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Dialogue through the eyes: Exploring teachers' focus of attention during educational dialogue

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ABSTRACT

This study explored teachers' focus of attention during educational dialogue. Teachers' focus of attention was recorded in 54 Grade 1 classrooms using Tobii Pro Glasses 2 mobile eye-tracking device. From the video recordings, episodes of educational dialogue were identified and categorised by quality. Teacher's focus of attention on students was examined during the dialogue episodes. Results showed that teachers allocated their attention relatively unevenly among the students. More students got visual attention during high-quality educational dialogue than during moderate-quality dialogue. This study provides insight into the quality of educational dialogue by combining assessment of the verbal dialogue with observations of the non-verbal focus of teacher's attention in classroom.

Keywords: Educational dialogue; Focus of attention; Eye tracking; Teacher; Student

1. Introduction

People's cognitions on the background of their gaze can be studied from interaction and speech that occur simultaneously (McNeill, 1985). Since gaze behaviour is central to social interaction and its regulation (Pfeiffer, Vogeley, & Schilbach, 2013), it is suggested that more research is needed regarding teachers' focus of attention and its distribution during whole-class dialogue, a busy and dynamic learning situation that requires both visual and verbal attention from the teacher. Recent research has highlighted the key role of dialogic interactions in students' learning, development and reasoning (e.g. Littleton & Howe 2010; Mercer & Littleton, 2007). Therefore, there has been growing interest in studying the diverse qualities and forms of effective educational classroom dialogue. However, previous studies have predominantly focused on the verbal exchanges between the teacher and the students and mostly neglected the non-verbal aspects of educational dialogue. These non-verbal aspects have been studied in terms of gestures, facial expressions, gaze and other symbolic actions used as a way of interacting and conveying meaning (Bavelas, Coates, & Johnson, 2002). However, only a few studies have examined the teacher's or whole-class verbal interaction in association with the teacher's focus of attention. In the present study, teachers' gaze during educational dialogue is not studied as a 'typical' non-verbal way of communication but as a way of discovering how teachers distribute their focus of visual attention among the students during classroom dialogue.

In interaction among people, varying from two people to larger groups such as classrooms of teacher and students, gaze is an important way of showing attention and of distributing turns (Mason, 2012). A few innovative studies have explored teachers' focus of attention in classroom situations with their students (e.g. van den Bogert, Bruggen, Kostons, & Jochems, 2014; Cortina, Miller, McKenzie, & Epstein, 2015; McIntyre, Jarodzka, & Klassen, 2019; McIntyre, Mainhard, & Klassen, 2017), but they have predominantly focused

on exploring teachers' classroom management, communication style or teaching experience (Cortina et al., 2015; McIntyre et al., 2019; McIntyre et al., 2017). To date, hardly anything is known about teachers' focus of attention during educational dialogue in the classroom, in which shared knowledge is built together between teacher and students.

Research focusing on verbal interaction has shown that managing educational dialogue and scaffolding students' participation and shared knowledge building can be challenging for the teacher (Muhonen, Rasku-Puttonen, Pakarinen, Poikkeus, & Lerkkanen, 2016). Good and effective teaching through dialogue requires teachers to be adaptive and sensitive to critical moments in the discussion, to be able to interpret situations, to have a repertoire of actions to draw on and to display judgment regarding instructional decisions (Lefstein & Snell, 2014). Especially in whole-class educational dialogue, the capabilities required of a teacher include clarity and coherence, adequate representation of content, equitable participation, time management (O'Connor, Michaels, Chapin, & Harbaugh, 2017) and standardised testing of the students' learning (Segal, Snell, & Lefstein, 2017). Many teachers reportedly feel pressure to engage students equally in classroom interaction (O'Connor et al., 2017). This raises questions regarding how many students actually get the chance to participate vocally in the discussion in a whole-class setting and how many students receive the teacher's attention during educational dialogue. The present study utilises a mixed-method approach of eye-tracking analysis and classroom talk to examine how teachers distribute their visual attention among the students during educational dialogue and to discover whether the distribution of attention varies according to the quality of the dialogue.

1.1. Educational dialogue

The characteristics, quality and patterns of effective educational classroom dialogue have been broadly studied and have yielded suggestions for characterising teachers' and

students' involvement in dialogue. Howe, Hennessy, Mercer, Vrikki and Wheatley (2019) recently presented some of the vital characteristics of verbal educational dialogue in the classroom, namely: 1) the use of open questions; 2) making extended contributions, elaborations and building on previous knowledge; 3) acknowledging, probing and critiquing different opinions; 4) seeking integrated lines of inquiry, and 5) adopting the metacognitive perspective on verbal interaction. This is largely in agreement with Alexander's (2000, 2006, 2017) concept of dialogic teaching, which describes five principles for effective educational dialogue. Principles of *collectivity*, *reciprocity* and *supportiveness* represent the type of culture of relationships in which dialogue is likely to emerge and support students' participation and sharing of their thoughts. The principle of *cumulation* highlights the dialectic nature of classroom discussion and the stepwise growth of shared understanding. The fifth principle, *purposefulness*, indicates that, although dialogue is of itself extremely important, the discussion should comprehend an educational goal or content if it is to be developmentally meaningful for the students. Lefstein (2006) has suggested adding two further features of dialogic teaching: *criticalness* (participants identify and investigate points and explore questions within the group) and *meaningfulness* (teachers and students relate to the topic and bring their own perspectives to the discussion).

Nevertheless, even if the educational dialogue fulfils all the above-mentioned criteria, the quality and pattern of the verbal exchange between teacher and students is likely to vary, since not all dialogues follow the same pattern. Muhonen et al. (2016) characterised educational dialogue by differences in quality. In the coding undertaken by Muhonen et al., higher-quality educational dialogues included versatile and rich scaffolding strategies that were likely to support students' conceptual thinking, joint understanding and synthesis of ideas and information. Moderate-quality educational dialogues included relatively unitary forms of questioning, less support for active participation and lower support for shared

understanding of content. These two qualities of educational dialogue have been verified in several studies, at different levels of schooling and in both Western and non-Western contexts (see Muhonen et al., 2016; Muhonen, Pakarinen, Poikkeus, Lerkkanen, & Rasku-Puttonen, 2018; Muhonen, Pakarinen, Lerkkanen, Barza, & von Suchodoletz, 2020).

Although educational dialogue can also happen between students only, it is acknowledged that the teacher has an important role in orchestrating the classroom discussion and scaffolding students' learning through it (Gillies, 2013; Rogoff, 2008; Rojas-Drummond, Torreblanca, Pedraza, Vélez, & Guzmán, 2013). However, teachers tend rarely to encourage their students to explain their thinking or broaden the discussion for the whole class to elaborate (Webb et al., 2009). One reason why teachers do not conduct educational dialogue may be lack of both time and the opportunity to involve all the students equally in the discussion (O'Connor et al., 2017). Students seldom take the initiative to explain their reasoning or justify their thoughts without the teacher's encouragement (Myhill, 2006), which is why active teacher involvement is often needed (Muhonen et al., 2016). The expectation of effective educational dialogue is that all participants (teacher and students) should be highly involved (Howe et al., 2019). O'Connor et al. (2017) studied vocal and silent participants in classroom discussion and found that students in both categories learned the content equally well, suggesting that vocal participation is not a necessary condition for benefiting from such discussion. The present study aims to explore teachers' focus of attention on both vocal and silent students during educational dialogue in the classroom.

1.2. The teacher's focus of attention in classroom interaction

Although interaction and educational dialogue are important in supporting students' development and learning in the classroom (e.g. Howe et al., 2019; Muhonen et al., 2018), we are still far from understanding how teachers allocate their visual attention during classroom

interaction. In interaction, eye contact and gaze have been acknowledged to have several major functions, such as asking for feedback or a reply, listening, indicating that the space for discussion remains open or recognition of a social relationship (Argyle & Cook, 1976).

Teachers' visual attention, measured through gaze, represents their ability to process information present in the classroom environment (van den Bogert et al., 2014). In previous research, similar terms such as *focus of attention* (van den Bogert et al., 2014) and *gaze pattern* or *gaze behaviour* (McIntyre et al., 2017; McIntyre et al., 2019) have been used to describe teachers' visual attention in the classroom. In the present study, the term 'focus of attention' is used when referring to teachers' visual attention, as measured through their gaze behaviour. It is only during the past decade that the technology for mobile eye tracking has been developed and utilised to study focus of attention in authentic classroom interaction (see Cortina et al., 2015; McIntyre et al., 2017, 2019). Fixation data obtained in the form of time duration are the measure most often used in eye-tracking studies to determine the focus of visual attention on an object (Cortina et al., 2015; Yamamoto & Imai-Matsumura, 2012), in the present case on students. In addition, pupil diameter and its dilation can reflect person's cognitive load and concentration (Beatty, 1982). The greater the concentration and mental effort, the greater the person's pupil diameter typically is (Rosenbaum, 2010).

As mentioned above, studies to date have predominantly investigated teachers' focus of attention in relation to classroom management, communication style or teaching experience (see van den Bogert et al., 2014; Cortina et al., 2015; McIntyre et al., 2019; McIntyre et al., 2017). Cortina et al. (2015), for example, stated that, although traditionally it has been argued that an effective teacher should monitor his or her classroom by distributing attention evenly, this may not be correct. In fact, an effective teacher is likely to give more attention to students who either have difficulties in learning or actively demonstrate their knowledge. However, the gaze data in themselves are not enough to explain the teachers' focus of

attention, and additional data such as verbal interaction that happens simultaneously with the gaze are needed to better understand the teachers' gaze distribution and the rationale behind it (van den Bogert et al., 2014).

McIntyre et al. (2017) analysed 'communicative gaze' (gaze during talking and sharing information) and 'attentional gaze' (gaze during questioning) among expert and novice teachers. They found that expert teachers focused their attention more on students and had greater gaze efficiency during both sharing information and asking questions. The expert teachers were also more flexible when asking questions but showed less flexibility during communicative gaze. Cortina et al. (2015) examined teachers' focus of attention in association with the quality of classroom interaction. They found that the quality of teacher feedback, meaning teacher's efforts to encourage students to elaborate on their responses, was associated with teachers focusing their attention more on certain individual students than on all equally. The findings are important, since providing high-quality feedback for the students requires the teacher to focus attention on those students who are receiving the feedback. On the other hand, Cortina et al. (2015) also suggested that experienced teachers are capable of monitoring their whole classroom through gaze while providing feedback or facilitating discussion with individual students. Dessus, Cosnefroy and Luengo (2016) investigated teachers' classroom awareness during interaction, utilising eye tracking. They found that every student in the classroom received at least some attention from the teacher but very small groups of students received more. They also found very little variability across different pedagogical activities.

1.3. Aims of the study

To date, educational dialogue has been predominantly studied by exploring the verbal aspect of the interaction. However, verbal participation, though very important and the most

visible aspect of dialogue, can be considered as only one aspect of the dialogue. In the present study, one non-verbal aspect, teacher gaze, was examined, not as a way of studying communication per se but rather as a way of obtaining information about teachers' focus of attention in order to gain insight about teachers' orchestration of the dialogue, that is, whether they distribute their visual attention evenly or the focus of attention mainly accompanies vocal participation. In addition, since educational dialogue does not always follow the same pattern, the present study examined whether the quality of educational dialogue is linked to variation in teachers' focus of attention on students. Due to the lack of previous research on this topic we are not able to set clear hypotheses for the study. The specific research questions were as follows:

1. How do teachers distribute their focus of attention among students during educational dialogue?
2. Does teachers' focus of attention on students vary according to the quality of educational dialogue?

2. Method

2.1. Participants and procedure

The present study examined Finnish Grade 1 teachers and students in their classrooms. The participating teachers (50 female, 4 male) were on average 44.6 years old, had a Master's degree in Education and had on average 16 years of teaching experience (minimum 0.5 years, maximum 39 years). On average, there were 17.8 students (minimum 6, maximum 23) present in the classroom during the data collection, reflecting the typical average class sizes in Finnish Grade 1 classrooms (though the group sizes can vary within the country). Children ($n = 780$, 49% girls and 51% boys) were approximately seven years old and had entered primary school a couple of months earlier. Parents' ($n = 577$) education ranged from no

vocational education to a licentiate or doctorate (*Mode* = vocational school degree).

Participation in the study was voluntary and the participating teachers and the parents of the students gave their written consent. The research project received ethical approval from the university's ethics committee.

The teachers wore eye-tracking glasses for 20 minutes during one lesson (one lesson per teacher, in total 54 lessons, including the subjects of literacy, mathematics, science and art). The recording was conducted utilising a Tobii Pro Glasses 2 mobile eye-tracking device. Two research assistants set and calibrated the eye-tracking glasses immediately before the recording and confirmed that every teacher felt comfortable functioning and moving around while wearing the glasses. At the end of the 20 minutes, the research assistant removed the tracking equipment from the teacher and stopped the recording. The sampling rate of the eye-tracker was 50 Hz (25 frames per second) and the calibration of the device was done using one point. The eye-tracker yielded a 1,920 by 1,080 pixels video, capturing 82 degrees horizontally and 52 degrees vertically. An audio recording was made at the same time. To secure the quality of the data analysis and calibration, the teachers were asked to look at three set points on the wall at the beginning of the video recording. The research assistants verified that the teachers' gaze met the three points accurately.

Eye-tracking video recordings having 70% and above gaze sample were selected for the analysis to ensure that that the teachers' eyes were detected at least during 70% of the recording duration. Therefore, 3 out 54 videos were not considered for analysis due to less than 70% gaze sample percentage and poor quality of the video.

2.2. *Analysis of the data*

2.2.1. *Episodes of educational dialogue*

The first part of the analysis focused on the aspects of educational dialogue. The 20-

minute video recordings were watched in order to identify episodes of educational dialogue occurring in the classrooms. An episode of educational dialogue was defined as continuous and extended verbal exchange between the teacher and students, in which the topic stayed the same and in which the five principles of dialogic teaching (Alexander, 2006) were reflected: *collectivity* (participants address learning tasks together); *reciprocity* (participants listen to one another, share ideas and consider alternative viewpoints); *supportiveness* (students articulate their ideas freely without fear of embarrassment); *cumulativity* (participants build on their own and one another's ideas and link them to coherent lines of thinking and enquiry); and *purposefulness* (the teacher plans and steers discussion with specific learning goals in mind). An episode would consist of several verbal exchanges between the teacher and students. A new initiative, for example a question or the sharing of a different type of information or knowledge, could lead to a new subtopic and therefore to a new episode. For each episode, start and end time were identified. On average, the identified episodes of educational dialogue lasted 3 minutes and 6 seconds (minimum 27 seconds, maximum 11 minutes 40 seconds).

Next, the identified episodes of educational dialogue were transcribed. Verbal exchanges that did not fulfil the criteria of dialogic teaching (such as initiation-response-feedback (IRF) exchanges) or classroom activities that did not include interaction between the teacher and students were not included in the episodes and therefore were not transcribed. After this, the transcribed episodes were analysed by Muhonen et al. (2016) with respect to their content and communicative acts to categorise them into two qualities of educational dialogue. In *moderate-quality* educational dialogues, the teacher asks many short/closed questions to keep the dialogue going. Students rarely participate without the teacher's help or encouragement and the dialogue is led by the teacher. In *high-quality* educational dialogues, the teacher asks fewer questions but they are mostly open-ended and the teacher welcomes a

variety of suggestions and views. Scaffolding of this kind allows students to participate and formulate their own initiatives in the shared knowledge-building process.

2.2.2. Teachers' focus of attention measured with mobile eye tracking

The second part of the analysis focused on teachers' focus of attention (eye gaze) during the identified episodes of educational dialogue from the 20-minute video recordings. First, the continuous stream of the video was divided into sequences of fixations by the Tobii Pro Analyzer software. Based on the default setting of the software, fixation was defined as an eye gaze on a target (student) for 60 milliseconds or more. The Tobii I-VT Attention Filter was used in the coding, since it is designed to identify fixations also when either the subject (teacher) or the target (student) moves often. Each fixation was given a code based on what the teacher was focusing on at the time. This was done manually by trained research assistants applying predetermined gaze behaviour codes as per the division devised by McIntyre et al. (2019). The codes were as follows: *student* (each student was identified with his or her own number), *student material*, *teacher material* and *other* (non-instructional targets such as walls or tables). Twenty percent of the video recordings were also double-coded. The agreement between two independent coders varied from 83.6% to 94.3%.

The present study concentrated only on the teacher's focus of attention on students during educational dialogue (codes of *student material*, *teacher material* and *other* were excluded). After coding the whole 20-minute recordings of teachers' gaze, the codings during episodes of educational dialogue (from the episode start time to the end time) were extracted and used for further analysis.

To measure teachers' focus of attention and its distribution, the fixation count and total fixation duration for each student per dialogic episode were calculated with the Tobii Pro Lab software, which was also used to visualise the coded gaze data by creating gaze plots. The

gaze plot visualisation shows the sequence and number of fixations on each student and the size of the dot indicates the fixation duration (the larger the dot the longer the duration). The nonparametric Mann–Whitney U test was employed to compare mean values of the measures (fixation duration, fixation count, vocal students, students who received visual attention) between the two qualities of educational dialogue. The Wilcoxon signed-rank test was used to compare teachers' fixation durations and fixation counts between verbally and not verbally participating students. In addition, the Gini coefficient (GC; see Cortina et al., 2015; Dessus et al., 2016) for each episode of educational dialogue was calculated to measure how evenly the teacher distributed his or her attention among the students. Cortina et al. (2015) and Dessus et al. (2016) noted that the Gini coefficient, being a measure of statistical dispersion, is the most appropriate measure of inequality of attention distribution: the measures for students are not independent, since if one or some students receive a large amount of the teacher's attention, then less attention is evidently left for the other students. The value of the GC varies from 0 (all students receive the same amount of attention from the teacher) to 1 (one student receives all the attention). In addition, the size of the teacher's left and right eye pupil diameters were calculated for two example dialogues.

3. Results

3.1. Teachers' focus of attention during educational dialogue

The first research question sought to determine how teachers distribute their focus of attention among students (both verbal and silent) during educational dialogue in general. In total, 31 episodes of educational dialogue were identified from the classroom video recordings. Table 1 presents the statistics describing the teacher's visual attention (fixation duration and fixation count per student), students' vocal participation, length of dialogic episodes and number of students in the classroom during dialogue. The majority of the

students in the class (84.29%) received at least some visual attention during educational dialogue. On average, teachers fixated on a student for 5,806.04 milliseconds and for 12.62 fixations during an educational dialogue. However, the average GC of 0.56 indicates that there was variation in the teachers' attention distribution when considering the total fixation duration per student. On the other hand, on average fewer than half of the students in the classroom (45.44%) participated verbally in the educational dialogue. The Wilcoxon signed-rank test showed that the verbally participating students received higher amount of teachers' attention measured both with fixation duration ($Z(30) = -4.47, p = 0.00$) and with fixation count ($Z(30) = -4.53, p = 0.00$) compared to the silent students.

Table 1

Descriptive statistics for teacher's focus of attention

	Mean	Std. deviation	Minimum	Maximum
Episode length (in seconds)	179.83	143.49	27	605
Students in the classroom	17.46	4.39	6	23
Students who participated verbally in educational dialogue ^a	7.92 (45.44%)	4.45	2 (13.64%)	18 (81.81%)
Students who received visual attention from the teacher ^a	15.08 (84.29%)	5.41	4 (40.00%)	22 (100%)
Average fixation count per student	12.62	8.94	1.25	36.42
Average fixation duration per student (in milliseconds)	5,806.04	3,606.08	1,106.66	14,087.33
Average fixation count per student who participated verbally	16.60	12.89	2.67	60.39

Average fixation duration per student who participated verbally	12,105.09	16,531.09	533.33	73,352.20
Average fixation count per student who did not participate verbally	6.15	6.52	0.00	28.57
Average fixation duration per student who did not participate verbally	2,284.09	2,231.82	0.00	9,751.71
GC	0.56	0.15	0.33	0.86

Notes. ^aNumber of students per classroom. GC = Gini coefficient

3.2. Variation in teachers' focus of attention according to the quality of educational dialogue

The second research question examined whether teachers' focus of attention on students varied according to the quality of educational dialogue. The identified episodes of educational dialogue were divided into two groups based on the quality of the dialogue. Thirteen of the dialogic episodes represented educational dialogues of moderate quality and 18 of the dialogues represented high-quality dialogues. Table 2 presents descriptive statistics for teacher's focus of attention and students' vocal participation in relation to these two qualities. The Mann–Whitney U test showed a marginally significant difference between the two qualities of educational dialogue in terms of the number of students who received visual attention ($U(I) = 38.0, p = 0.051$). During high-quality educational dialogue, more students received visual attention from the teacher than during educational dialogue of moderate quality. However, there were no statistically significant differences between the two qualities in fixation count per student ($U(I) = 60.0, p = 0.505$), in total fixation duration per student ($U(I) = 51.0, p = 0.235$) or in GC ($U(I) = 55.0, p = 0.339$). In addition, the eye pupil diameter size for the two teachers conducting the moderate and high quality dialogues was calculated. There was no significant difference in the pupil size between the moderate and high quality dialogues (Table 2).

Table 2

Descriptive statistics for the two qualities of educational dialogue.

	Moderate quality		High quality	
	Mean	Std. deviation	Mean	Std. deviation
Episode length (in seconds)	181.64	190.29	178.31	96.36
Students in the classroom	15.64	5.14	19.00	3.06
Vocal students	6.64 (43.14%)	3.70	9.00 (47.40%)	4.89
Students who participated verbally in education dialogue ^a	12.55 (77.21%)	6.09	17.23 (90.28%)	3.79
Students who received visual attention from the teacher ^a	13.15	12.02	12.18	5.69
Average fixation duration per student (in milliseconds)	5,708.66	4,457.76	5,888.43	2,889.34
GC	0.60	0.18	0.53	0.12
Left eye pupil diameter (in millimetres)	4.09	0.34	4.10	0.22
Right eye pupil diameter (in millimetres)	4.21	0.39	4.10	0.23

Notes. ^a Number of students per classroom. GC = Gini coefficient

Example 1 demonstrates a typical teacher-initiated dialogue of high quality in a science lesson. The verbal discussion in which both teacher and students participate actively is focused on small creatures that overwinter. In the dialogue, the teacher asks one main question (*What kind of creature spends the winter under rocks, leaves and branches?*), to which children suggest various alternative answers (*voles, rats, spiders*). The teacher is relatively open to suggestions and asks clarifying questions (*Oh, you mean like voles or... You mean those?*), even though he/she is looking for one specific answer (*beetle*). With the clarifying or extending questions, the teacher shows his/her interest in the child and the

knowledge that the child is sharing. Both teacher (*Rats are big. Rats don't hibernate, they don't go into winter quarters or anything like that.*) and students (*Voles are scared of people.*) share their knowledge and the children participate in the discussion even without the teacher's continuous encouragement.

Example 1. Educational dialogue of high quality

- T: What kind of creature spends the winter under rocks, leaves and branches? [C2]
C2: Mmmm those Those little ones. I can't remember their name but...
T: What little ones?
C2: I can't remember the name.
T: All right.
C2: It's brown and it looks like a guinea pig but it is...
T: Oh you mean like voles or... You mean those?
C2: Yeah.
T: Well, actually no, but those voles and others spend their winter in their holes and may scurry around above ground; mice sometimes scamper around on the snow in winter.
C5: And voles run around on roads. And voles on roads in winter.
T: But these ones are really tiny, the ones that spend winter here. So tiny. And even a bit repulsive to me. You knew straight away. Not necessarily creatures that make me run out of the classroom, but there are other ones as well. [C14]
C12: A spider.
T: Well, yeah, that is a disgusting one. But there are other tiny ones. What could they be called? [C4]
C1: Ants.
T: [C4].
C4: Rats.
T: Not rats, smaller. Very tiny ones.
C3: Rats are big.
T: Rats are big. Rats don't hibernate, they don't go into winter quarters or anything like that.
T: [C14] wants to continue.
C5: Voles are scared of people and that's why they go underground.
C14: Well... a beetle.
T: Yes. All kinds of bugs, for example beetles.
C3: Beetles are just fun.
C5: And voles are scared of people.
T: Well, yeah, in theory they can be fun, but...
C5: Voles are really cute.
T: ... they're a bit nasty too, I think.
C5: Voles are scared of people.
T: That's right, many animals are scared.

The same dialogic episode continues around the topic of bugs, and more children join in.

Figure 1 (see also Appendix 1, gaze map of the same episode of educational dialogue)

demonstrates how the teacher distributes his/her focus of attention (fixations) among the students during the high-quality educational dialogue reproduced in Example 1. Seventeen out of 18 students (94%) received the teacher's visual attention (at least one fixation), but his or her attention was not distributed evenly among the 18 students. The GC for the teacher's visual attention distribution was 0.55, indicating relatively high variation in the teacher's focus of attention per student (see also Figure 1). On the other hand, 11 out of 18 students (61%) in the class participated in the dialogue vocally by sharing their knowledge and views. Interestingly, the only student (C1) who did not receive the teacher's visual attention still participated vocally in the discussion. There was no statistically significant difference in the teacher's focus of attention (fixation duration) between vocal and silent students during the episode ($U = 25.0, p = 0.221$) (see Table 2).

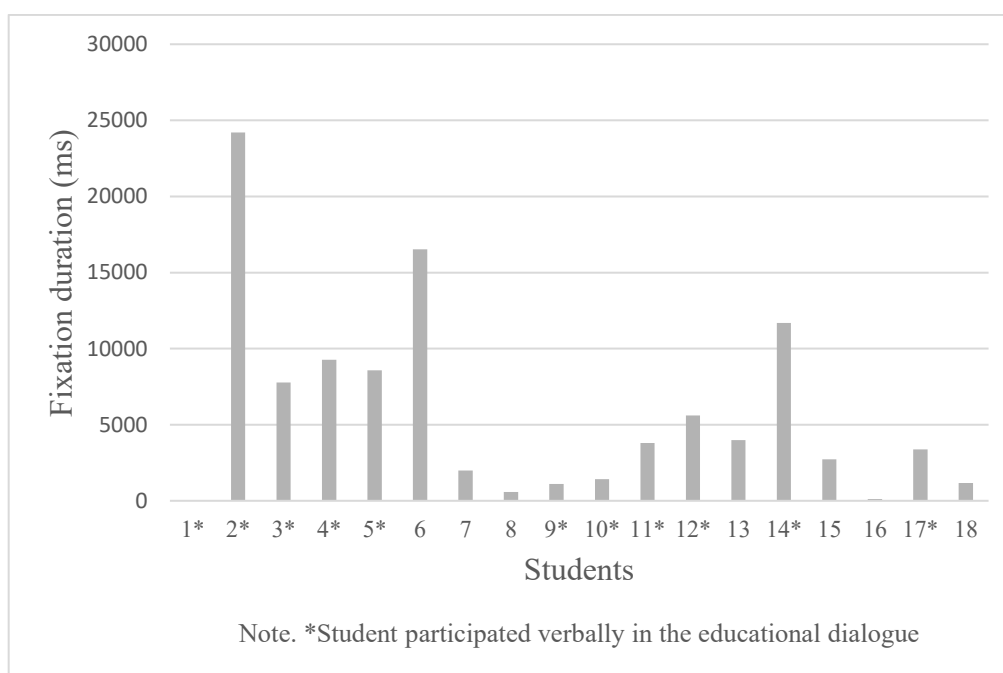


Figure 1. Teacher's distribution of fixation duration per student during educational dialogue of high quality (Example 1).

Example 2 demonstrates a typical educational dialogue of moderate quality. The subject was literacy. The verbal discussion focused on the famous Finnish author Aleksis

Kivi and his flag day. As in Example 1, the teacher asked questions to which he/she was looking for a certain specific answer (*What day is October 10th?; And who might Aleksis Kivi be?*). Students are participating actively but often suggesting answers that are not what the teacher intended to elicit (*Finland's 100-year birthday; Finland's president!*). However, unlike in Example 1, the teacher is not very open to accepting new turns in the discussion and provides only short feedback to the suggested answers (*No, it's not the 100-year birthday yet. I just said so.; No, not Finland's president.*). There are no clarifying or extending questions from the teacher and the discussion is focused on factual knowledge, rather than the sharing of views or experiences.

Example 2. Educational dialogue of moderate quality

T:	So, as I just mentioned, what special thing did you see this morning on your way to school? What difference did you notice in the school yard? [C6]
C16:	A swing.
C6:	Mmm, well, there was the Finnish flag on the pole.
T:	Yes. Why is the Finnish flag up on the pole today? What day is October 10 th ? [C2].
C2:	Mmm, I've forgotten.
T:	There was a little hint about it earlier if you happened to notice. Finland ... it's not Finland's 100-year birthday yet. [C1].
C1:	100-year birthday.
T:	Could you say that a bit louder?
C1:	100-year birthday.
T:	No, it's not yet the 100-year birthday. I just said so. So, [C14].
C14:	Aleksis Kivi day.
T:	Right. And who might Aleksis Kivi be?
C16:	Finland's president!
T:	No, not Finland's president.
C2:	Sauli Niinistö!
T:	Yes, he is Finland's president.
C11:	He is expecting a baby!
T:	But who is Aleksis Kivi?
C16, C2:	<i>[shouting out their unclear suggestions]</i>
T:	This is not a shouting match! We are not having a shouting match [C2]. [C16]. Look, I'll have to put your name on the board if you can't be quiet. The other students don't like this either. So, Aleksis Kivi was a famous Finnish author. He was the first man to write a novel in Finnish. And a novel means a very large book, which includes stories.

Teacher and students continue discussing Aleksis Kivi.

Figure 2 (see also Appendix 2, gaze map of the same episode of educational dialogue) demonstrates how the teacher distributes his/her focus of attention (fixations) among the students during the moderate-quality educational dialogue reproduced in Example 2. Fifteen out of 18 students (83%) received the teacher's visual attention (at least one fixation). There were three students (C5, C7 and C17) who did not receive visual attention and one student (C11) who received notably more attention than the others (see Figure 3). The GC measuring total fixation duration per student was 0.53, indicating relatively high variation in the teacher's visual attention distribution. Six out of 18 students (33.33%) in the class participated in the dialogue vocally, sharing their knowledge. All the vocally participating students received the teacher's visual attention. There was no statistically significant difference in the teacher's focus of attention (fixation duration) between vocal and silent students during the episode ($U = 21.0, p = 0.159$) (see Table 2).

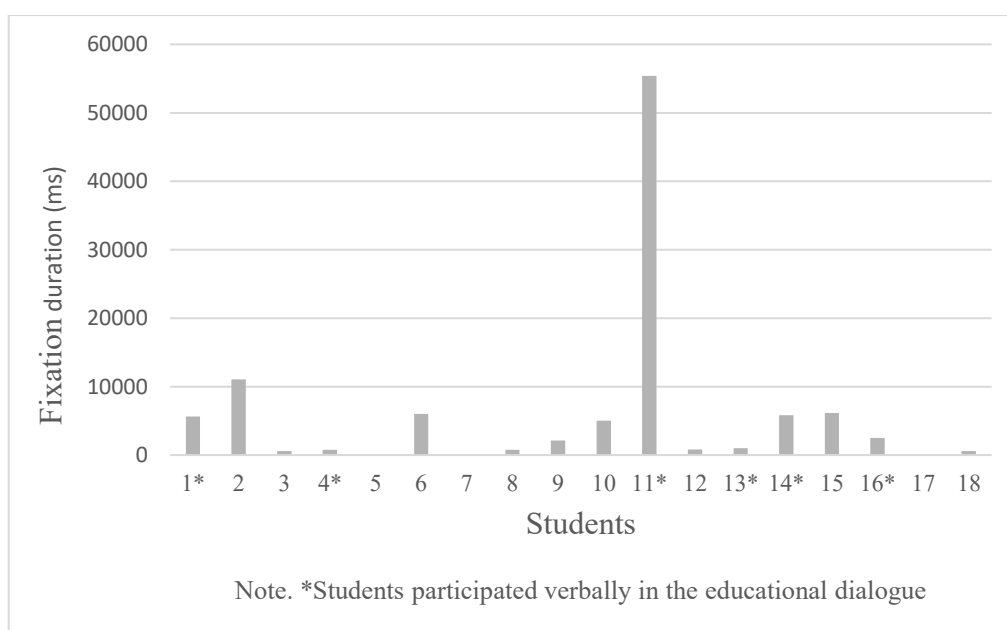


Figure 2. Teacher's distribution of fixation duration per student during educational dialogue of moderate quality (Example 2).

4. Discussion

The present study was one of the first attempts to investigate teachers' focus of attention during educational dialogue. The results showed, first, that, in 31 episodes of educational dialogue, teachers allocated their visual attention relatively unevenly among the students and verbally participating students received higher amount of teachers' attention compared to the silent students. Second, when taking into account the quality of the dialogues, the results showed that, during high-quality educational dialogue, more students got visual attention from the teacher than in educational dialogue of moderate quality. Also, the two example dialogues indicated quality differences in the verbal exchange and in teachers' focus of attention: more student received attention in high-quality dialogue but there were no significant differences in the teacher's focus of attention between the vocal and the silent students.

The first research question investigated how teachers distribute their visual attention among students during educational dialogue in general. The results showed that, on average, fewer than half of the students (45%) present in the classroom participated in the dialogue vocally, but teachers focused their visual attention on 84% of the students on average (at least one fixation per student). However, the verbally participating students received more teacher's attention than the students who did not participate verbally. This might indicate that teachers do monitor and pay attention to the majority of the students in the class, even though they are focused on verbal dialogue and particularly on certain students. McIntyre et al. (2019) reported that expert teachers prioritised students in their focus of attention in the classroom during both attentional and communicative parts of their teaching. This finding may indicate that it is not only the verbal questions but also the gaze that teachers use to invite students to participate in classroom discussion.

Studying teachers' focus of attention during educational dialogue can provide insights into his/her orchestration of the dialogue, not only verbal but visual as well. Cortina et al. (2015) suggested that experienced teachers are able to monitor their whole classroom while providing verbal feedback for certain individual students. The results of the present study are in line with Dessus et al. (2016) in that, although the majority of the students received at least some visual attention, the amount of attention (total fixation duration per student) varied between the students, measured by GC. However, it should be kept in mind that a low GC number does not necessarily indicate effective teacher monitoring and a high number does not reflect low monitoring; rather, some students can participate differently in the classroom activities, requiring a different amount of teacher attention (Cortina et al., 2015). For instance, in educational dialogue it might be expected that the teacher focus more on the students who share their ideas with the class.

The second research question compared teachers' focus of attention between the moderate- and high-quality educational dialogues. Overall, the number of fixations and the total fixation duration per student varied substantially in educational dialogues of both moderate and high quality. In high-quality educational dialogues, the teachers were found to pay attention to a higher number of students than in the moderate-quality educational dialogues. Cortina et al. (2015) found that the quality of teacher feedback, meaning teachers' efforts to engage students in elaborating on their responses, was associated with teachers focusing their attention more on certain individual students, rather than distributing their attention evenly. Moreover, our exploratory study illustrated that the teachers indeed distributed their attention among the majority of the students but that some students received more attention than others. Previous research on teachers' focus of attention in the classroom suggests that an effective teacher is likely to give attention especially to students who participate actively and display their knowledge (see Cortina et al., 2015). In educational

dialogue, students are expected to demonstrate their knowledge vocally, which would lead us to assume that vocally participating students would receive more attention during educational dialogue. However, this was not the case in the present study, since there was no statistically significant difference in teachers' focus of attention between vocal and silent students in the educational dialogues of either quality. This may partly be due to the very small sample, indicating that more research needs to be done with a larger sample size, the present study having been one of the first attempts to combine two different approaches methodologically.

On the other hand, during the high-quality dialogue, the teacher also invested time in verbal dialogue with the vocally participating students by asking clarifying questions or extending their knowledge. This finding seems reasonable, since investing time in discussion and providing individualised feedback require focus of attention. In educational dialogue, which includes active shared knowledge building between the teacher and the students, the teacher usually provides intentional scaffolding to encourage students to explain and justify their ideas (Alexander, 2006). According to Howe et al. (2019), important characteristics of educational classroom dialogue are that the participants make extended contributions and elaborations and build on previous knowledge and that they also acknowledge and critique different options and opinions. Through eye contact, the teacher can communicate these functions that support vocal discussion, such as asking for feedback or a reply, listening, indicating that the space for discussion remains open or recognition of a social relationship (Argyle & Cook, 1976). The example of high-quality dialogue showed that the teacher acknowledged answers other than those he or she was suggesting and extended them to others for the purpose of sharing views and opinions. Therefore, it may not be realistic to expect the teacher to allocate his or her attention evenly among students, when visual attention is linked with extended knowledge building.

In the moderate-quality educational dialogue, the verbal discussion was mainly focused

on brief exchanges between the teacher and the students consisting essentially of facts.

Example 2 also shows that the teacher's gaze behaviour was scattered and that there were three students who did not receive visual attention at all. In conducting an educational dialogue, teachers may feel pressure to include most of the students in the discussion as equally as possible (O'Connor et al., 2017). This pressure could lead to a scenario in which the teacher scans the classroom, inviting all students into the discussion with short questions, but does not have time to invite them to engage in deeper elaboration and exploration.

Conducting whole-class educational dialogue can undoubtedly be very demanding and require practice and expertise. McIntyre et al. (2017), for example, showed that expert teachers were more student-centred in their focus of attention than novices. Short questions may be an easier and faster way to involve more students in classroom interaction, whereas extending the discussion may require more experience, in both vocal and attentional aspects of classroom interaction. In the present study, also teachers' pupil diameter was measured to examine their concentration and cognitive load during educational dialogue. Dilated pupil (4-8mm) can indicate person's higher cognitive processing (Rosen, 2010), which is required especially when conducting high-quality educational dialogue. However, the findings of the present study did not indicate difference in the teachers' pupil size between the moderate and high quality dialogue and did not indicate significant dilation. In the future, research with larger sample size is required to study this phenomenon in more details.

4.1. Implications, limitations and future directions

The present study has both practical and theoretical implications. The findings may encourage and help teachers to become more aware of their focus of attention during whole-class situations that include dialogue with students. Conducting and scaffolding verbal educational dialogue and shared knowledge building in a whole-class situation can be

extremely challenging, not to mention that the teacher should be aware of his or her focus of attention throughout. If teachers are to focus their attention only on the vocally participating students, a large number of students would be left without attention.

Further research is needed on teachers' focus of attention during educational dialogue, taking into account students' non-verbal participation. In many classrooms, students raise their hand to indicate their willingness to participate; yet, it may be only a single student who gets the opportunity to share his or her knowledge. However, it is very likely that the silent students' non-verbal signal of raising a hand attracts the teacher's attention. On the other hand, the teacher's focus of attention may be different in educational dialogue in which students do not raise their hand but are allowed to share their thoughts spontaneously to the teacher and one another. Raising a hand may provide more students with an opportunity to indicate their knowledge to the teacher and receive attention, even though the actual verbal participation might not be enabled. Teachers simply do not have time to focus on every child with every question they pose, which is why there have to be other ways of enhancing students' participation, such as indicating agreement or disagreement with thumb up or down, pair work or group discussions.

It is acknowledged that more attention should be paid to both in- and pre-service teachers' skills on how to conduct and scaffold educational classroom dialogue (Lefstein & Snell, 2014). Previous research has also shown that, when student teachers in teacher training notice an event in the classroom, they give it their full attention, ignoring some other relevant events, whereas more experienced teachers continue monitoring the whole classroom while noticing the event and perhaps participating in it (van den Bogert et al., 2014). A vocally participating student might attract all of a student teacher's attention. Eye-tracking methodology can add to teachers' personal development to help them become more aware of their focus of attention and decision-making during educational dialogue, for instance, what

kinds of questions they might ask and which students they should pay attention to after posing the question. Utilising eye tracking together with a retrospective think-aloud interview (see Olsen, Smolentzov, & Strandvall, 2010) could offer teachers opportunities to reflect on their behaviour, interaction and attention distribution in the classroom. Olsen et al. (2010) have shown that an eye-tracking video encourages participants to reflect aloud on their actions and challenges.

From a theoretical and methodological standpoint, the study provides important new confirmation that teachers do monitor their classroom during educational discussion. A mixed-method approach was employed to analyse both verbal and non-verbal aspects of educational dialogue. Previous research has suggested that eye-tracking methodology should be complemented with verbal data to gain background information that can explain and verify the findings in the focus of attention (van den Bogert et al., 2014). In addition to eye-tracking, in the present study, qualitative analysis of educational dialogue was done, relying on the previous research of Muhonen et al. (2016), by categorising the dialogues based on their quality. This type of exploratory mixed-method approach should be developed and utilised more in future research.

The present study also had limitations that need to be considered before attempting to generalise the results. First, as noted above, it was a small study, including only 54 teachers. In addition, the group size in the sample varied from 6 to 23 students. It is important to acknowledge that the number of students may have an impact on the opportunities of how much and what kind of educational dialogue may occur in the classroom and how teachers focus their attention on students during the dialogues. However, in the present study, the smaller group size did not favour the occurrence of educational dialogues (only one dialogic episode occurred in a group smaller than 10 students). In the future, more research is needed on the associations between the group size, educational dialogue, and teachers' focus of

attention. Second, the qualitative analysis was based on the quality of educational dialogue, in which the teacher's scaffolding and participation play an important part. However, other coding schemes (e.g. Hennessy et al., 2016; Michaels & O'Connor, 2011; Resnick, Michaels, & O'Connor, 2010; Wells, 1999) could have been utilised to analyse a wider variety of educational discussion, such as small group work or paired work. Third, the available data did not provide information about students' achievements or behaviour. Teachers' focus of attention and individualised instruction are most likely highly linked with students' needs and behaviour. In the future, it would be interesting to investigate background information about students' achievements in relation to teachers' focus of attention and verbal contribution. Fourth, the sample consisted only of teachers and students in one country, Finland. In future, similar studies should be conducted in other educational contexts, where, for example, class sizes and teacher education are different. Fifth, the sample included lessons of diverse subjects (literacy, mathematics, science and arts). It is important to acknowledge that the subject or lesson topic itself may have an influence on the teacher's attention distribution or the opportunities to promote educational dialogue. For instance, teaching arts may require the teacher to focus more on the art works, which might leave less time and opportunities to look at the students, compared to some other subject. Sixth, the present explorative study describes the nature and quality of teacher focus of attention and educational dialogue. In the future studies, it would be important to track in more details how the teacher's gaze matches with the students' initiatives. It is important to gain more fine-grained information of the elements of dialogue, such as individual questions, their quality, and how the teachers' gaze meets the students' initiatives in those interaction moments.

4.2. Conclusions

There has been a growing interest in studying educational classroom dialogue and its diverse forms and qualities (Howe et al., 2019). However, to our knowledge, no previous studies have examined the quality of educational dialogue in conjunction with the teacher's focus of attention. The findings of this study showed that teachers distribute their visual attention relatively unevenly among students during educational dialogue in Grade 1 classrooms. Though verbal students received more teacher's visual attention than the silent ones, the majority of the students seem to receive at least some visual attention during educational dialogue. This may indicate that teachers monitor the class during dialogue and invite students into the discussion with their focus of attention. Although the example dialogues provided hints about variation in both verbal and visual attention, a larger sample is needed to capture differences in teachers' focus of attention linked with the quality of verbal interaction. Educational dialogue is not only a verbal phenomenon but also includes diverse non-verbal aspects of interaction and instruction. The present study provides important insights into the non-verbal aspects of educational dialogue and teachers' orchestration of it.

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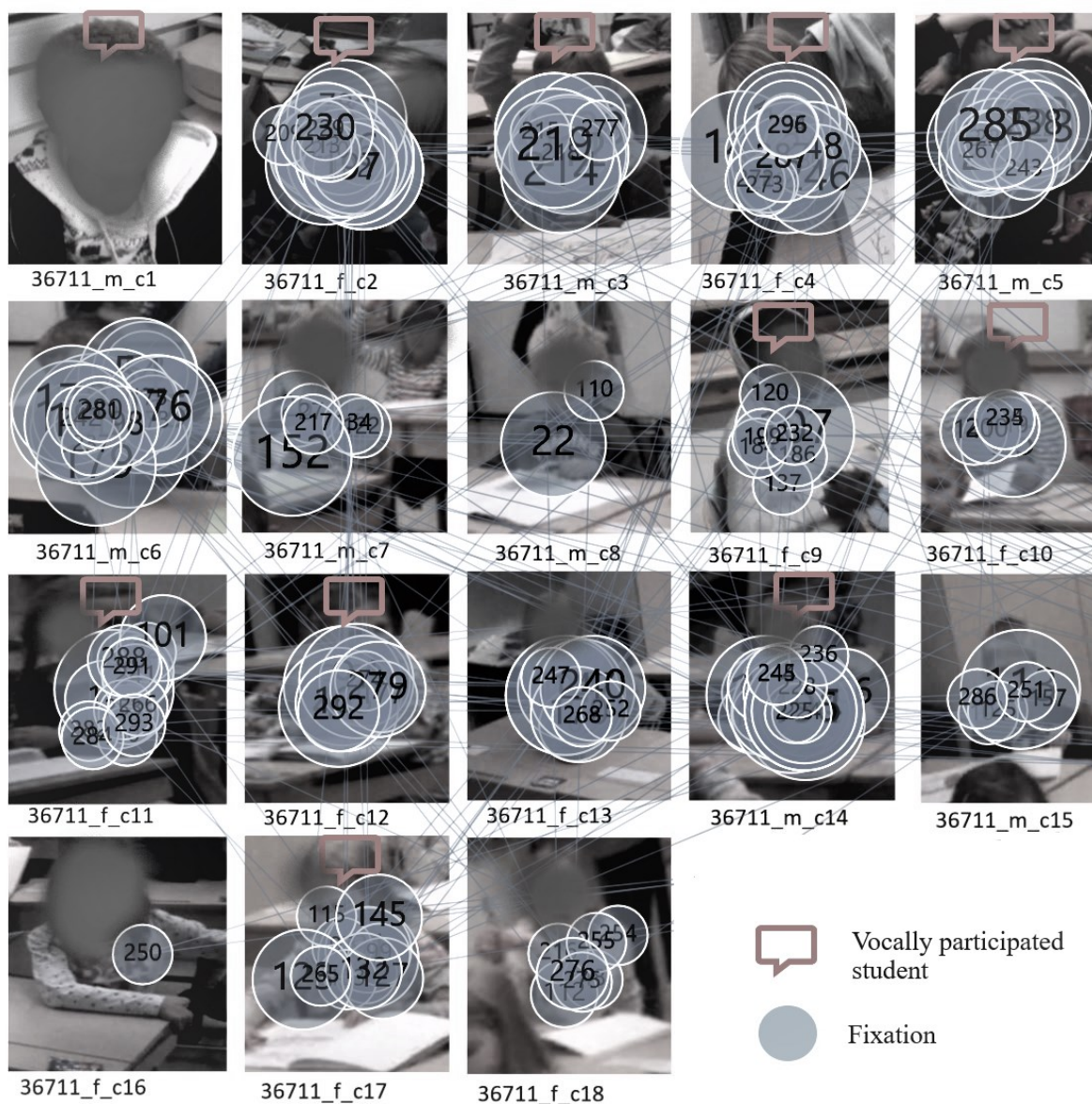
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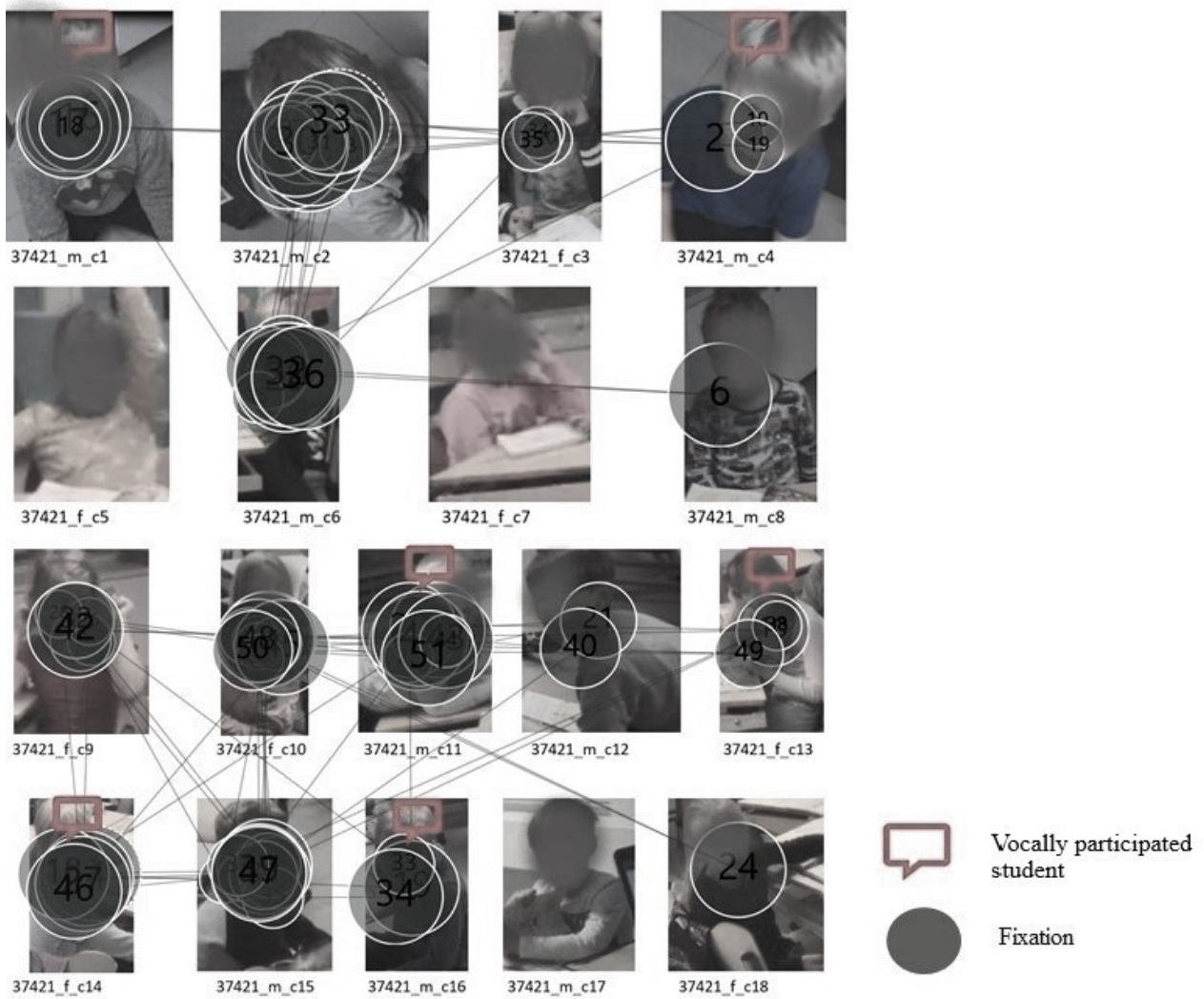
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Appendix 1. Teacher's gaze map of Example 1



Notes. Circle numbers indicate the order of the fixations during the dialogue. The size of the circle indicates the duration of the fixation (bigger circle indicates longer fixation). The lines between the circles map the teacher's gaze path that follows the order of the fixations (teacher's focus of attention moved from one student to another).

Appendix 2. Teacher's gaze map of Example 2



Notes. Circle numbers indicate the order of the fixations during the dialogue. The size of the circle indicates the duration of the fixation (bigger circle indicates longer fixation). The lines between the circles map the teacher's gaze path that follows the order of the fixations (teacher's focus of attention moved from one student to another).