP1B planning session, where decisions about the learners' worksheets were agreed, he knew the final lesson preparation tasks to be carried out. The teacher might have handled well the tasks for the lesson conclusion, a lesson planning part which was planned in the teacher's absence because it only included asking learners to explain the properties of angles formed between a transversal and parallel lines. Since these properties were already discussed and emphasised during planning of tasks for inducing and applying the angle properties, it was not challenging for the teacher to conduct the lesson as planned. Probably this explains why the teacher's partial absence from the planning session and his colleagues' withdrawal from lesson ownership did not affect the lesson implementation.

As agreed by the teachers during reflection for Teaching 2, the shifting of lesson ownership to the lesson teacher affected the lesson implementation. The teachers' observation agrees with literature that one of the challenges of collaboration during LS is lack of ownership of LS by individual teachers [16] and that selection of the lesson teacher before finishing lesson preparations can make teachers stop contributing actively during LS as it results into shifting of the lesson preparation [7].

5.2 Shift from interpreting collaboration as division of labour to also mean individual and group ownership of lesson.

In this paper, I argue that in addition to shifting of lesson ownership to the lesson teacher, the quality of lesson implementation can worsen when the lesson teacher who is chosen in advance did not participate in planning for the lesson. As the findings from this study have shown, the lesson teacher's absence from lesson planning session for teaching 2 resulted into knowledge gaps on the final lesson preparation tasks that she was expected to do, unlike in teaching 1 where the lesson teacher was available for most part of lesson planning session and knew the final lesson preparation tasks to be done. This might imply that T4's absence coupled with her colleagues' withdraw from lesson ownership affected the quality of the lesson. These findings confirm literature which recommends that all teachers must take part in the planning sessions to develop together the knowledge of improving the lesson and understand implementation of the teaching and learning tasks [7, 16]). Although the teachers did not directly agree that the teacher's absence affected the quality of the lesson even after teaching 2, they co-constructed their interpretation of collaboration as involving lesson ownership and continued working together in all stages of LS as suggested by Peterson et al. [7] that LS is successful when all teachers in the group work together from conceptualisation of the problem to planning, teaching and lesson reflection. Although one teacher would teach the lesson, all teachers are expected to assume ownership of the lesson, as such, a teacher who would teach the lesson should not be known until the teaching day [7]. This agrees with what the teachers learnt during reflection of teaching 2 that the failure of the lesson was due to withdraw of their ownership of the lesson upon nominating the teacher of the lesson. Also confirming Richit et al. [11] that mutual encouragement and support, cooperation, and reflection are critical intrinsic features to collaboration. In the South African LS, the challenge of collaboration arose because the teachers felt that they were being personally attacked during lesson reflection and began to view the reflection phase of LS as less useful [32]. In this study however, although T4 did not teach the lesson according to plan, the fellow teachers did not attack her, instead they blamed themselves for the failure of the lesson. Consequently, the lesson reflection phase proved to be more useful for the teachers as it became a vehicle for promoting their learning of both how to improve the teaching of geometry as well as how to collaborate during LS. This agrees with Lewis et al. [16] that one of the major goals of the reflection phase is to articulate what individual team members and observers learned from the lesson study cycle, so that this knowledge becomes available to others within and outside the team. When the teachers in the LS agreed to plan the lesson and teaching materials together, and decided to conduct peer teaching, their lesson was successful. The fact that the teachers attributed the lesson success to their working together and ownership of the lesson meant that they had opportunities for expanding their learning about teacher collaboration. Thus in addition to learning how to improve their teaching of geometry, the teachers also increased their knowledge of the LS process. Confirming Gutierez [20] that when teachers collaborate well during lesson planning and lesson reflection, their learning from LS is enhanced and their bonds of mutual support and trust are strengthened.

In addition, as the teachers learnt this in the context of a lesson that was not implemented according to their plan, this also confirms the importance of reflecting on lessons that shift from the original plan in a lesson study as suggested by Lewis et al. [16]. It was through discussing the causes of the flaws in teaching 2 and the successes in teaching 3 that the teachers learnt about collaboration as involving exercising lesson ownership and mutual support. As a sign of sense of ownership, they realised that each teacher needed to assume that they were going to teach the lesson, hence indirectly agreeing with the KO1's prior suggestion as well as confirming literature which recommend pending nomination of the teacher of the lesson until all lesson preparations are completed [7]. Through the teachers' practicing of their interpretation of collaboration as involving lesson ownership in preparation for teaching 3, this study also confirms that ideas for lesson improvement that emerge from discussions during lesson reflection need to be verified and refined through lesson re-enactments [3]. Similar findings are also reported by Richit et al. [34] and Gutierez [20] that through mutual support and encouragement, trust and motivation for continued belonging to a LS group is established, hence the LS group's professional learning is promoted. Helping the teachers to develop mutual support and encouragement to enhance the teachers' professional learning was one of the roles of the KOs in this study. Through the teachers' mutual decision to do teaching 3 on their own, we learn that when teachers are helped to understand the implications of their actions or decisions on lesson quality, they willingly take initiatives to devise solutions for improving their lessons.

5.3 Lessons for knowledgeable others on conducting lesson study with teachers inexperienced in lesson study.

The roles of the KOs in the Malawian adapted LS were different from those of Japanese LS because the Malawian secondary school teachers were not experienced in LS, so they were not only learning to improve on their lesson preparation and delivery, but they were also learning to do LS. As such, the KOs needed to help the teachers to understand how to conduct LS, so during lesson planning and reflection, she did not only intervene on content issues but also on LS process. Three suggestions by KO1 are reported in this study, one of these was taken up by the teachers while two were resisted. The suggestion which was taken up easily by the teachers focused on examples, a dimension of MTF which was easily taken up by the teachers during PD and implemented in their lesson planning [35]. Examples are widely used in mathematics and are a critical pedagogical tool in facilitating the learning process in mathematics, hence they are also regarded as the main source of learning mathematics [36]. Thus selecting of examples is one of the complex and critical routine practice for mathematics teachers. As such, the teachers might have taken up the suggestion of revising the example set because this was a familiar practice for them as also confirmed by Adler and Alshwaikh [12] and Mwadzaangati [35]. The teachers' quick take up on the suggestion to revise examples might have also been influenced by KO1's ability to justify the need for the revision. This justification was possible because KO1 was already familiar with the aspect of exemplification in the MTF and had also discussed with the other KOs why it was necessary to revise the examples.

Two suggestions that were not taken up by the teachers despite being repeatedly emphasised were: (1) nominating a teacher who was present throughout the lesson planning session to teach the lesson, and (2) pending nomination of the teacher to teach the lesson until all preparations for the lesson were completed. Although these issues are critical for the success of LS [23], KO1 failed to challenge or convince the teachers when they resisted, a challenge that is commonly faced by inexperienced KOs [2]. As Lewis et al. [16] and Seino and Foster [23] explain, novice KOs of LS face challenges because they have very little tools to manage resistance. KO1's lack of facilitation experience did not only lead to failure to contend with the teachers' resistance, but it also raised a dilemma regarding the extent to which KOs can push teachers to take their advice and when to give teachers autonomy to make final decisions about their teaching plans. These findings confirm Adler and Alshwaikh [12] that the role of the KO is crucial and significant in cascading the implementation of LS in new contexts where both the teachers and the KOs are inexperienced in conducting LS.

Although it is recommended that LS be introduced by experienced KOs in new contexts [29], this was impossible in Malawi due to lack of resources. As a result, the LS was introduced by KO1 who had attended PD sessions on the theoretical process of LS but was not familiar with participating in and facilitating LS practically. Therefore, KO1 depended on the two experienced KOs who acted as remote trainers for the inexperienced KOs. When the experienced KOs watched video recordings of lesson planning, lessons, and lesson reflection sessions together with the inexperienced KOs and discussed feedback to be shared with teachers by KO1, the teachers usually welcomed the feedback probably because it was clearly justified. However, the challenge for KO1 was on addressing other pertinent issues that rose during the teachers' discussions and needed immediate intervention and how to justify her suggestions so as to convince the teachers to adopt them. This implies that the challenges of inexperienced KOs are even greater when LS is a new practice to them because they are not only learning to facilitate LS but also learning the process of LS itself. As such, they

face difficulties to motivate teachers on issues that they themselves are not knowledgeable and experienced in. Thus, the findings further suggest that when the experienced and inexperienced KOs collaborate remotely, the opportunities for both teachers' learning and the inexperienced KO's learning might be delayed or slowed down. These findings imply that the challenges of introducing LS to secondary mathematics teachers in Malawi are not only associated with understanding and implementing theory driven frameworks that are used to structure discussions as reported earlier by Adler and Alshwaikh [12] and Planas et al. [37], but also in understanding the practice of LS itself by both the teachers and the inexperienced KOs. Confirming literature which indicate that educators who adopt and adapt LS outside Japan experiences difficulties in implementing LS because they only possess theoretical knowledge of LS but not practical knowledge as they lack first-hand experience of LS [18].

5.4 Limitations of the study

As it is the case with small qualitative studies, this study has got some limitations. Firstly in this study I have only reported on how the teachers collaborated in one LS cycle. I can therefore not claim that the teachers' practices in terms of collaboration in LS continued to improve unless a follow-up study is conducted. Secondly, the focus of the study has only been on the teachers but not students, so the findings of the study do not illuminate whether the improvement in teachers collaboration really resulted in improvement in learners' understanding of the concept of lines and angles as no interviews were conducted with the learners.

6 Conclusion

In this paper, I started by describing LS as a powerful teacher PD practice and highlighted on teacher collaboration as a premise in which learning occurs with the help of the KO. Then I explained the state of Malawian mathematics teachers in terms of their participation in LS, followed by reviewing literature on teacher collaboration and the role of the KO in LS. The reviewed literature showed gaps in terms of clarifying how inexperienced KOs work with teachers when adapting LS in new contexts and called for more research in this issue. I have addressed this call by providing empirical evidence on how secondary mathematics teachers' understanding of collaboration shifted from division of labour to mutually working together, and what KOs can learn from LS conducted by inexperienced KOs. The findings reveal how teachers' knowledge of collaboration shifted from that of division of labour to that of working together to achieve a common goal. This learning opportunity was opened up for the teachers through deliberation on lesson that was not implemented according to their plan as well as during planning and reflecting on a remediating lesson. An evidence that lessons that deviates from teachers' plans are also powerful tools for teachers' learning in LS. This study also provides evidence about the KOs challenges in conducting LS in contexts where the practice is new to both the facilitating KOs and the teachers, and the importance of building the capacity of KO's competences in facilitating LS. I make three conclusions about lessons for KOs especially those adapting LS in new contexts. The first is that when the teachers understand the KOs' motive behind their suggestions and when the suggestions are in line with the teachers' routine practices, the teachers might not resist much, unlike when they are imposed to new and unclarified instructions. This conclusion poses a challenge for the KOs to improve their capacity or skills in making elaborate and justified suggestions when facilitating LS in new contexts. The second is that when the KO's questions probe teachers' thinking about their practice or decisions, opportunities for teacher learning are opened up during lesson reflection. This also challenges KOs to be critical observers at each stage of LS in order to prompt teacher thinking with relevant questions. Like any practice, resistance is normal, hence this calls for studies on knowledge and skills for handling teachers' resistance during LS. These findings further suggest that inexperience KOs working with LS in new contexts require more time and prompt guidance from experienced KOs to improve their LS facilitation skills, and that more practicing of facilitating LS can provide learning opportunities for inexperienced KOs to improve their facilitating skills. Thus the role of the KO is very critical especially when it is not so trivial for teachers to move from their routine practices. Considering that the teachers' shift in their understanding of collaboration from division of labour to mutual working and supporting took place in the context of LS, I also conclude that LS opens learning opportunities for collaboration in contexts where teachers are used to working individually.

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Declarations

Competing interests The authors declare no competing interests.

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