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# What questions do mathematics mentor teachers ask?

Raymond Bjuland, Reidar Mosvold and Janne Fauskanger

University of Stavanger, Faculty of Arts and Education, Stavanger, Norway, [raymond.bjuland@uis.no](mailto:raymond.bjuland@uis.no)

*Lesson study was originally a professional development initiative from Japan. In some of the previous attempts to introduce it into initial teacher education, the role of the teacher educator has been highlighted. In this study, we analyse the questions that two mathematics mentor teachers ask in mentoring sessions, one in a lesson study intervention and one in a regular practice period in teacher education. Our findings indicate that the mentor teacher's questions in the lesson study intervention were more focused on planning, observation and pupil engagement and less focused on a deep understanding of the mathematical content.*

**Keywords:** Lesson study, initial teacher education, mentoring sessions, questioning.

## INTRODUCTION

A main goal in teacher education is to develop reflective practitioners who are able to carry out the work of teaching mathematics with high quality and proficiency. Lesson study has a focus on teachers' critical reflection about the content and organisation of lessons in order to develop more high-quality teaching and learning. A decisive feature of lesson study is that groups of teachers conduct focused observation of lessons along with collection of data necessary to collectively analyse the lesson (Lewis, Perry, & Murata, 2006). Although originally used in systematic professional development in Japanese schools, lesson study has lately been applied also in teacher education (Hart, Alston, & Murata, 2011). When Murata and Pothen (2011) implemented lesson study in mathematics methods courses for student teachers, they devoted 8–9 weeks to preparation and lesson planning, and they also underlined the importance of the written guidelines in creating lesson plans as well as carrying out the entire lesson study. Dudley and Gowing (2012) argue that lesson study is relevant for student teach-

ers because it enables them to learn from detailed micro-level practices and allows them access to the tacit knowledge of their experienced mentor teachers.

The teacher educator has an important role when lesson study is applied in teacher education (Potari, 2011). In the school-based part of initial teacher education in Norway, the mentor teachers have the role of teacher educators (Nilssen, 2010), and the interaction between the mentor teacher and student mathematics teachers is important in this respect. Recently, lesson study has been implemented in a Norwegian teacher education context, and the role of the mentor teacher is a natural focus of investigation. Initial teacher education in Norway is organised as a four-year bachelor programme with 20 weeks of field practice. For this research project, the student teachers were in their second year (fourth semester), preparing for a three-week long field practice.

In this paper, we focus our attention in particular on the questions posed by two mathematics mentor teachers in the pre- and post-lesson mentoring sessions. We approach the following research question:

What kind of questions does the mentor teacher ask in mentoring sessions in a lesson study intervention compared with the questions asked in a regular period of teaching practice?

As our initial attempt to investigate this question, we analyse two cases: one mentor teacher and a group of student teachers in the lesson study intervention, and another mentor teacher with her group of student teachers in a regular teaching practice with no lesson study intervention.

## MENTOR TEACHERS ASKING QUESTIONS

In a review of research on the role of mentor teachers in mentoring dialogues, Hennissen and colleagues (2008) found that mentor teachers are normally directive and focused on organising activities. This coincides with analyses of mentoring sessions in Norway (Helgevold, Næsheim-Bjørkvik, & Østrem, 2014). In this paper, we investigate the questions that mentor teachers pose to student teachers when mentoring them in connection with the teaching practice that is part of their initial teacher education. Asking questions is related to characteristics of mentor teachers with non-directive supervisory skills, highlighted as important for student teachers' learning (Hennissen et al., 2008).

Gadamer (2004) proposes that questions are imperative to the development of knowledge, but this requires that the questions are "true". He refers to questions where the answer is already settled as apparent questions; questions where the answer is not settled are referred to as true questions. Following Gadamer, it can be argued that mentor teachers should ask true questions, which guide the student teachers toward subject matter knowledge (SMK) and pedagogical content knowledge (PCK) in the mentoring sessions (Johnsen-Høines, 2011).

Posing questions that guide the student teachers toward SMK and PCK relates to Shulman's (1986) early categorisation of teacher knowledge. His categories have been important for the development of several frameworks for teacher knowledge. Shulman divided teachers' content knowledge into three domains: SMK, PCK, and curricular knowledge. PCK relates to instruction, integrating teachers' knowledge of content with their knowledge of pedagogy. SMK, on the other hand, relates to content knowledge only. Shulman's work, in particular PCK, has created debate and has given rise to new categorisations (e.g., Graeber & Tirosh, 2008), all including knowledge of instructional strategies and knowledge of pupils' understanding (e.g., Ball, Thames, & Phelps, 2008). Both types of content knowledge are highlighted as important for high quality teaching (e.g., Ball et al., 2008). A focus on SMK and PCK is therefore emphasised as important in mentoring of student teachers (Johnsen-Høines, 2011). Therefore, it is of importance to study the content of questions posed by mentor teachers while mentoring student teachers.

## METHODS

The present study is a part of the larger TasS ("Teachers as Students") project. This project aims at investigating student teachers' learning in field practice through a time-lagged design experiment (Hartas, 2010). Two groups of student teachers from each of four subject areas (mathematics, science, English as a foreign language, and physical education) participated in a control group situation; the same number of groups participated in an intervention situation. The control group is referred to as the "business as usual condition" (BAU), and the intervention group is referred to as the "lesson study approach condition" (INT). In BAU, data collection included video observations from student teachers' planning lessons with their mentor teacher (pre-lesson mentoring sessions), from carrying out lessons and from mentoring sessions after carrying out the lessons (post-lesson mentoring sessions). In INT, data collection included video observations from pre-lesson mentoring sessions, from carrying out lessons, from mentoring sessions after carrying out the lesson for the first time, carrying out the lesson for a second time, and from post-lesson mentoring sessions. In mathematics, which is in focus here, data were collected from four groups of student teachers (two BAU and two INT groups) altogether. In one of the INT groups, the mentor teacher was replaced by a colleague during the lesson study cycle due to sick leave. In this paper, we therefore analyse the four mentoring sessions from one BAU group and one INT group. The duration of the mentoring sessions varied from 18 to about 46 minutes (see Table 1). Both the mentor teacher from the BAU group (we have called Rut) and the mentor teacher from the lesson study intervention (referred to as Ina) are experienced mathematics teachers.

The mentor teachers in the lesson study intervention participated in three workshops on lesson study. In the first workshop, the mentor teachers were introduced to important ideas concerning lesson study and the different phases of the lesson study cycle. The aim of the second and third workshops was to develop a draft version of a "Handbook for Lesson Study". Inspired by Munthe and Postholm (2012), this handbook provided suggestions for possible questions to ask throughout the lesson study cycle. More specifically, crucial elements of the handbook were to highlight questions that could help the student teachers to make a detailed lesson plan, emphasising careful

planning and focused observations with a clear content goal for the research lesson. The handbook also stressed the importance of posing a research question for the research lesson. This research question would normally have a focus on increasing pupils' learning of the mathematical content. An aim of the planning and observation throughout the lesson study cycle is to answer this question. The aspects stressed in the handbook are closely related to SMK and PCK.

The unit of analysis is the mentor teachers' questions as posed in the mentoring sessions. The analytical approach is directed content analysis (Hsieh & Shannon, 2005), and the coding was inspired by important elements emphasised in the handbook. In order to increase the reliability of the coding, the first and third authors coded the questions independently. The codes were discussed and agreement reached in the few instances where there was a mismatch. The second author then revised and ensured that the coding was consistent.

Initially, we identified three main categories: *Observation*, *Planning* and *Other*; these were further split into sub-categories of questions (see Table 1, first column). The mentor teachers' questions that are related to more general comments, concerning observation in the classroom were coded as *Observation* (Obs). The subcategory Obs-Goal is related to the goal for the lesson. Obs-Content focuses on mathematical observations from the classroom. The subcategory Obs-Pupil highlights observations about pupils' learning. The subcategory Obs-Teaching is related to observations based on incidents from the student teachers' teaching in the classroom.

The questions that are related to the planning of a lesson were coded as *Planning* (Plan). The subcategory Plan-Goal focuses on the planning of a lesson with a more general focus on the goal. The subcategory Plan-Content is related to a focus on the mathematical content. The subcategory Plan-Pupil Engagement highlights questions, emphasising how the chosen problems or activities could lead to increasing or decreasing pupil involvement and motivation. Plan-Prediction refers to the subcategory of questions that is related to possible teaching problems or pupil difficulties that may arise in a lesson. The subcategory Plan-Teaching focuses on questions that are related to practical considerations about the organisation of the teaching activities.

The third category, *Other*, refers to questions that do not fit into any of the other categories, for instance, a question about practical issues and clarifications. Two particular consecutive questions, challenging the student teachers to reflect on what they have learned about the pupils' learning, were also included in this category.

In Table 1, MS1 and MS2 refer to the mentoring sessions before and after the first (research) lesson that was recorded; MS3 and MS4 refer to the mentoring sessions before and after the second lesson. The four student teachers of the INT group had written in their lesson plan document that the plan for the research lesson was to teach the pupils in this particular tenth grade class about algebraic factorisations and how to simplify algebraic expressions. In the BAU group, the three student teachers' plan for the first lesson was to teach the pupils in this eighth grade class about the equal sign and the unknown, helping the pupils understand the balance in a simple equation like  $\text{box}(x) + 3500 = 5000$ . In the second lesson of the BAU group, the student teachers planned to teach the pupils about the difference between an unknown and a variable.

## RESULTS

In our analysis, we mainly focus on the qualitative differences between the two mentor teachers' questions. When applying content analysis, however, a combination of counting the frequency of particular words or content and a more qualitative interpretation of the content is often used (Hsieh & Shannon, 2005). In our study, the counting of frequencies was useful to discover patterns in the data that were later investigated more qualitatively. Table 1 displays the comparison of relative frequencies of the different categories of questions posed by Ina and Rut.

### Planning for pupil engagement

In lesson study, there is a focus on planning for pupil engagement, not only on how to deliver the content (e.g., Dudley & Gowing, 2012). Rut, the mentor teacher in BAU (Table 1, shaded columns), did not ask any questions related to planning for pupil engagement. She was more focused on questions related to prediction and planning the teaching. Ina, the mentor teacher in the intervention (Table 1, white columns), on the other hand, asked a number of questions about planning for pupil engagement. In the first mentoring session, when discussing pupils who were not active,

	MS1		MS2		MS3		MS4	
	BAU	INT	BAU	INT	BAU	INT	BAU	INT
<b>Observation</b>								
- General	0,08	<b>0,28</b>	0,07	<b>0,22</b>	0,10	0,05	0,00	0,07
- Goal	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,00
- Content	0,00	0,00	0,12	0,08	0,07	0,00	0,14	0,00
- Pupil	0,00	0,00	0,10	0,16	0,00	0,16	<b>0,28</b>	<b>0,17</b>
- Teaching	0,00	0,00	0,12	0,03	0,00	0,03	0,27	0,07
<b>Planning</b>								
- General	0,08	0,14	0,06	0,14	0,02	0,11	0,00	0,00
- Goal	0,03	0,07	0,05	0,03	0,00	0,00	0,02	0,10
- Content	0,15	0,10	0,05	0,03	<b>0,26</b>	0,16	0,08	0,00
- Pupil Eng.	0,00	<b>0,20</b>	0,00	0,11	0,00	0,14	0,00	0,07
- Prediction	<b>0,36</b>	0,10	0,07	0,03	0,10	0,05	0,02	0,03
- Teaching	<b>0,31</b>	0,03	0,16	0,08	<b>0,21</b>	<b>0,22</b>	0,17	0,00
Other	0,00	0,07	<b>0,21</b>	0,08	<b>0,26</b>	0,08	0,03	<b>0,50</b>
Duration	18:17	33:43	40:36	33:33	19:45	33:53	46:10	38:12

**Table 1:** Relative frequency of questions in the four mentoring sessions

Ina asked: “Yes, what do you think we as teachers can do then, in order to include these pupils?” Later in the same mentoring session, they were getting more practical and discussed tasks that are suitable for a diversity of pupils: “Do you feel these tasks are suitable for all levels? I mean, to start with what is known in order to move them along.” As a third example from the same mentoring session, Ina addressed the issue of motivating pupils to learn algebra: “Yes, how are you going to motivate all pupils to learn algebra? Because that should be the goal, right?” Later on she asked about the potential use of manipulatives and games to motivate pupils.

In the second mentoring session, after the teaching of the first research lesson, Ina asked: “Could you have done it differently in order to get more pupil engagement?” Later, when commenting on how two of the student teachers reported that they had ignored some initiatives from the pupils, she asked: “Do you think you managed to activate the pupils? Could they have been even more active, participated more, contributing more verbally?” Towards the end of this mentoring session, she commented on the diversity of pupils in the class, and she asked: “Looking back at this group of pupils, I’m thinking: how could we ensure that everyone is following us?” She returned to these questions in the next mentoring session, where the student teachers were planning for the second teaching of the research lesson. One of the student teachers commented that she would observe whether or not the pupils are active, and Ina challenged her on this: “Yes, you say that you will observe if they are

active, but there are some pupils who never participate or say anything. How are you going to ensure that they participate?” This question was followed by some questions about how they were going to observe the pupils during the research lesson. This leads to another interesting difference between the two groups. In the intervention, the mentor teacher posed more questions related to observation, which is also highlighted in lesson study research (e.g., Dudley & Gowing, 2012).

**Focus on observation**

A feature of lesson study is that teachers use observation as a means to collect data in order to analyse a lesson (Lewis et al., 2006). We find examples of such questions about observation in the first mentoring session in the intervention group. Having grasped this aspect of lesson study, Ina challenged the student teachers with regards to observation: “How are you going to observe to see that the pupils actually learn something from the teaching, in relation to what you have been planning and the goals you have?” One of the student teachers responded that they are going to observe which pupils are active and which not. Ina followed up by asking: “Yes, but what about pupils who are not active in the lesson, who you don’t observe raise their hands, would that imply that they have not received anything, or that there is no learning?” When the student teachers responded that they plan to ask the pupils after the lesson, Ina continued to challenge them on this: “Yes, what do you think is the reason that they – if it appears that they have really

learned something from the lesson – that they are not active; what is the reason for that?”

In the second mentoring session, Ina reminded the student teachers about what they had planned to observe, and she asked: “What issues were the observations supposed to focus on? [...] [W]hat questions did you pose yourselves there?” Later on in the same mentoring session, she asked: “How did you plan this thing about observation before [the lesson]? Did you ask yourselves how, what you were going to observe, how, and why?” When planning for the second teaching of the research lesson, in the third mentoring session, Ina returned to this and asked: “And how are you then going to see and evaluate whether or not the pupils learn?” She followed up with questions about how they were going to plan for pupil engagement, before she posed some more questions about how they were going to observe the pupils.

Rut also posed some questions concerning observation in the mentoring sessions in the BAU group, but her questions were different from Ina’s. Whereas Ina focused on challenging the student teachers about how they were planning to observe, using observation as a tool to collect data (e.g., Lewis et al., 2006), Rut mainly asked questions related to observation in the sessions after the lessons. Her questions were mainly focusing on what the student teachers asked and what the pupils responded. As an example, they were discussing some observations from the first lesson (in the second mentoring session), and Rut said: “And then you underlined this and said: Yes, so you thought the opposite, how many ice creams do you need?” This question was related to an observation of pupils, but Rut was mainly referring to the student teacher’s question rather than asking about the pupil’s learning. Shortly after, she asked a question related to an observation concerning the content: “Is this a correct use of the equal sign?” This leads to another observed difference between the two mentor teachers. Whereas Ina asked more questions about planning and observation, Rut asked more questions that focused on content. This is interesting, since a deep reflection about content is emphasised in lesson study research (e.g., Murata & Pothen, 2011).

### **Focus on content**

In the third mentoring session, prior to the second lesson, Rut asked several questions about how the student teachers planned to present the content. At

the beginning of the session, she asked the following question to clarify the focus of the lesson: “So, the lesson is really about variables then?” Shortly after, she posed another question about the content: “Are you going to end up with some kind of definition, or are you only going to teach them about variables?” After having discussed this for a while, they started to discuss the concepts of ‘unknown’ and ‘variable’. Rut asked: “Why do we use two different words [variable and unknown] in this situation?” When one of the student teachers responded, Rut continued to challenge them about the connection between these two concepts by asking: “Because we end up with letters in both, don’t we?”

Later, in the third mentoring session, Rut posed some more questions about planning and observation related to content: “It is about an expression that contains parentheses, but we mentioned yesterday that we are missing a small revision really, about what a parenthesis really is? And then one of the pupils also asked: What is it really, what does a parenthesis mean?” She followed up by challenging the student teachers about the meaning of a parenthesis by asking: “How would we respond to that, what does a parenthesis really mean?”

In comparison, Ina asked fewer questions that focused on content. Her questions seemed less focused on challenging the student teachers about their understanding of the content and more focused on the pupils’ learning of the content. Some examples from the second mentoring session, after the first research lesson, illustrate this: “If you had asked her [referring to one of the pupils] if she knew prime factorisation, do you think she would have known what to do then?” In the third mentoring session, she posed some more questions about prime factorisation, but this time with a focus on the planning of the second research lesson: “And then you mentioned about prime numbers, because in the previous lesson you started off directly with factorisation and didn’t mention prime numbers a lot. And I observed that, and if this is what is important, that they should be able to do prime factorisation, then you should probably mention it?” Later she followed up by asking another question about their planning of this: “Yes, and then you are going to explain factorisation and reducing?” When comparing the two, it appears that Ina focused less on asking questions about the content than Rut, and when she did, her focus was more on how the student

teachers were going to plan their teaching of the content in order for the pupils to learn. Rut was more focused on challenging the student teachers' own understanding of the content.

## CONCLUDING DISCUSSION

Teachers who participate in lesson study are supposed to have a strong focus on specifying a clear goal for the lesson. In addition to this, a deep reflection about content as well as pupil engagement and prediction of pupils' responses is often emphasised in lesson study groups (Munthe & Postholm, 2012; Murata & Pothen, 2011). When implementing lesson study in teacher education, the role of the teacher educator has been stressed (Potari, 2011). In our study, the mentor teacher had the role of a teacher educator, and it is thus interesting to observe the differences in emphasis in the mentor teachers' questions in these two groups. We notice that the mentor teacher in the business as usual condition asked far more questions regarding the mathematical content and teaching (Table 1, shaded columns). The questions on teaching were, however, mostly related to practical issues such as organisation. Contrary to what one might believe, we observe that this mentor teacher also had more questions relating to prediction of pupil learning than the mentor teacher in the lesson study intervention. More specifically, the analyses of the BAU-sessions have revealed that the mentor teacher (Rut) posed several questions on Plan-Content and Obs-Content, and these questions have the potential of being true questions (Gadamer, 2004). We suggest that these types of questions, emphasising the mathematical content to be learned by the pupils in the classroom, could be an important affordance that might inform future implementations of lesson study (Table 1, white columns). Our analyses have also illustrated that these types of questions were not that prominent in the INT sessions.

Murata and Pothen (2011) emphasise the importance of spending a lot of time on preparation and lesson planning, discussing the mathematical theme in focus. The student teachers in this study did not have the same opportunity to work on their lesson planning for several weeks and future implementations of lesson study might consider this. The student teachers in our study had also finished their course work in mathematics before their period of teaching practice and the subsequent lack of involvement from the teacher educator at the university could have led to a lack

of focus on the mathematical content in the lesson study cycle. The lack of time for preparation and lesson planning as well as the lack of involvement by the teacher educator could represent serious constraints for the lesson study implementation. It is also possible that the "Handbook for Lesson Study", developed during the TasS workshops, was too focused on more general questions related to planning and observation since it was designed for use across subjects. In that respect, the handbook could function both as an affordance (initiating pedagogical questions), but at the same time it could function as a constraint (too little emphasis on the subject matter).

Lesson study seems to have several benefits when implemented in the right way and one benefit is the focus on important aspects of SMK and PCK such as planning and student engagement, observation as a means to collect data in order to analyse a lesson (Lewis et al., 2006) and content. The handbook inspired by Munthe and Postholm (2012) used in this study provided suggestions for possible questions to ask throughout the lesson study cycle highlighting these important aspects of SMK and PCK. Our study indicates that implementing lesson study in teacher education is far from straightforward. The mentoring dialogues in the intervention had a stronger focus on planning and pupil engagement, as well as observation, but a weaker focus on content. The questions on content in the lesson study intervention were also more related to planning for pupils' learning of the content, whereas the questions in the business as usual condition had a stronger focus on the student teachers' own understanding of the mathematical content. Further studies are needed to investigate whether or not this is a general tendency, or if a stronger focus on the content can be achieved by revising the handbook.

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