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Research paper

Noticing as reasoning in Lesson Study teams in initial teacher education

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HIGHLIGHTS

- The analysis approach developed for this study helps reconstructing noticing as reasoning during LS-conversations.
- Two mixed LS-teams in initial teacher education reason about learning, teaching and mixed problems.
- The two mixed LS-teams provide their reasoning with similar elements.
- Both LS-teams pay more attention to identification and planning than to interpretation elements.
- Both LS-teams differ in foci, extent of planning considerations, and continuity in their reasoning.

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ABSTRACT

In the current study on noticing as reasoning of Lesson Study (LS)-teams in initial teacher education (ITE), we analyzed the reasoning two mixed LS-teams set up about pupils' subject-related learning of. Both teams consisted of a student teacher and experienced teachers. Both teams paid more attention to identification (describing pupils' learning behavior) and planning elements (considering and deciding how to act) than to interpretation elements (determining and explaining pupils' problems with learning). They differed in the extent to which they considered plans and provided continuity in their reasoning. Stimulating meaningful reflection may help further develop noticing among LS-teams in ITE.

1. Introduction

A central goal in initial teacher education (ITE) is to promote student teachers' subject pedagogical competence so that they can support their pupils' subject-related learning (Grossman et al., 2005). In this context, in the past two decades educational research has devoted a great deal of attention to "teacher noticing". Teacher noticing (hereinafter referred to as 'noticing') is "honing in on a key aspect of or instance that occurs during a lesson and engaging in reasoning to make sense of it" (Stockero & Rupnow, 2017, p 282). Such a key aspect concerns often pupils' difficulties understanding the subject matter at hand. In noticing, teachers reflect on pupils' learning by identifying key events during the lesson that affect pupil learning, interpreting those events, and planning follow-up activities designed to promote that learning (Jacobs et al., 2010; Mason, 2011; Sherin et al., 2011; Van Es; 2011). Noticing is discursive at its core, meaning that teachers construct meaningful reasoning in which their identifications, interpretations and plans are interconnected (Sherin et al., 2011). To emphasize this discursive nature of noticing we prefer to use *noticing as reasoning*.

Developing this practice of noticing as reasoning during teacher training is desirable because it can help student teachers better understand their pupils' subject-related learning, so that they can effectively align their actions with that learning (Sherin et al., 2011). However, this development does not take place automatically during ITE, partly because the student teachers' and their internship supervisors' focus is not so much on pupils' subject-related learning but on student teachers' classroom management skills (Berliner, 2004; Erickson, 2011), and partly because student

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teachers themselves establish few relationships between the subject pedagogical knowledge provided to them during their ITE curriculum and their own teaching practice (Leeferink, 2016).

To stimulate the development of noticing as reasoning in ITE, it may be recommended that student teachers perform learning tasks that trigger noticing activities. Lesson study (LS) can be such a task. In LS, a team of teachers collectively chooses a learning or teaching problem, designs a research lesson to address that problem, observes pupils' thinking and learning during that lesson, jointly analyzes their observations, redesigns the research lesson, observes, and so on, repeating the cycle (Dudley, 2014; Lewis & Perry, 2014). During a LS cycle, the team reasons at various meetings about their pupils' learning and teaching and gains more insight into how pupils learn the subject matter, the difficulties they encounter, and the relationship between learning and teaching (de Vries et al., 2016).

LS has several variants in ITE (de Vries et al., 2017; Larssen et al., 2017), differing in dimensions such as the composition of the teams, place of implementation, and number of research lessons carried out within a cycle. The most extensive form is the LS variant in which student teachers form a LS-team together with experienced teachers at their internship school, going through the entire cycle several times, in which all team members get to perform one (or more) research lessons in their own classes (Amador & Weiland, 2015; Cajkler & Wood, 2016b; Larssen et al., 2017). This variant with mixed teams seems to offer opportunities for stimulating student teachers' noticing as reasoning; the participating experienced teachers have more practical knowledge than the student teachers, are better at recalling details related to pupils' learning, and in making their analysis consistent with details of pupils' learning and with what is known from literature (Jacobs et al., 2010). By sharing their knowledge, these experienced teachers can help the student teachers reason about pupils' learning, and develop and deepen their pedagogical subject knowledge, views, and routines (Amador & Weiland, 2015; Cajkler & Wood, 2016a; Cajkler et al., 2013; Grossman et al., 2005; Næsheim- Bjørkvik & Larssen, 2019; Schelfhout et al., 2006; Zwart et al., 2009).

Amador and Weiland (2015), Lee (2019) and Karlsen and Helgevold (2019) have shown that mixed LS-teams indeed partly engage in reasoning about pupils' subject-related learning while preparing and evaluating the research lessons. However, these studies determined noticing levels, using a rubric in which three to four levels of noticing are distinguished based on several indicators. The rubric provides insight into the level and eventual growth opportunities concerning student teachers' noticing, but do not provide a clear view on the actual reasoning they set up. What we don't know, for example, is what kind of subject-related problems they are reasoning about, what elements their reasoning consists of, how they divide their attention among those elements, and to what extent they provide continuity in their reasoning. More specific knowledge about how mixed LS-teams reason about pupils' subject related learning contributes to noticing research in general and to noticing of LS in ITE particular. That is why we set up an exploratory study with a multiple case design. We analyze the reasoning developed by two mixed LS-teams during their preparation and evaluation meetings. The participating experienced teachers of both teams differ in teaching experience - novice teachers in one team and very experienced in the other – revealing potential heterogeneity in the way mixed LS-teams set up their reasoning (Swanborn, 2010).

2. Theoretical framework

2.1. The concept of noticing

Noticing is a concept that is related to the concept of reflection. Dewey describes reflection as an "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and further conclusions to which it tends" (Dewey, 1933, p. 9). Teacher reflection concerns a complex, purposeful, intellectual effort in which teachers think about what they did in teaching-learning situations, why and how with the aim of arriving at (new) insights (van Veen & Van de Ven, 2008). Based on Deweys work, Rodgers (2002) formulated four phases of reflection: 1. Gain experience; 2. Description of that experience; 3. Analysis of the experience; 4. Testing a possible solution to the problem.

In noticing, teachers reflect on pupils' learning by *identifying* key events during the lesson that affect pupil learning (Rodger's phase 2), *interpreting* those events (Rodger's phase 3), and *planning* follow-up activities designed to promote that learning (partly Rodger's phase 4) (Jacobs et al., 2010; Erickson, 2011; Mason, 2011; Van Es; 2011; Sherin et al., 2011; Criswell & Krall, 2017; Lee & Choy, 2017; Stockero & Rupnow, 2017). Often, studies do not treat the actual implementation of plans as a fourth activity as part of noticing (Erickson, 2011; Jacobs et al., 2010; Mason, 2011; van Es, 2011), because converting plans into actions requires different complex skills (Jacobs et al., 2010) and many preconditions apply (Davis et al., 2016).

Studies have conceptualized noticing in various ways, and determining how these conceptualizations relate to one another can be difficult (LaRochelle, 2018). For example, some studies limit themselves to noticing-in-the-moment where identifying, interpreting and planning only takes place during the lesson (e.g., Jacobs et al., 2010). This noticing-in-the-moment is similar to Schön's reflection-in-action (Schön, 1983). Others focus on noticing-after-the-moment - Schön's reflection-on-action - which takes place after the lesson while evaluating the lesson (e.g. Santagata, 2011). Others again indicate that noticing-in-the-moment and noticing-after-the-moment are dialectical pairs that reinforce each other; through reflection-on-action, teachers anticipate on events in the following lesson that require immediate actions and irrelevant events that better can be ignored. Frequent reflections-on-action make teachers become increasingly aware of relevant situations during the lesson, as a result of which more noticing will take place in-the-moment (Erickson, 2011; Mason, 2011; Sherin et al., 2011). Choy et al. (2017) and Amador et al. (2017) argue that lesson preparation is also a crucial part of noticing; by anticipating potentially important events while preparing for the lesson, noticing-in and after-the-moment are reinforced. For these researchers, noticing is a triad of preparing-to-notice, noticing-in-the-moment, and noticing-after-the-moment. Due to the specific character of noticing in LS - an issue which we will address in 2.3 - we define noticing during LS as the process by which teachers jointly set up reasoning about pupils' subject-related learning before (preparing-to-notice) and after (noticing-after-the-moment) the research lesson.

A second difference in the conceptualizations of noticing involves the object of noticing. For example, van Es's (2011) 'Framework for learning to notice pupils' thinking' allows for noticing with regard to both subject-related learning and classroom management, whereas in other studies (Choy et al., 2017; LaRochelle, 2018), noticing is only geared toward improving pupils' subject-related learning, even though teachers' insights in subject-related learning and teaching may arise from concerns related to classroom management (LaRochelle, 2018). Cause of the central goal of

ITE - the promotion of subject pedagogical competence - we focus in the current research on noticing that is aimed at pupils' subject-related learning.

2.2. Noticing as reasoning

In order to analyze reasoning of LS-teams a theoretical model that describes the reasoning process during LS as well as the result of this reasoning process is needed. Because that model was not yet available, we developed one, see Fig. 1 below. In the rest of the section we will explain how we arrived at this model.

For the description of the reasoning *process* we found good starting points in Choy et al.'s (2017) 'Theoretical model for productive noticing'. This model describes noticing activities that teachers can perform sequentially before (preparing-to-notice), during (noticing-in-the-moment), and after class (noticing-after-the-moment) to promote pupils' – in this case mathematical – thinking. As we define noticing during LS as the process by which teachers jointly set up reasoning about pupils' subject-related learning before (preparing-to-notice) and after (noticing-after-the-moment) the research lesson, we will only discuss noticing activities before and after the lesson.

With regard to *lesson preparation*, Choy et al.'s model breaks down the three basic noticing activities – identifying, interpreting, and planning - in five consecutive activities: (1) identify the mathematical concepts to be learned, and (2) recognize what pupils (could) find confusing or difficult about these concepts (identifying); (3) analyze what difficulties pupils may have with learning them (interpreting), and (4) analyze possible teaching activities to overcome those learning difficulties (interpreting), and (5) develop and implement concrete learning tasks (planning). With regard to *lesson evaluation*, activities 2, 3 and 5 are also distinguished, but activities 1 and 4 are missing. Furthermore, activity 2 in lesson evaluation is divided into three separate activities: (2a) describe relevant lesson events that reveal pupils' mathematical thinking, (2b) identify what pupils understand about mathematical concepts, and (2c) recognize what confuses pupils. Activity 3 is split into (3a) analyze what pupils do and do not understand about the concepts and (3b) an activity in which the teachers generate new understanding about pupils' mathematical thinking from the analysis of these instances.

In order to transform Choy at al.'s model into a model that describes the noticing as reasoning process as well as the result of this process, we needed to make some additions and adjustments. First of all, in order to make the model suitable for a school subject in general, we changed the direct references to learning and teaching 'mathematical concepts' into 'subject matter'. With respect to *lesson preparation* activities we made three adjustments. Based on Grossman et al. (2005), we define Choy et al.'s first noticing activity in lesson preparation more broadly: when teachers thoroughly prepare a lesson, they consider not only the subject matter to be learned, but also pupils' initial situation, the lesson objectives, how mastery of the subject matter will be tested, and so on. In other words, they characterize the lesson to be taught. Secondly, we added 'identifying pupils' thinking and learning behavior', because when preparing the lessons, (good) teachers also think about what concrete thinking and learning behavior they expect to see during the lesson (Grossman et al., 2005). Based on these identifications they deduce and determine what pupils probably will find difficult or confusing about the subject matter. The third adjustment concerns formulating plans (activity 5); we distinguished between plans involving the subject matter and lesson goals (the what, i.e. the content) and plans involving student and teacher activities (the how, i.e. the way of instruction and its pedagogy).

Concerning the *lesson evaluation* activities, we added three noticing activities to the model. When evaluating the lesson, teachers take the same reasoning steps making sense of their pupils' learning as they do in preparing for the lesson; 1) teachers first may need to recapitulate and characterize the lesson taught, 2) then analyze why pupils found the subject matter (still) difficult or confusing, and 3) (re)analyze possible ways to address pupils' problem in learning the subject matter. Including this last step is necessary, because interpretations of pupils' learning during the lesson may lead to a reconsideration of choices made while preparing for the lesson. Furthermore, we combined the first two evaluation steps (2a and 2b) of Choy et al.'s model because of the small distinctions between them; both concern the identification of observed pupils' thinking and learning behavior. At last, we removed 'Generate new understanding about how pupils think about the concept from the analyses of these instances' as we see new understanding about pupils' learning and teaching as the product of all reasoning activities together.

Choy et al.'s model is meant to describe noticing activities and does not address the reasoning that results from the activities. We consider the result of each activity as an element of a reasoning about pupils' subject related learning. For instance, the activity 'characterizing the lesson to be taught' leads to a corresponding element of the reasoning: 'The subject matter, learning objectives, and educational activities of the lesson to be taught concern […]'. The activity 'Identifying pupils' thinking and learning behavior during the lesson' leads to the corresponding element of the reasoning 'pupils responded by doing or saying […]' et cetera. Furthermore, as noticing is discursive (Sherin et al., 2011), we consider all distinct elements of the reasoning as interrelated, in the sense that a subsequent element follows logically from the previous element.

2.3. Noticing as reasoning during Lesson Study

During LS, noticing takes place in a different way than around regular lessons in other educational settings. After jointly developing the research lesson, one team member teaches the research lesson as precisely as possible. The teaching teacher more or less hands over the identification activities to the observing team members, who in turn do not interfere in the actual implementation the research lesson. During the evaluation meeting after the research lesson, the team then collectively gives meaning to what the observing teachers have observed during the lesson. Thus, during the research lesson, noticing activities 'observing' on the one hand and 'interpreting/planning' on the other are more or less strictly separated; observing occurs in-the-moment, but the actual reasoning - in which observation, interpretations and plans are connected – does not take place in-the-moment, but after-the-moment, during the evaluation meetings. Therefore, in the context of LS, we would define noticing as the process by which teachers jointly set up reasoning about pupils' subject-related learning before (preparing-to-notice) and after (noticing-after-the-moment) the research lesson. Because of this specific character of noticing during LS our data collection and analyzes focus on the preparation and evaluation meetings.

LS in itself scaffolds the process of noticing as reasoning, due to two characteristics. First, student teachers must address practical problems in their own classes, which mirrors the complicated practice of teaching and approximates practice (Grossman et al., 2009). Second, decomposition of practice (Grossman et al., 2009) occurs as a result of the LS approach; in LS, the complex practice of teaching is divided into important steps that the teachers jointly go through several times. In this way, the overwhelming amount of information that student teachers often experience while teaching is structured, which can help them identify and select relevant

	Nr	Noticing activities while planning the research lesson:	Noticing activities while evaluating the research lesson	Corresponding element of the reasoning
Identifying	1	Characterize the lesson to be taught	Characterize the lesson taught	The subject matter, learning goals, and educational activities concern […]:
		⬇	⬇	
	2	Identify expected pupils' thinking and learning behavior	Identify observed pupils' thinking and learning behavior	Pupils respond/responded by doing or saying […].
		⬇	⬇	
Interpreting	3	Determine the problem: analyzing expected pupils' thinking and learning behavior, and recognizing what pupils will find difficult or confusing about the subject matter.	Determine the problem: analyzing pupils' responses to the research lesson and recognizing what pupils found difficult or confusing about the subject matter.	From these identifications we deduce that pupils will have/had difficulty with […]
		⬇	⬇	
	4	Explain the problem: analyze why pupils will find the subject matter difficult or confusing.	Explain the problem: analyze why pupils found the subject matter difficult or confusing.	We can explain that difficulty by […]
		⬇	⬇	
Planning	5	Analyze possible ways to address the problem.	Analyze possible ways to address the problem.	Possible solutions to pupil's problem and our considerations thereof are
		⬇	⬇	
	6	Plan subject matter and learning goals in order to solve the problem	Revise the lesson: planning subject matter and learning goals in order to further solve the problem	To solve pupils' problem, we select the following subject matter and learning goals
	7	Plan pupil and teacher activities in order to solve the problem	Revise the lesson: planning pupil and teacher activities in order to further solve the problem	To solve pupils' problem, we select the following pupil and teacher activities: […]

Fig. 1. Theoretical model for noticing as reasoning while preparing and evaluating lessons during Lesson Study, adapted from Choy et al. (2017).

events in the lessons (Sherin et al., 2011). Besides, teacher training could support the noticing process even further. Forming mixed LS-teams, with student teachers and expert teachers, may allow for scaffolding student teachers' noticing process for reasons we mentioned earlier. In addition, explicit commands can be given to stimulate noticing. For example, in Lee's study (2019) the student teachers from the mixed LS-teams interviewed their pupils and jointly analyzed the outcomes, using subject-specific concepts discussed in a course prior to the LS. In Amador and Weiland's study (2015) noticing was elicited by various stimuli: having notes taken during the observations, giving individual thinking time to analyze these notes before the group discussion takes place, and giving prompts that encourage various noticing activities. In this study, setting up reasoning is not specifically supported by explicit commands. However, identifying pupil learning, as part of the reasoning, is supported through the provision of observation forms and a guideline for a semi-structured interview (see 3.2). In the current study, setting up reasoning is not specifically supported by explicit commands. However, identifying pupil learning, one of the elements of reasoning, is supported through the provision of observation forms and a guideline for a semi-structured interview.

2.4. Nature and aim of the current study

The aim of the current study is to generate knowledge about how mixed LS-teams in ITE reason about pupils' subject-related learning. The following questions will be answered in the current study:

1. What is the focus of the reasoning: about what (kind of) subject-related problems is being reasoned?
2. What are the elements that compose the reasoning?
3. How extensively are the various elements discussed?
4. What differences exist between the preparation and evaluation conversations in terms of the focus, composition, and extent of the reasoning?

The study has a explorative character, because the emphasis is on discovering ideas and insights and less on collecting statistically accurate data. We have chosen for a two case design – two mixed LS-teams whose participating experienced teachers differ in teaching experience – with the aim of discovering both possible similarities and differences in the reasoning LS-teams set up (Swanborn, 2010).

3. Method

3.1. Context and participants

We carried out the study in the Dutch teacher training program for teaching in higher secondary education at the University of Groningen in the Netherlands. To fulfill the research part of the curriculum, four out of twenty-five native-language student teachers chose LS. The student teachers found fellow native-language teachers at their internship school willing to participate in a LS-team. Those fellow teachers taught in parallel classes in the same grade and level of upper secondary education, meaning that the team compositions were partly determined by the conditions at school.

From these four teams, we selected two teams that chose the same topic as subject for their LS. Both teams differed in team

composition. In addition to the student teacher, LS-team 1 consisted of three highly experienced teachers, including the internship training supervisor. The fellow teachers of LS-team 2 were novice teachers with only a few years of teaching experience (see Table 1 for an overview of the participants and their characteristics). Because of these different team compositions - novice teachers on one team and highly experienced in the other - potential heterogeneity in the way mixed LS-teams set up their reasoning can be revealed (Swanborn, 2010).

The chosen topic was perspective taking - the cognitive activity of looking at situations from someone else's point of view (Davis, 1983; Wang et al., 2014). Perspective taking plays a role in literature and conversation skills education, in which pupils are expected, among other things, to "identify empathically with different characters" and "postpone a response" until interpreted and judged by someone else (van Beek et al., 2008, p. 42 and p. 22, respectively). Although perspective taking is considered an important educational goal in the Netherlands (Onderwijsraad, 2011), it is not explicitly taught at native language education in the Netherlands, making the topic rather new to the LS-teams.

3.2. Working method of the LS-teams

Because the participating teachers were unfamiliar with LS as well as with perspective taking, and a facilitator, who leads LS conversations and acts as a process monitor (Lewis, 2016), was not available, we took the following steps to support the LS-process. First, before starting LS, we explained the goals and working methods of LS to both teams. Second, we provided a manual, based on Dudley (2014) and de Vries et al. (2016), showing how the teams could perform the LS cycle step by step. Third, the first author organized seven process conversations with all participating student teachers in which experiences were discussed and tools for the next step of the LS process were provided. Fourth, a resource kit was offered in line with Lewis and Perry's (2014) finding that collaboratively discussing and redesigning existing teaching materials can facilitate coherent knowledge, beliefs, and routines, especially in teams whose members differ in knowledge, experience, and status. The resource kit consisted of (1) a sample lesson series of three lessons, including a teacher manual; (2) background articles on perspective taking; (3) two observation forms to identify individual pupils' perspective-taking behavior before the lesson and to characterize the group interaction as competitive, cooperative, or constructive (see Littleton and Mercer (2013); Mercer and Hodgkinson (2008); (4) a guideline, based on Dudley (2014), for a semi-structured interview that the observing teachers conduct immediately after the research lesson with the pupils they observed. The purpose of this interview is to collect information about how pupils experienced the lesson, what they learned and which elements of the lesson did or did not promote their learning. The guideline contained sample questions that the LS-team was allowed to adjust as they saw fit; and (5) an instrument to measure pupils' ability to take perspective. This instrument was used to compile heterogeneous or homogeneous (according to low, average, and high perspective-taking ability) student groups to collaborate and be observed.

3.3. The LS cycle in the current study

The LS cycle of both teams consisted of several rounds. Each team chose one lesson from the lesson series of three to form the research lesson. LS-team 1 chose the second lesson and LS-team 2 the third lesson. Each team member performed the entire lesson series, but only the research lesson was observed by the other team members. Each team performed as many rounds as team members, such that LS-team 1 conducted four rounds and LS-team 2 three. In accordance with Cajkler and Wood (2016b), an experienced teacher conducted the research lesson in the first round, while the others observed and interviewed pupils; in the second round, the student teacher taught the lesson; and then an experienced teacher taught the following rounds.

After the resource kit was handed out, each LS-team further developed the example lesson series during several preparation discussions to make it useful for their specific class context. The student teacher adjusted the teaching materials on the basis of the agreed-on changes and made this material available again to the team members. Before the start of the lesson series, each team member measured their own pupils' perspective-taking behavior using the measuring instrument from the resource kit. LS-team 2 held a closing conversation at the end in which members discussed findings and outcomes across the entire cycle, LS-team 1 did not. Fig. 2 presents an overview of the execution of the cycle.

3.4. Data collection

The student teachers audio recorded all LS conversations. Despite that LS-team 1 conducted four research lessons and LS-team 2 conducted three, LS-team 2 spent three times as much time conversating as LS-team 1 (see Table 2). LS-team 1 held two preparation and two evaluation conversations with an average of 25 min each. LS-team 2 held three preparation and four evaluation - of which one overall closing conversation - which took an average of about 45 min each. The differences between the teams show the differences in bandwidth in how LS can be performed. LS is not a fixed method with a prescribed amount of time and meetings (the fidelity perspective, Anderson, 2017), but is an approach that can be adapted to one's own local practice, as long as teachers adhere to the core components of the professional development approach (the local adaptation perspective, Quinn & Kim, 2017). Although the closing conversation can be considered a core component of LS, we believe that lack of it does not necessarily matter for the purpose of our research, which is to explore the focus, composition, and extent

Table 1
Overview of participants and their characteristics.

	LS team 1	LS team 2
School environment	Rural, comprehensive school	Rural, comprehensive school
School type and grade	Havo 4	VWO 4
Teacher 1 = student teacher	Female, 24 years	Female, 26 years
Teacher 2	Female, 35 years 10 years of experience, supervisor	Female, 27 years 3 years of experience
Teacher 3	Female, 52 years 10 years of experience	Male, 25 years 2 years of experience
Teacher 4	Male, 65 years >20 years of experience	

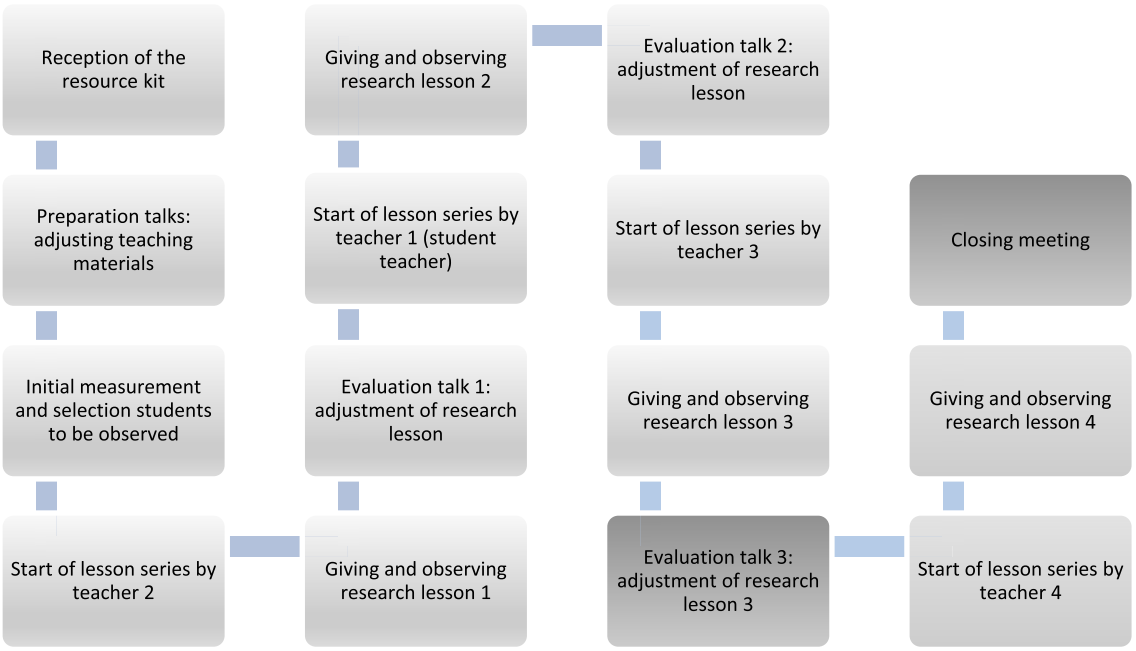

Fig. 2. LS cycle as performed by the LS teams. Blue = performed by both teams; yellow = performed by LS team 1 only; green = performed by LS team 2 only. Note: please use the colors with this figure in print.. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 2
Overview of collected data.

LS team	Number of preparation conversations	Total duration of preparation conversations, in minutes	Number of evaluation conversations	Total duration of evaluation conversations, in minutes	Total duration in minutes
1	2	73	2	24	97
2	3	152	4	161	313

of the reasoning about pupils' subject-related learning. An initial exploration revealed that the more limited amount of data from LS-team 1 still generated sufficient research material.

3.5. Data analysis

3.5.1. Preprocessing conversation recordings: unbundling into threads of conversation

The audio recordings were transcribed without including intonation and pauses. We then identified conversations as preparation or evaluation, numbered them, and divided them into fragments. Fragments are stretches of conversation that center on a topic that relates to the teaching and learning activities from the example lesson material such as introduction of the subject, explanation of concepts, and doing assignments. A fragment starts when the LS-team raises a new topic and ends when the discussion of the topic closes and moves to another topic. As both LS-teams discussed the sample material from front to back, such that they both discussed the same topics. We excluded fragments in which organizational aspects about the process of LS were discussed.

Topics are interspersed throughout the conversation in both LS-teams. By linking the separate instances of one and the same topic, we reconstructed 'conversation threads'. Each conversation thread contains all fragments that address the same topic. Within the conversation threads we gave the fragments a follow-up number. Appendix A lists the conversation threads and the number of fragments in which the teams discussed the topics.

3.5.2. Analysis tool

Based on our *Theoretical model for noticing as reasoning while preparing and evaluating lessons during Lesson Study* we performed the analysis in a number of steps as described in Table 3. The coding numbers correspond to the numbers from Fig. 1.

The first three steps involve selecting fragments in which noticing activities related to pupils' subject-related learning are present. In step 1, we coded all turns according to subactivities 1–7 from Fig. 1. If the team did not spend any turns formulating the problem (code 3) or did not explicitly mention the problem, but it was clear that team members agreed on what was perceived as the problem, we reconstructed the problem according to the context. van Kruiningen (2013) also highlights the common phenomenon that participants in group conversations often refer implicitly to the common topic about which they reason. We only performed these reconstructions for the problem element because the other elements cannot be easily reconstructed in their entirety from the context alone. In step 2, we then determined whether the problem involved pupils' subject-related learning and excluded classroom management problems. In the third step, we only included reasoning having the following three elements: the determination of (expected or observed) learning behavior in pupils (2), the determination of problem (3), and the planning of subject matter or teaching and learning activities (5 or 6) because in noticing identifications, interpretations and plans are linked, and without these three elements there is no connection.

In step 4, we reconstructed the reasoning by summarizing the content of all turns with the same code per fragment and filling in

Table 3
Overview of the analysis steps.

Step	Activity
1	Coding of the noticing activities (1–7).
2	For code 3: determining whether the problem involves pupils' subject-related learning. If so → step 3.
3	Determining whether a noticing as reasoning is present in each fragment. If so → steps 4–8.
4	Formulating the noticing as reasoning.
5	Determining the focus of the noticing as reasoning: Which problem is involved? Is it a learning problem or a teacher problem?
6	Determining the composition of the reasoning: which elements are part of the noticing as reasoning?
7	Determining the extent to which the elements of the noticing as reasoning have been discussed.
8	Identifying differences between the preparation and evaluation conversations with regard to the focus, composition, and extent of the noticing as reasoning.

the gaps of the described elements of a noticing as reasoning. Subsequently, we added structure indicators to connect elements to each other one after the other, such that they led to a coherent reasoning. Sometimes multiple reasoning activities were present within a fragment, such that several problems were discussed together, each problem having its own identifications, explanations, or solutions. We describe these distinct reasoning activities separately.

To gain more insight into the types of problems that receive attention during LS, we distinguished learning and teaching problems in step 5 (see Appendix B and C for an overview of the problems discussed in both teams). A pupil's learning problem lies in the complexity of the subject matter or learning objectives, whereas in a teaching problem, the explanation lies with the selected pupil and teacher activities. In case of mixed problems, explanations are presented from both the content and from the pupil and teacher activities. In step 6, we determined which elements were and were not part of the reasoning. As an indication of the extent of the reasoning (step 7), we counted how many words in how many conversations were spent on the discussion of the separate elements (for a similar analysis, see van Kruiningen, 2010). In the last step, we compared the focus, composition, and extent of the reasoning during the preparation and evaluation conversations.

During the analysis, we alternated between working from the bottom up and the top down (Boeije, 2009). We established the reasoning on the basis of recognition of the elements, and this recognition was in turn guided by identifying their link with the unifying greater whole. After multiple sessions, the three authors arrived at a definitive determination of the reasoning by comparing and discussing differences in interpretation.

Our analyses are primarily of a qualitative nature. The recognition of topics and threads, the coding of noticing activities and the reconstruction of the reasoning is interpretive work. On this qualitative basis we present quantitative data on the distribution of aspects of noticing as reasoning in order to answer our research questions.

To give an idea of the reasoning that the teams set up, we present in Table 4 a reasoning one of the two teams set up during a preparation meeting. This reasoning contains all elements that are distinct, and is average in length.

4. Results

4.1. Results LS-team 1

In total, LS-team 1 exchanged 17,251 words during the four conversations. The team generated 10 noticing as reasoning strands about the pupils' subject-related learning with a total volume of 3921 words; in other words, the team spent 23% of the talk time on setting up noticing as reasoning about their pupils' subject-related learning. The 10 noticing as reasoning strands are set up around four conversation threads (see Table 5). Conversation thread 3—about the explanation of the central concepts—generated half the reasoning.

4.1.1. Focus of noticing as reasoning: learning and teaching problems

LS-team 1 identified ten subject-related problems: six learning problems (see appendix B numbers 1, 2, 3, 4, 5, and 8), like ""*Pupils are expected to have difficulty understanding the concepts of norms, values, and (moral) dilemma, because these are abstract concepts*", one teaching problem (number 10) '*pupils did not give feedback on each other's performance during their collaboration. They are able to give good feedback on each other's performance, but the assignment does not invite them to do so*'. Two problems (numbers 6 and 7) involved a combined learning and teaching problem, and one problem (number 9) was not explained.

4.1.2. Composition of noticing as reasoning

Table 5 shows the constitution of all ten noticing as reasoning of LS-team 1. In 3 reasoning strands (numbers 1, 3, 4), all seven distinct elements were addressed by LS-team 1. The other 7 reasoning strands were missing one or more elements. All 10 the identification of learning behavior (code 2), the problem (code 3) and the planning of teaching activities (code 6) were present. In 4 reasoning strands, the team also planned new subject matter or learning goals. In 6 reasoning strands LS-team 1 weighed up plans. In 8 reasoning strands the lesson was characterized (code 1), and in 9 reasoning strands explanations for the learning problem were given (code 4).

4.1.3. Extent of noticing as reasoning

Table 5 shows that LS-team 1 gave by far the most attention to reasoning strands 4 and 6; the team spent about half the total number of words and turns setting up reasoning strands around these two problems. The team paid significantly less attention to reasoning strands 2, 3, 5, 8, and 9—on average, fewer than 15 turns per reasoning strand, or about 3 short turns per element. Table 6 shows the distribution of the number of words and turns over the elements of the reasoning. The characterization of the lesson (1002 words in 66 turns) and planning of the student and teacher activities (1227 words in 119 turns) received the most attention. LS-team 1 paid little attention to identifying the problems. For example, they used only 253 words in 32 turns to identify the seven explicitly mentioned problems—on average, only about 36 words in just under 5 turns per problem. In addition, they paid relatively little attention to identifying learning behavior, generating explanations for the problems, and weighing up plans.

4.1.4. Differences in reasoning between the preparation and evaluation interviews

Tables 5 and 6 also provide insight into the differences between the preparation and evaluation conversations. Noticeably more reasoning took place during the two preparation conversations

Table 4
An example of reasoning about pupils' subject-related learning from one of the LS-teams. Italicized text are elements not specifically worded that way but implied.

	Nr	Noticing activities while planning the research lesson:	Corresponding element of the reasoning
Identifying	1	Characterize the lesson to be taught	The goal is for pupils to understand the concepts of norms, values and moral dilemma. These concepts are introduced in the introduction section of the teaching materials. We agreed that we read this introduction together and then you say something about the case presented there. This case is an example that clarifies the concept of empathy.
		⬇	
	2	Identify expected pupils' thinking and learning behavior	We, as adults, are very inclined to name values and norms in one statement. However, for our pupil, that is abracadabra.
		⬇	
Interpreting	3	Determine the problem: analyzing expected pupils' thinking and learning behavior, and recognizing what pupils will find difficult or confusing about the subject matter.	Pupils will have difficulty understanding the distinction between norms and values.
		⬇	
	4	Explain the problem: analyze why pupils will find the subject matter difficult or confusing.	Because values and moral dilemma are abstract concepts for our pupils and if there is no continuous feedback to those concepts, they will not understand the concepts at all.
		⬇	
Planning	5	Analyze possible ways to address the problem.	We are therefore going to disconnect norms and values. We are going to state that you have values and a norm is then what you do with them, as an action.
		⬇	
	6	Plan subject matter and learning goals in order to solve the problem	*We will disconnect norms and values by successively asking the following questions about the case:1. Which persons appear in this story? 2. What are the values of the persons? 3. And what are the standards of the persons? 4. What then is the moral dilemma here? 5. And how do they solve this? We are going to tell the pupils that the closer a character is to you, the easier it is to empathize with that person.*
	7	Plan pupil and teacher activities in order to solve the problem	*It is necessary to disconnect norms and values in this way and to refer to the concepts to be learned when formulating the questions, otherwise pupils cannot come to the moral dilemma. That is quite difficult for pupils (and us), but this way you keep things clearer for the pupils.*

Table 5
Noticing as reasoning of LS team 1. PC1 = first preparation conversation, PC2 = second preparation conversation, EC1 = first evaluation conversation, EC2 = second evaluation conversation. P = this element was present and made explicit by the team. P(R) = a learning or teaching problem that was not made explicit by the team but that could be reconstructed. N = this element was not discussed.

			Composition							Extent	
			Identification		Interpretation		Planning				
			1	2	3	4	5	6	7		
Rreasoning strand number	Conversation	Conversation thread	Characterizing the lesson	Identifying (expected or observed) learning behavior	Determining the problem	Explaining the problem	Planning content	Planning student and teacher activities	Weighing up plans	Number of turns	Number of words
1	PC1	2	P	P	P	P	P	P	P	22	340
2	PC1	3	P	P	P(R)	P	N	P	P	12	150
3	PC1	3	P	P	P	P	P	P	N	11	166
4	PC1	3	P	P	P	P	P	P	P	75	842
5	PC1	3	N	P	P(R)	P	N	P	N	17	124
6	PC2	3	P	P	P	P	P	P	P	84	1139
7	EC2	4	N	P	P	P	N	P	N	72	545
8	EC2	4	P	P	P	P	N	P	N	18	181
9	EC2	4	P	P	P	N	N	P	P	16	184
10	EC1	7	P	P	P	P	N	P	P	15	250
Number P			8	10	8	9	4	10	6		
Number P(R)			nvt	nvt	2	nvt	nvt	nvt	nvt		
Number N			2	0	0	1	6	0	4		
Total			10	10	10	10	10	10	10	342	3921

than during the two evaluation conversations (six and four, respectively). The first preparation conversation was by far the most productive than the second: five of the six noticing as reasoning strands took place there. This corresponds with the time

Table 6
Distribution of number of words and turns among different noticing activities of LS team 1.

	Identification		Interpretation		Planning			Total number
	1	2	3	4	5	6	7	
	Characterizing the lesson	Identifying (expected or observed) learning behavior	Determining the problem	Explaining the problem	Planning content	Planning student and teacher activities	Formulating alternatives and weighing up plans	
Preparation sessions Number of turns	45	10	12	10	44	81	19	221
Preparation sessions Number of words	744	145	110	119	553	895	195	2761
Evaluation sessions Number of turns	21	20	20	9	0	38	13	121
Evaluation sessions Number of words	258	213	143	94	0	332	120	1160
Total number of turns	66	30	32	19	44	119	32	342
Total number of words	1002	358	253	213	553	1227	315	3921

spent on both types of meetings (74 min versus 24 min, respectively). Importantly, LS-team 1 discussed expected learning behavior (code 2) and problems (code 3) in the preparation conversations in about 1 in 10 turns, but the attention to these elements in the evaluation conversations almost doubled to 18%.

Only one reasoning strand occurred during the evaluation conversation after the first research lesson, compared with three at the second evaluation conversation, even though the latter was shorter by half than the former. In addition, the topics of the reasoning strands in the preparation conversations differed from those in the evaluation conversations. The preparation conversations involved the introduction of the subject (perspective taking), the explanation of concepts and one any other business, whereas in the evaluation conversations discussion topics were the reflection assignment, the pupils' group discussions, and the assignments. Thus, LS-team 1's reasoning was rather disjointed; in the evaluation meeting, the team addressed new problems and did not reflect on problems identified during the preparation meetings.

4.2. LS-team 2 results

In total, LS-team 2 exchanged 59,923 words during seven conversations. LS-team 2 set up 15 reasoning strands about pupils' subject-related learning, around five conversation threads. Conversation threads 2 (the introduction of perspective) and 4 (the text and processing assignments) generated more than half the reasoning. The 15 noticing as reasoning strands totaled 13,109 words. In other words, the team spent almost 22% of the total talk time setting up a noticing as reasoning about the pupils' subject-related learning, which is comparable to LS-team 1.

4.2.1. Focus of noticing as reasoning: learning and teaching problems

LS-team 2 identified 15 subject-related problems: one learning problem (see Appendix C number 5), six teaching problems (numbers 1a, 1b, 2a, 3, 4a, and 10), and five combined learning and teaching problems (numbers 4b, 6, 7a, 8a, and 8b). An example of a mixed problem is: *Recognizing and naming your own role in collaboration is difficult. Possible explanations are: (1) The teacher did not go into this deeply; he found it difficult to go into this very deeply because the student has to look very closely at himself in this assignment and it is quite difficult to "understand why the other judges the way he does"; (2) For most pupils it seemed a bit exaggerated to summarize what someone just had said; (3) Pupils find it difficult to judge themselves and to talk about it in a larger group; if there are few pupils, they want to do self-reflection; [and] (4) there was also a lot of time between the lessons, which made reflection difficult'.* Three problems (2b, 7b, and 9) were not explained.

4.2.2. Composition of noticing as reasoning

Table 7 shows the constitution of all ten noticing as reasoning of LS-team 2. In 1 reasoning strand (number 2a), all seven distinct elements were addressed by LS-team 1. All reasoning included the identification of pupils' learning (code 2), problems (code 3), the planning of teaching activities (code 6) and weighing up those plans (code 7). In 2 of the 15 reasoning strands, LS-team 2 also planned new subject matter or learning goals (code 5). In 12 of the 15 reasoning strands, the team provided a characterization of the lesson (code 1), and in 12 of 15 reasoning strands, the problem was explained (code 4).

4.2.3. Extent of noticing as reasoning

Table 7 shows that LS-team 2 spent the most turns and words on reasoning strands 1a, 2a, and 4b and paid the least attention to reasoning strands 2b, 3a and 3b. Table 8 shows that LS-team 2, like LS-team 1, devoted by far the most attention to the characterization of the lesson (3034 words in 234 turns) and planning student and teacher activities (3316 in 289 turns) and the least attention to determining the problem, explaining the problems, and planning the content of the lesson. However, whereas LS-team 1 paid little attention to evaluating the plans, LS-team 2 paid almost as much attention to weighing up the plans as it did to formulating the plans themselves.

4.2.4. Differences in reasoning between the preparation and evaluation conversations

Tables 7 and 8 also show differences between the preparation and evaluation conversations. They indicate that more noticing as

Table 7
Noticing as reasoning of LS team 2. PC1 = first preparation conversation, PC2 = second preparation conversation, PC3 = third preparation conversation, EC1 = first evaluation conversation, EC2 = second evaluation conversation. EC3 = third evaluation conversation, EC4 = fourth evaluation conversation. P = this element was present and made explicit by the team. P(R) = a learning or teaching problem that was not made explicit by the team but that could be reconstructed. N = this element was not discussed. The follow-up numbers 1a, 1b, 2a, 2b, and so on, indicate that in a subsequent conversation, the team set up a new reasoning strand (b) about an earlier noted problem (a).

			Composition							Extent	
			Identification		Interpretation		Planning				
			1	2	3	4	5	6	7		
Rreasoning strand number	Conversation	Conversation thread	Characterizing the lesson	Identifying (expected or observed) learning behavior	Determining the problem	Explaining the problem	Planning content	Planning student and teacher activities	Weighing up plans	Number of turns	Number of words
1a	PC1	1	P	P	P	P	N	P	P	133	1535
1b	EC3	1	P	P	P	P	N	P	P	19	215
2a	PC1	2	P	P	P	P	P	P	P	153	1928
2b	EC2	2	N	P	P	N	N	P	P	30	385
3	PC1	2	P	P	P	P	N	P	P	31	330
4a	EC1	4	P	P	P(R)	P	N	P	P	54	836
4b	EC1	4	P	P	P	P	P	P	P	119	1523
5	EC3	4	N	P	P	P	N	P	P	48	583
6	EC3	4	N	P	P	P	N	P	P	79	924
7a	EC1/EC2	6	P	P	P	P	N	P	P	119	1175
7b	EC3	6	P	P	P(R)	N	N	P	P	70	797
8a	PC3	7	P	P	P	P	N	P	P	101	1159
8b	EC1	7	P	P	P	P	N	P	P	72	890
9	EC3	2	P	P	P(R)	N	N	P	P	30	340
10	EC4	7	P	P	P	P	N	P	P	29	489
Number P			12	15	12	12	2	15	15		
Number P(R)			nvt	Nvt	3	nvt	nvt	nvt	nvt		
Number N			3	0	0	3	13	0	0		
Total			15	15	15	15	15	15	15	1087	13,109

Table 8
Distribution of number of words and turns among different noticing activities of LS team 2.

	Identification		Interpretation		Planning			Total number
	1	2	3	4	5	6	7	
	Characterizing the lesson	Identifying (expected or observed) learning behavior	Determining the problem	Explaining the problem	Planning content	Planning student and teacher activities	Formulating alternatives and weighing up plans	
Preparation sessions Number of turns	160	38	10	23	3	88	96	418
Preparation sessions Number of words	1994	495	176	270	19	1080	918	4952
Evaluation sessions Number of turns	74	112	61	44	3	201	174	669
Evaluation sessions Number of words	1040	1479	829	508	48	2236	2017	8157
Total number of turns	234	150	71	67	6	289	270	1087
Total number of words	3034	1974	1005	778	67	3316	2935	13,109

reasoning took place while evaluating the research lessons than while preparing them: 11 of the 15 reasoning strands emerged during the evaluation conversations, even though the duration of these conversations was approximately equal to that of the preparation conversations. The third evaluation conversation—after the research lesson of D3—was particularly rich in reasoning. The closing conversation (E4), in which the team reviewed findings from the entire cycle and created a final version of the teaching material, provides only one noticing as reasoning strand. The second preparation conversation produced no reasoning at all.

The follow-up numbers 1a, 1b, and so on, demonstrate that in a subsequent conversation, LS-team 2 picked up a problem identified previously to reason further or differently about it—for example, as a result of observations made during the research lesson. Thus, unlike LS-team 1, LS-team 2 addressed new problems after the research lesson *and* continued their reasoning about previously identified problems. As with LS-team 1, the evaluation conversations generated relatively more attention to identifying pupils'

learning behavior and determining their problems in learning; in the preparation conversations, approximately 1 in 10 turns was about these two elements, but in the evaluation conversations, the number more than doubled.

5. Discussion and conclusion

In the current explorative multiple case study, we examined the focus and composition of the reasoning two mixed LS-teams in ITE set up about their pupils' subject learning, as well as the extent to which the two teams discussed the different elements of the reasoning. Each LS-team consisted of a student-teacher and a number of more experienced co-teachers at the internship school, in one team highly experienced and in the other novice co-teachers. This multiple case design with different team compositions has revealed similarities and differences in the way LS-teams in ITE reason.

Concerning the *focus* of the reasoning we found that both LS-teams detected learning problems – caused by the complexity of the subject matter -, teaching problems – caused by the pupil and teaching activities, and mixed learning and teaching problems. With regard to the *composition*, in all reasoning of both teams the following elements were present: the determination of pupils' thinking and learning behavior, the determination of pupils' difficulties learning the subject matter, and the planning of teacher and pupil activities. Characterizing the lesson and explaining difficulties were regular, and planning new content was sometimes part of the reasoning. With regard to the *extent* to which the two teams discussed the different elements of the reasoning, both teams spent by far the most words and turns on the identifying and planning elements, and least on interpreting. With respect to *the differences between the preparation and evaluation conversations*, both teams generated relatively more noticing as reasoning in the evaluation conversations.

Both teams differed in the extent they articulate their thoughts about alternatives and considering plans, and in the extent to which they brought coherence and continuity to their reasoning. The LS-team with the novice co-teachers paid much more attention to weighing plans, and often the team reasoned further about the problems they had previously identified, for example because the team gained additional information about parts of the reasoning through the observations or interviews. Contrary, the LS-team with the highly experienced co-teachers spent little turns and words on weighing their plans, and at each meeting the team mainly developed new reasoning about newly identified problems.

The analysis tool we have developed has been very helpful. However, our analysis is aggregated at the team level, not at the individual participant level. As a result, the particular input of the student teachers in the reasoning has not become visible, which is a limitation of the current study. Although Vrikki et al. (2017) show that in LS a positive correlation exists between the learning activities of the team as a whole and those of the individual participants, we do not know whether this is the case in our teams.

The relatively little attention to interpretative elements of both teams' reasoning confirm the results of Lee's study (2019). This underrepresentation of the interpretative elements and the differences between the two teams concerning weighing plans and continuity in reasoning, make us think about the relationship between the reasoning and underlying reflective practice (Leavy & Hourigan, 2016; Næsheim- Bjørkvik & Larssen, 2019) of the participants.

Although we are aware that quantity does not always say something about quality, these findings may reflect a more or less meaning-oriented reflection (Mansvelder-Longayroux et al., 2007). Meaning-oriented reflection is geared to why something works or does not work, and to identify the mechanisms and principles that underlie pupils' learning processes and the relationship between teacher activities and pupils' learning processes (Mansvelder-Longayroux et al., 2007). With meaningful reflection, teachers are focused on understanding what is happening, rather than on only improving their own actions.

In this sense, meaning-oriented reflection seems to be more present in the reasoning of the less experienced LS-team than of the very experienced LS-team. This is somewhat surprising, as the more experienced teachers have more knowledge about learning and teaching processes that they could share during the LS conversations (Jacobs et al., 2010), which could lead to a more meaningful reflection among the experienced LS-team. But perhaps this is the well-known phenomenon that, although highly experienced teachers may have more practical knowledge, this knowledge often remains tacit (Eraut, 2000); experienced teachers assume that their knowledge is part of the common ground of the team and as a result, their knowledge may have remained in their "pedagogical black box" (Cajkler & Wood, 2016b). Maybe, it is precisely this lack of practical knowledge of the less experienced LS-team that created a need to understand the learning of pupils and to explore the relationship between teacher activities and pupils' learning processes. The novice teachers may also have a greater inquiry stance (Cochran-Smith & Lytle, 2015) leading to a more meaningful reflection; they have recently completed ITE which - in the Netherlands - is aimed at stimulating this inquiry stance, while highly experienced teachers often have not followed such a training. In addition, a study by de Vries et al. (2013) shows the trend that as teachers get older, they engage less in reflection activities.

The school as a professional learning community may also have played a role. In schools with a professional learning community, teachers collaborate and talk exploratively with each other (Mercer & Hodgkinson, 2008) with the goal of professional development and school improvement (Lomos et al., 2011; Stoll et al., 2006). Such a school context will influence the nature of the LS conversations. Perhaps the school of the experienced LS-team showed no or fewer characteristics of a professional learning community. The fact that this spent much less time on this LS-study than the less experienced LS-team may be indicative for this.

What may also have contributed is heterogeneity in conversation skills of both student teachers. More than the student teacher of the experienced LS-team, the student teacher of the less experienced LS-team raised questions and topics of discussion from the manual frequently, asked about arguments and considerations and questioned whether solutions found in the preparation meetings had actually solved the identified problems. This student teacher used different talk moves, such as dialogic moves and supportive moves (Fauskanger & Bjuland, 2019; Vrikki et al., 2017; Warwick et al., 2016), which are known to promote the exploratory nature of LS conversations in ITE (Karlsen & Helgevold, 2019).

This research has provided specific knowledge about how mixed LS teams reason about student subject-related learning. The analyzes show that mixed LS teams in ITE compose their reasoning on subject-related issues in similar ways, but also that differences occur, differences that prompt reflection on issues of meaningful reflection. We recommend ITE's that wish to implement LS in mixed teams, to pay attention to the composition of the teams, to student teachers' present conversation skills and features of the participating schools in terms of learning organization. We also recommend ITE's to help LS-teams structure their conversations through the use of a facilitator or, if that is not possible due to time and money issues, by using conversation cards or guided questions (Næsheim- Bjørkvik & Larssen, 2019). In particular, scaffolding of interpretation activities may help stimulate a more meaningful

reflection of mixed LS-teams in ITE. Further research is needed to generalize findings, to test possible explanations and to investigate the individual contribution of the student-teacher during noticing as reasoning during LS in ITE.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tate.2022.103656.

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