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UTILIZING INFORMAL FORMATIVE ASSESSMENT AND DIALOGICITY DURING REFLECTIONS ON EDUCATIONAL DIALOGUE IN MATHEMATICS

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ABSTRACT

In this study, educational dialogue is explored through informal formative assessment and dialogicity. We enhance the understanding of informal formative assessment and dialogicity by considering their relationship. Even though the interconnection of informal formative assessment and dialogicity is acknowledged, it has not been explicitly examined in research on educational dialogue. The data consists of video-stimulated joint reflections between mathematics student teachers and a teacher educator. The reflections were part of a teacher education program integrated in a mathematics pedagogic course. Conversational analysis was conducted to detect interactional patterns and indicators that emerged from the data. The findings show how the presence and absence of single informal formative assessment moves, such as recognizing and using learners' ideas, contribute differently to dialogicity and educational dialogue.

KEYWORDS

educational dialogue, informal formative assessment, dialogicity, mathematics teacher education

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Introduction

The central role of educational dialogue has long been recognized in studies of classroom interactions (Howe & Abedin, 2013). In this study, educational dialogue was applied in the context of mathematics teacher education and addressed through informal formative assessment and dialogicity. Formative assessment is often outlined as a continuous cyclical process that draws out learners' thinking and supports further learning (Bell & Cowie, 2001; Furtak et al., 2016). Regarding informal formative assessment, we focused on the interactive nature of formative assessment taking place in educational dialogue. Informal formative assessment employs specific interactional moves to elicit and use learners' ideas (Ruiz-Primo, 2011). The main point is that informal formative assessment practices involve interactions that go beyond the transmission modes of teaching and encourage learners to take active roles in knowledge building. Consequently, features of dialogicity need to be present in interactions through the consideration of different views and ideas (Ruiz-Primo & Furtak, 2007).

Although the benefits of more learner-centered and dialogic interactions have also been acknowledged in mathematics (Alrø & Skovsmose, 2002; Bakker et al., 2015), the quest for correctness as a driving force in interactions has been distinctly present (Wood, 1994). The work on dialogicity across subject disciplines suggests that the prevailing forms of interaction can be challenged through the explicit consideration of learners' ideas and their integration into discussions (Alexander, 2006). This also rationalizes the discussion on dialogicity in the teacher education context, as introduced in this study. Teacher reflection has been found to be an essential element in developing teaching (Helleve, 2009). In particular, joint reflection on video clips has been considered to foster mathematics teacher development, often with regard to using students' mathematical ideas (Borko et al., 2014). In this study, the reflection discussions focused on aspects of educational dialogue and dialogicity. Facilitating reflection discussions as an interactional process can be similar to facilitating educational dialogue in the classroom. We seek to explore the potential of this parallelism.

1. Theoretical background

Informal formative assessment as a built-in interactional pattern. Interactions in mathematics and science are widely dominated by the triadic IRF pattern (Monteiro et al., 2019), where *I* stands for teacher initiation, *R* for learner response, and *F* for teacher feedback (Lemke, 1990; Mercer et al., 2009; Sinclair & Coulthard, 1975). The subject-centeredness and authorittiveness in mathematics and science may be seen in teacher questioning that aims for correct and expected answers (Chin, 2007). Etched with brief wait times (Chin, 2004) and evaluative teacher feedback (Cullen, 2002; Park et al., 2020), authoritativeness is enforced and there is little space for the authentic exploration of ideas. In contrast to authoritativeness, dialogicity is enabled via teacher follow-ups, such as feedback (F) and probes (P) that push learners further in their thinking. The cultivation of these elements could finally lead to extended dialogue and a chained IRFRF pattern (Lemke, 1990) or IRPRP pattern (Scott et al., 2006).

The introduced feedback turn plays a central role in triadic and derived extended interactional patterns (Cullen, 2002; Scott et al., 2006). The dialogic approach and openness to different perspectives are the starting points for more supportive feedback (Mortimer & Scott, 2003, 2020), meaning that the teacher is sensitive to learners' ideas and efforts. While dialogic interactions are often linked to chained patterns, the cyclical nature of the formative assessment can be addressed through a four-move interaction pattern (ESRU). In the ESRU cycle, the teacher elicits a question (E), the student responds (S), the teacher recognizes the response (R), and the teacher uses (U) the collected information to support learning (Ruiz-Primo & Furtak, 2006). The ESRU pattern has been used to describe the on-the-fly nature of informal formative assessment practice manifesting in instructional dialogue (Nieminen et al., 2021; Ruiz-Primo, 2011). As in dialogicity, the importance of probing feedback is crucial (Ruiz-Primo & Furtak, 2007).

The ESRU structure may not always exist as a uniform pattern; rather, its variations have equal potential to enrich both interactions and learner understanding. Whereas teacher use of learner responses plays a central role when providing feedback that takes thinking and learning further, we consider teacher recognition to be crucial in establishing the dialogic nature of the discussion through neutral or supportive (verbal or non-verbal) recognition of learner responses (Berland & Hammer, 2012). Through this move, a teacher may internally recognize the unveiling of learner misconceptions (c.f., Bell & Cowie, 2001) or potential ideas that may be used and explored further (Nieminen et al., 2021).

The relationship between dialogicity and informal formative assessment. Dialogicity is often approached with principle-level descriptions for dialogic teaching (Alexander, 2006):

- Collectivity: Teacher and learners pursue learning tasks jointly either in small groups or whole-class discussions
- Reciprocality: Teacher and learners listen to each other, share thoughts, and consider different views
- Supportivity: Learners express and justify their ideas without fear of being right or wrong and help each other in meaning-making
- Cumulativity: Teacher and learners build on to each others' ideas and experiences
- Purposefulness: Discussions are meaningful in terms of learning goals

It is possible to introduce teachers to features of dialogicity through these principles (Lehesvuori et al., 2017). However, it is through dialogic indicators that the practice can be meaningfully linked to the principles (Nystrand, 1997; Sedlacek & Sedova, 2017). Some research has addressed how dialogic teaching (Sedova et al., 2016) and informal formative assessment (Chan & Yau, 2021) are viewed by teachers and student teachers. Some results have shown that both teachers and student teachers are able to grasp features of dialogicity within their views in spite of challenges arising in implementation (Lehesvuori et al., 2021).

The connection between dialogicity and informal formative assessment has been acknowledged to some extent (Ruiz-Primo, 2007, 2011). Accordingly, dialogicity has been implicitly brought up as a cornerstone of informal formative assessment (Black & William, 2009). That is, a teacher should facilitate activities and forms of interactions that enable feedback that advances learning. However, there has not yet been an explicit in-depth consideration of this relationship.

2. Research questions

We explore whether and how the teacher (i.e., the university lecturer) orchestrates dialogic interactions when discussing dialogicity through the following research question:

> How are informal formative assessment moves and dialogic indicators present and interlinked in joint reflections on dialogicity?

Three example cases (a, b, c) will be presented. The cases are titled based on the contextual topic of the joint reflections:

a. Providing options for teacher elicitation techniques
b. Getting responses from the pupils
c. Using and building on pupils' incorrect and incomplete ideas and questions

3. Method

3.1 The context

Participants. The mathematics student teacher group of the University of Jyväskylä consisted of twelve student teachers, of which three were involved in this explorative case study. In general, "student teacher" refers to a university graduate who is qualifying as either a class teacher or a subject teacher. The mathematics student teacher participants were conducting their one-year teacher education and practicum, which usually takes place after the Bachelor's subject studies. This format is a very typical path for subject teachers receiving pedagogical qualifications in Finland. The department of teacher education emphasizes research-based and theoretical ideas; the practicum conducted in teacher training school is more related to implementing the ideas in practice.

The program. The program was designed within a larger OPA project funded by the Ministry of Culture and Education, Finland. The aim of the program was the development of pre- and in-service teachers' assessment skills through interactions. The selected themes for the mathematics student teachers were Teacher Sensitivity, Quality of Feedback, and Dialogicity (Figure 1). Teacher sensitivity focuses on creating a positive atmosphere nurtured by closeness and shared emotional expression. This could mean using a warm tone of voice and utilizing eye contact (Pöysä et al., 2021). Some features of the feedback theme are linked to dialogicity. In particular, follow-up questions and seeking elaboration have been addressed before. The theme discussed in this study is dialogicity.

The order of the implementation of the themes was discussed with the university lecturer of pedagogy of mathematics. While dialogicity was perceived as the most challenging (e.g., Lehesvuori et al., 2011, 2017), it was placed at the end of the program. The cyclical program structure and the schedule overview are presented in Figure 1. The program was integrated into a university course addressing the pedagogy of mathematics and student teacher practicum in a teacher training school. Each cycle had three phases:

1. An introductory theoretical workshop;
2. A video recording of a lesson and the selection of an example for reflection; and
3. A joint (online) reflection session on selected examples.

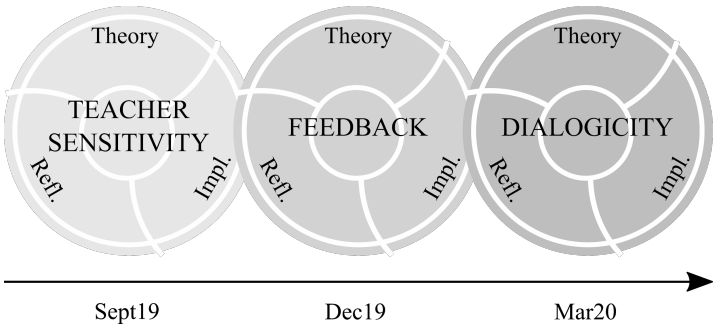

Figure 1
The program for the mathematics group

The structure of a cycle followed a fundamental triad that included crucial elements for teacher development (Westerman, 1991). More specifically, aspects of "knowing," "seeing," "doing," and "reflecting," as introduced by Hamre et al. (2013), were repeated in the program. After each introductory session, there was an average two-month period in which student teachers video-recorded, self-reflected, and selected a video clip example for the joint reflection session. Basically, the reflections followed the principles for a stimulated recall interview in which videos were used to trigger joint reflections (O'Brien, 1993) and theory was bridged to practice (cf. Scherer & Steinbring, 2007; Zhang & Zhang, 2020).

3.2 The data collection and analysis

The data collected in all three cycles included audio-recorded workshops, video-recorded mathematics lessons, and onsite/online audio-recorded reflections of one's own lessons and peer lesson examples. Videos were recorded by GoPro cameras placed in the classrooms by the student teachers themselves. Due to the COVID-19 lockdown, the last cycle, especially the reflection session on dialogicity, was organized differently. Instead of bringing all of the students to the same onsite joint reflection session, the group was divided into five subgroups formed by the student teachers themselves. Three groups included three student teachers, and two groups included two student teachers. The joint reflections took place via Zoom because of the remote recommendations due to COVID-19.

The selection of the group, video clips, and the reflection sessions. The whole dataset of the last cycle, that is, the videos of the student teachers' lessons and the joint reflections addressing the theme of dialogicity, was screened in a previous study when detecting student teachers' noticing dialogic

indicators (Lehesvuori et al., 2021). No further micro-scale or conversational analysis has yet been conducted. There were five groups; we purposefully selected (Patton, 2015) one group for a micro-scale conversational analysis based on the group characteristics revealed in the study on student teachers noticing dialogicity. The group provided the most frequent suggestions related to enhancing informal formative assessment and dialogicity through open questions, probing feedback, and talk distribution. The group consisted of three student teachers (ST1, ST2, ST3). ST1 and ST2 were able to video record their lessons in the last dialogicity cycle; ST3 selected a clip from the lesson video recorded during the second theme period (i.e., feedback). Before their joint reflection sessions, the student teachers screened their videos with the help of an observational form categorizing features of dialogicity (Pöysä et al., 2021). They selected a clip that they believed presented some feature(s) of dialogicity. This clip was then shared with the university lecturer who organized the joint online reflections around the examples. In all of the reflection sessions, the first episode begins with the university lecturer opening the discussion on dialogicity and ends with closing down toward more structured reflections. Thus, the examples build uniform and comparable units for fine-grained analysis.

Analyzing informal formative assessment moves and patterns of interaction. The analysis followed sophisticated conversational analysis techniques for patterns emerging from the data (cf. Hsu et al., 2009). First, the reflection examples were analyzed turn by turn and codes were given for every move (see Table 1). A speaker turn can include several moves (codes). Close attention was paid to the presence and absence of single moves that could play a role in fostering dialogue and idea-sharing. Second, we used coding to depict distinct patterns of interaction. That is, we sought to determine how both incomplete and extended variations of the ESRU cycle link to dialogicity.

There is a need to complement the ESRU cycle (Ruiz-Primo, 2011) in terms of taking into account learners' active role in dialogue. For example, it is not always the teacher who asks the questions and seeks information (elicits); the dialogue may be initiated by a learner wonderment question (Aguiar et al., 2009; Monteiro et al., 2019). However, when linking back to informal formative assessment, the focus is placed on how the teacher recognizes and uses these questions when facilitating extended dialogue and/or the creation of knowledge and understanding. We also differentiate explicit use of learner responses from lecturing, such as when a teacher is moving from learners' ideas to more of a lecture mode when introducing concepts and solutions. Table 1 illustrates examples of the moves considered in the micro-scale analysis.

Table 1
Moves considered in a micro-scale analysis of informal formative assessment

Move	Code	Description	Data extract
Elicitation	E	University lecturer elicitation is typically a question. By nature, the question may be open or closed. Teacher elicitation could be a result of previous moves, yet the teacher is not explicitly using learner responses. (Note: Wait time provided right after acknowledgement should not be considered as an explicit elicitation)	Well, that kind of clip. What kind of ideas came to mind?
Student teacher response	S	Student teacher responds to teacher initiation or elicitation	Well, there was the kind of situation when the student responded a bit wrongly, then she wasn't like, "Not really," rather she asked, "Do you agree?"
Recognition	R	University lecturer recognizes student teacher's response by repeating it or providing (non-evaluative) feedback. Recognition can also be confirmatory or disconfirmatory (i.e., evaluative)	Yeah, that might be true ((wonderingly))
Use	U	University lecturer uses the student teacher's idea in the follow-up turn. Can be followed by initiation on another topic or a subsequent, yet independent, elicitation	So, excellent question in a way. But how can it be formulated in a way that helps achieve the goal of the question?
University lecturer (Teacher) lecture	T_L	University lecturer presenting or lecturing to the whole class. Not explicitly using student teacher ideas; rather, exposition to new ideas. (Note: T_L is coded when university lecturer shifts from using student teacher ideas to a clear presentation mode and explanation of concepts. There is a communicational shift toward a more non-interactive lecture mode)	In a way, when thinking about it, there was quite a long list of those responses. So, are the students able to keep up with what they are disagreeing with?
Student teacher question	S_Q	Student teacher poses a wonderment or clarification question. (Note: Student teacher responding in the form of a question should not be coded as S_Q)	Should we find dialogicity in it or…?
University lecturer response	T_R	University lecturer responds to student teacher's wonderment or clarification question	Yeah, and of course anything else that comes to mind.

Analyzing dialogic indicators. Dialogic indicators (Table 2) are based on the introduced literature. Whereas single informal formative assessment moves take place in every turn, dialogic indicators were coded when being explicitly present. Principle-level interpretations, as described in the theoretical background (Alexander, 2006), were based on the analysis of the prevailing indicators. For example, if the university lecturer facilitated the distribution of the talk to collect ideas and built on this information, then both collectivity and cumulativity are considered to have taken place.

Table 2
Dialogic indicators and their descriptions

Dialogic indicator	**Code**	**Description**	**Data extract**
Open question	OQ	The question is open by nature, seeking student teachers' ideas	Well, that kind of clip. What kind of ideas came to mind?
Wait time	WT	Clearly detectable wait time ranging often from a few seconds to dozens of seconds	Yeah (5-second wait time after which student teacher responds)
Neutral recognition (and/or repetition)	NR	Teacher (university lecturer) recognizes student teacher response without an evaluative tone. Could take place in the form of repetition.	Yeah, that might be true.
Probing feedback	P	The feedback is probing by nature, seeking further elaboration of the previous response	Any other strategic moves coming to mind for Marie or Paula?
Student (teacher) questions	S_Q	See Table 1 for S_Q	See Table 1 for S_Q for implementation

3.3 Research ethics and trustworthiness

Student teachers were informed about the study and their right to take part and withdraw at any point. All student teachers volunteered and signed a written consent form. Similarly, pupils of the video-recorded lessons and their parents were informed and written consent forms were signed. All the names used in the transcriptions are pseudonyms. For the conversational analysis, the coding of the transcripts was done independently by two researchers (Authors 1 and 2). Points of disagreement were discussed until consensus was established. This procedure aligns with researcher triangulation (Miles & Huberman, 1994). The third author was also the facilitator of the joint reflections, and a member check was applied in terms of evaluating the analysis and interpretations (Lincoln & Guba, 1985).

4. Results

The topic and context of each video clip example are introduced by student teachers (STs) themselves, and the reflection examples begin right after the clip. A brief overview of the context of the reflection discussion is provided before the transcription examples. The reflection cases are not presented in chronological order, since the storyline (cases a, b, c) builds on highlighting the moves of the ESRU cycle in order. Thus, in the presentation of the results, the last reflection is addressed first. In terms of temporal considerations, the facilitator (i.e., university lecturer = UL) pointed out the use of wait time in the first presented example (Video clip ST1), so it was already noticed by the STs (Video clip ST2).

Case a – Providing options for teacher elicitation techniques

The first reflection example is based on a video clip in which ST1 reformulated her question in order to seek further elaboration from the pupils. She noticed that she could have formulated the question in a more open way.

Used transcription markers: (text) = talks over, right after or simultaneously, (x) = wait time x seconds, ((text)) = clarification or additional necessary information, (...) = cut off or reformulated sentence

Turn	Reflection transcription	Codes
1	UL: Well, that kind of clip. What kind of ideas came to mind?	E OQ
2	ST2: Well, there was the kind of situation when the pupil responded a bit wrongly, then she wasn't like, "Not really," rather, she asked, "Do you agree?"	S
3	(7) UL: Yeah (5) ((waiting for other responses))	R NR WT
4	ST1: Well, I did notice myself, now when I saw the clip afterward, that if I had a chance to ask the question again, then I would ask it in a way like, "What do others think?" Maybe that would have initiated further comments by others. But, now when I ask, "Does everyone else agree?" then nobody reacted to my question in any way.	S
5	UL: Yeah, that might be true ((wonderingly)). So, excellent question in a way. But how can it be formulated in a way that helps achieve the goal of the question? Maybe it could help if you formulated the question a bit differently. Well, if we focus on that, what alternative question would you have implemented then?	R NR U E P
6	ST1: Well, "What do others think?" Then they could have said more about what they themselves think, rather than merely asking "Do you agree?" with the pupil who just responded.	S

7	UL: All right ((wonderingly)).	R	NR
	So then there would not be a rivalry positioning.	U	
	Any other strategic moves coming to mind for Marie or Paula? (30) ((extensively long wait time until retargets the question))	E	P
	Could there have been a brief wait time? In a way when thinking about… In a way when thinking about it, there was quite a long list of those responses. So, are the pupils able to keep up with what they are disagreeing with? Should it have been explicitly displayed in a way that would help them to see what the pupil responded to? Thus enabling the comparison. And if we would think further in terms of dialogicity, then voting for opinions could have been a possibility if divergent views were clearly present. I'm quite sure there would have been different kinds of selections for polygons emerging. Then voting could make it visible that there are several pupils who have different opinions. Then nobody would be left alone with their opinions. It would create a natural ground for discussions when one sees that there are different opinions.	T_L	

Informal formative assessment and dialogicity. The episode began with an open question. This was a common denominator in all the reflections. The UL's neutral recognition complemented with wait time in recognition turns can be considered as repeating dialogic indicators facilitating an extended ESRESRU structure in turns 1 to 5. The absence of the using move could have triggered ST1's self-reflection in the beginning, leading to a change in the ESRU cycle that finally took place in turns 5 to 7 initiated by the UL asking for further elaboration on ST1's self-reflections. Since they received no further ideas for the last elicitation, UL began lecturing. All in all, dialogicity in this episode was successfully facilitated, as is evident in several indicators, such as neutral recognition, wait time, probing, leading to extended dialogue, and distribution of talk (collectivity). In terms of noticing and learning about dialogicity, ST2 was able to notice that ST1 was not evaluating the pupil response but rather re-formulating the question into a more open form.

Case b – Getting responses from the pupils

The second reflection example is based on a video clip in which ST2 was determined to get responses from the students. This was highlighted in the end by the UL.

Turn	Reflection transcription	Codes
1	UL: All right, what kind of notions on dialogicity? (3)	E OQ
2	ST1: Well, I did notice that there in the last item "providing time for pupils' thinking" ((refers to the observation form)). I think Jonna managed to do this. Although there was a pupil with a raised hand, Jonna did not immediately give them a turn. Instead, she let others think about it also, and only after that did she give them a turn.	S
3	UL: Okay, indeed there was good wait time. (5) ((waiting for further responses)	R WT
4	ST3: Yeah, I noticed the same thing. And I think it was also nice that when a pupil responded, Jonna moved closer to the pupils in a way. This way it seemed that she was actively listening to the pupils and being present in the situation. Like in a way listening well.	S
5	UL: Yeah, yeah (7). And it is also an indicator of active listening that one can clarify pupil responses (2) and extend them. Well it continued like… Well, you clearly understood what the latter pupil responded to, since you were able to elaborate it. (3) Well there were the starters. Let's have a look then, item by item, cumulativity and purposefulness. That is, the discussion is on the topic. Is the focus on understanding? Are you building on the previous? (5) ((moves toward more structured reflection based on the observation form))	R NR WT U E
6	ST1: Well yeah, the discussion stays on the topic and first you calculated the area of one wall and then based on that area of all the other walls. Well, isn't it about building on the previous also?	S
7	UL: Yeah, yeah (14) ((waiting for further responses before shifting to another subtopic)) What about understanding then?	R NR E P
8	ST3: Well, I think that for example when… Or it seemed so, that you ((refers to ST2)) are aiming to actually understand the pupil when he was actually counting on the other wall instead of what Jonna meant to be calculated. Then, Jonna clarified in a way that everyone stayed onboard. Like what was calculated in order to understand where they were going. And also emphasizing that the pupil had understood correctly, and just calculating the unintended part. And had just understood it ((the wall in question)) wrongly.	S
9	UL: Yeah (2). And also pupil turns are building on the understanding, when you think about the latter explanation. It was not only like 2 times 9 multiplied with a sum of 2 times 8 times 4 is some resulting number and a calculation. Rather, it was more about where the numbers came from. Like, what is that 2 times about? It is the kind of interaction in a way, within which the teacher ensures that the idea comes from the pupils themselves. And if not, then the teacher makes sure that she or he formulates the question in such a way that the response comes from the pupil. In this case this was realized right in the beginning. And, then the teacher ((refers to ST2)) clarified where the multiplying by 2 comes from, for example. ((discussion continues to collectivity and reciprocality))	R NR U T_L

Informal formative assessment and dialogicity. After an open question and ST's response, in turn 3, UL merely recognized the ST's response which led to ST3 taking the complementary turn. Thus, when it comes to the informal formative assessment structure, the U move is clearly missing. As in the first example, the neutral acknowledgment and absence of the U move contributed to the development of an extended ESRSRU structure (turns 1 to 5) conforming to dialogic interactions. That is, dialogic space was opened for the ideas of the STs. The key dialogic indicator in this episode is the use of wait time. Beginning from turn 5, UL shifted to more structured reflections manifested through more closed and structured interaction patterns. First, the discussion forms a triadic ESR chain (turns 5 to 7) left open with extended wait time. The last turns form a completed ESRU pattern (turns 7 to 9). In sum, whereas the beginning was more dialogic by nature, it is through using ST responses that the UL more authoritatively brought in the central idea of taking into account pupil perspectives when discussing the construction of knowledge and understanding. Thus, this episode also demonstrates the cumulative structure for meaningful learning through clear opening up and closing down phases characterized by different communicative approaches (Scott & Ametller, 2007).

Case c – Using and building on pupils' incorrect and incomplete ideas and questions

The third reflection example is based on the video clip demonstrating how ST3 reacted to a pupil's incorrect idea. The reflections address the potentiality of these instances.

Turn	Reflection transcription	Codes
1	UL: Well then. What kind of questions or comments emerge from the clip?	E OQ
2	ST1: Should we find dialogicity in it or...?	S_Q
3	UL: Yeah, and of course anything else that comes to mind.	T_R
4	ST2: I think this is a good clip!	S
5	UL: ((after waiting for 4 seconds)) What would you think was especially good about it?	E WT P
6	ST2: Well I think it was nice that when there was a question about whether the diameter could be used to calculate it, then Paula asked the others why it couldn't it be used, and did not just say that no because this and this.	S
7	ST1: Like she would not answer it by herself immediately, rather the question was jointly discussed. In a way, why doesn't it go like that?	S

8	UL: Yeah. It is a very common move that it is worthwhile to remember. In a way, it passes on the question to other pupils. And even in that situation, it's highlighting that it was a good thing to ask that kind of question, like sometimes pupils would think that those kinds of questions are not good questions, because it was wrong, or there were defects in the pupil's thinking. So those kinds of questions are actually welcomed. Any other ideas? (12) Did you interpret that the possible misconception there might have been in the pupil's thinking?	R NR U E P
9	ST2: Do you mean the idea that diameter could be used?	S_Q
10	UL: Yeah, and what was the logic behind?	T_R
11	ST2: Well, it was likely because there was a radius that was 2. And, the square of 2 is the same as 2 times 2. ((UL nods and says "Yeah")) So it would be the same as diameter.	S (R)
12	UL: Yeah, I was thinking that too. And it was also Paula who analyzed it on the fly in the same way. So it just happens to be the case that there would have been the diameter ((in the equation)). Although there isn't, it just looked like it. Now if we think about the principles of dialogicity, then where would you link this where a teacher interprets a possible misconception and then figures out further actions for how to address it? (17) ((STs are reading the form))	R NR U E P
13	ST2: Well, could it go with the last item "strategies and indicators" because the pupil question is acknowledged and what is behind the question is figured out?	S
14	UL: Well yeah, there is acknowledgement in my opinion too. Definitely. What about you Paula, what do you think?	R E P
15	ST3: Yes, I was beginning to think of it another way than previously, but maybe just that the responses are being acknowledged. So that would probably be it.	S
16	UL: Yeah, and I'm quite sure that it goes with something else too. Especially the item at the top, cumulativity. You are like building on the pupil's response. Like on the previous idea that came from the pupil… (moves on to supportivity)	R U

Informal formative assessment and dialogicity. Distinctly, in turns 1 to 3 and 8 to 10, the ES_QT_R pattern consists of teacher elicitation followed by a student teacher confirmatory question and UL's response. After ST3's vague response in turn 4, UL probed for a further response. In this case, as there was literally nothing UL could use, a further and more explicit elicitation was required. Indeed, in terms of orchestrating educational dialogue, UL demonstrated a variety of dialogic indicators to get the discussion going: open question, wait time, probing, and neutral recognition. As a result, the interaction pattern formed to ESSRU (turns 5 to 8) including ST3's and ST1's sequential and complementary responses, which UL then more clearly

recognized and used. This using move is central when highlighting the essential nature of dialogicity and welcoming and making use of pupils' ideas as they are. All in all, the pattern resembles an informal formative assessment within UL further extending and developing STs thinking (Nieminen et al., 2021). When it comes to implementing and noticing dialogic indicators, ST1 and ST3 clearly noticed in the video clip that ST2 tossed the question back to pupils after non-evaluative acknowledgement. This is related to probing for elaboration. Probing was also characteristic for UL's implementation strategy in this episode. While the STs were evidently noticing indicators (probing and pupils' questions), it is the UL who explicitly brought in the principle of cumulativity (turn 16). This was also overarchingly present in the video example building on pupil wonderment question holding in a typical misconception.

5. Discussion

In this study, we examined educational dialogue through the analysis of informal formative assessment and dialogicity. We focused particularly on exploring the on-the-fly nature of informal formative assessment and dialogicity in joint reflections between mathematics student teachers and a university lecturer. The results indicate that the nature of teacher recognition is crucial in establishing the dialogic nature of the discussion. The teacher recognition of learner responses can be neutral or supportive; it can also be verbal or non-verbal (Berland & Hammer, 2012). In terms of the single moves of the ESRU cycle that characterize the informal formative assessment nature of the interactions, the recognition move was characterized by dialogic indicators such as neutral stance and wait time that led to extended dialogues that fostered collectivity. Cumulativity was established by the use of learner responses, especially when drawing on conclusions during using moves. The two moves together are in line with the central role of the congruent feedback and/or probe moves acknowledged in earlier studies (Cullen, 2002; Lemke, 1990; Scott et al., 2006).

In our coding scheme, whereas the recognition move and related dialogic indicators were shown to serve dialogicity especially in terms of collectivity, the using move addressed more the content through cumulativity and purposefulness. Although the using move could serve for dialogicity when probing for elaborated thinking, the absence of the using move was especially important for extended dialogue when the university lecturer elicited for further participation. The university lecturer took responsibility for building meanings via chained interactions, as in the third example when drawing on cumulativity. The university lecturer delayed the using move to avoid

a communicational "U-turn" toward ending the discussion too early, which is likely a planned strategy since it is repeated in the examples (Mortimer & Scott, 2020). Reflecting on this, we shall continue the discussion on communicational balance.

Patterns of interaction, dialogicity and communicational balance in informal formative assessment. The findings show that incomplete and complete ESRU cycles serve different purposes and are linked to different communication stances and moves. The absence of the using move, replaced by neutral recognition, wait time, and probing follow-ups was linked to extended dialogues and dialogicity (Mortimer & Scott, 2003; Scott et al., 2006), whereas complete cycles were associated with the establishment of learning goals (cf. Menon, 2018). These results show that although dialogicity can be essential, especially when seeking information about learners' thinking, authoritativeness (focus on knowledge) carries more weight when heading for purposeful closures via cumulativity. In terms of communicative approaches (Mortimer & Scott, 2003), there is a wave motion between dialogicity and authoritativeness, and teachers should be sensitive about when to open and close discussions (Lehesvuori et al., 2013, 2019). Balancing the different communicative approaches is apparent in the ESRU cycle and its variations in the following ways:

- *Elicitation:* The dialogic approach is cultivated by open questions seeking different ideas and alternatives. Authentic learner questions potentially arise during dialogic interactions. An authoritative approach prevails when the teacher seeks the correct answer or options via closed and/or diagnostic questions.
- *Learner response*: The nature of learner response often aligns with the nature of the question posed. That is, for closed questions, learner responses are often brief and pre-determined, while open questions potentially engage learners in expressing their thinking.
- *Recognition:* In the dialogic approach, recognition takes place through neutral or supportive acknowledgement, which potentially leads to extended dialogues and idea-sharing. In the authoritative approach, the recognition of learner responses takes place with an evaluative and/or directive tone.
- *Using:* In the dialogic approach, the teacher uses learner response in order to stimulate further thinking or the teacher explicitly uses learner ideas when making links between different viewpoints, e.g., between everyday and scientific views (Mortimer & Scott, 2003; Ruiz-Primo & Furtak, 2007). In the authoritative approach, the teacher often uses learner responses to establish correct closures and conclusions.

Ideally, a teacher orchestrates a reciprocal interaction among participants by facilitating extended dialogues through intended forms of recognition and the meaning-making process by focusing on the cumulative building of content (Scott & Ametller, 2007). The latter can take place in the teacher's longer lecturing turns, extending beyond the use of learners' ideas toward more lesson-goal-oriented instruction. The challenge, however, is to balance authoritativeness and dialogicity (Lehesvuori et al., 2019; Scott et al., 2006). Within informal formative assessment, this could mean, for example, that the teacher balances between collecting and presenting information and between neutral recognition and evaluation of learner responses. This is also about reaching the two main aims of the informal formative assessment: first, for teachers to get information on students' learning and adapt their teaching methods accordingly; second, for students to get information on their learning progress and develop their knowledge and skills (Black & William, 2009).

Conclusion, limitations, and future study

First, it is worthwhile to point out that productive dialogic interaction can take place in online settings. In terms of practical issues, the small group sizes in online settings may be essential for the facilitator to be able to recognize and to use both verbal and non-verbal information obtained from video-on conferencing. The extremely extended wait time implemented by the university lecturer could be adopted to onsite and classroom settings, yet learners should also be aware of its function. Of course, while online settings offer other possibilities for getting information in video-off online mass-lectures (e.g., polls and chat), the results of this study speak for small groups when aiming for teaching through interactions as described in existing observation protocols (Pianta et al., 2012).

When it comes to questions about limitations, the reason that the student teachers selected the exact sample they did could not be confirmed. But, as peers and the university lecturer were able to detect features of dialogicity such as wait time and proximity, these features may also have been noticed during self-reflections. The university lecturer helped to go beyond noticing indicators of dialogicity by linking it to the joint creation of mathematical knowledge and understanding in terms of introducing the role of learners in this interactive process. We argue that the structure provided and the on-the-fly feedback provided by the university lecturer were essential features of the program implementation.

All in all, when thinking about student teacher learning in the described settings, the role of videos and the feedback was frequently brought up in supplementary data (i.e., the course feedback) as something that pushed

student teachers' thinking and understanding further (cf. Chan & Yau, 2021). As we have demonstrated that productive educational dialogue can take place in online settings through informal formative assessment and dialogicity, it would be interesting to study its boundaries and possibilities in different contexts and settings. This would provide further information for both teachers and teacher educators on how to set up and orchestrate educational dialogues both onsite and online.

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