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Quality of Educational Dialogue and Association with Students' Academic Performance

ABSTRACT

The study used a mixed-methods approach to examine the associations between the quality of educational dialogue and students' academic performance and to analyse what kinds of dialogic teaching patterns of different levels of quality can be identified in classroom lessons. A total of 158 Grade 6 lessons were video-recorded, and the quality of the educational dialogue was assessed using the Classroom Assessment Scoring System-Secondary (CLASS-S) observational instrument. Multilevel modelling indicated that the quality of educational dialogue was positively associated with students' academic performance (grades) in language arts and physics/chemistry. Qualitative analysis was subsequently used to examine the quality of the patterns of dialogic teaching in language arts and physics/chemistry lessons (n = 11). The analysis revealed that teacher-initiated patterns were predominant in both subjects and that physics/chemistry lessons were more typically characterised by high-quality educational dialogue than language arts lessons.

Keywords: Educational dialogue; Teacher-student interactions; Academic performance; Teacher-initiated; Student-initiated

1. Introduction

As the nature and intent of teaching are seen less as a transmission of information and more as guidance and support for students' self-regulated learning and shared knowledge building (Wells & Arauz, 2006), it has been acknowledged that the quality of learning and its outcomes rely on learning activities and students' involvement in exploratory action (e.g. Bransford, Brown, & Cocking, 2000; Vermunt & Verloop, 1999). Through their organisation of activities and classroom time, teachers create and shape the dynamics of interactive opportunities, but the quality of the interaction between teachers and students as well as that of educational dialogue are most critical for the construction of knowledge and learning in classrooms (Alexander, 2006). The relevance of the quality of educational dialogue for the development of students' deep understanding has been documented in science, in particular, but it also applies to other curriculum subjects (e.g. Alexander, 2000; Howe, 2010; Mercer & Littleton, 2007; Mortimer & Scott, 2003; Nystrand, 1997).

Although there is increasing documentation of the use and benefits of promoting exploratory talk among students in small-group discussions both in primary and secondary education (e.g. Dawes, Mercer, & Wegerif, 2000; Howe et al., 2007) as well as in higher education (e.g. Kaartinen & Kumpulainen, 2002), research evidence of learning gains relating to the quality of whole-class dialogue, as observed in authentic classroom situations, remains scarce. There is a need for more research on the benefits and learning outcomes of different types of educational dialogues (Howe, 2017; see Howe & Abedin, 2013 for a meta-analysis). Observations and video-recordings of authentic classroom discussions provide valuable data for examining students' learning and conceptual changes, but engaging in an analysis of this kind of data is also demanding and requires rigorous and systematic approaches (Mercer & Howe, 2012).

Consequently, the aim of our study was to utilise a mixed-methods approach to examine the association between the quality of educational dialogue in whole-classroom lessons and students' academic performance (grades) in Grade 6 as well as the quality of teacher-initiated and student-initiated dialogic teaching patterns in different subjects.

1.1. The sociocultural approach to learning and scaffolding

The conceptual basis of the present study draws from the sociocultural approach to learning and the Vygotskian view (1978) of the fundamental role of language in children's learning and development. According to the sociocultural theory, language can be defined both as a cultural tool for sharing and developing knowledge and as a psychological tool for analysing the content and processes of individual thoughts (Vygotsky, 1978); it is through language that individuals learn via interaction and build collective understanding. Although Vygotsky focused on adult-child interactions in general, sociocultural approaches to learning have been increasingly applied to teacher-student and peer interactions and to theoretical accounts of educational dialogue in the classroom.

Scaffolding is a term that is widely used to describe the process by which a teacher or more experienced peer supports a child's learning through interaction (Wood, Bruner, & Ross, 1976). Van de Pol, Volman and Beishuizen (2010) suggest that scaffolding consists of three main features: 1) *contingency* (tailored, responsive and adjusted support); 2) *fading* (gradual withdrawal of the support over time) and 3) *transfer of responsibility* (the teacher eventually transfers the responsibility of performing the task to the student). Ideally (and what is meant by scaffolding in this study), the process of scaffolding is interwoven in educational dialogue whereby the teacher supports students' participation, meaning making and independent thinking,

for example, through open questions, inquiry and feedback and encourages them to explain their thinking (Gillies, 2013; Rogoff, 2008; Rojas-Drummond, Torreblanca, Pedraza, Vélez, & Guzmán, 2013). Muhonen, Rasku-Puttonen, Pakarinen, Poikkeus and Lerkkanen (2016) identified patterns of teacher- and student-initiated dialogic teaching with different qualities of teacher scaffolding and initiation of the dialogue. Two of the patterns presented moderate quality, with relatively unitary forms of scaffolding for students' participation, and shared understanding, e.g. mostly closed questions that did not invite students' active sharing and elaboration of their thoughts. In addition, the level of the questions and teachers' comments was mostly on an abstract level, not closely tied with the students' experiences and everyday lives. The two other patterns presented more versatile and rich scaffolding of students' participation and shared understanding, e.g. authentic open-ended questions, summaries of the main concepts, invitations for students to explain their opinions and justify them and the use of inquiry-stimulating vocabulary.

1.2. Educational dialogue and dialogic teaching

There is no clear consensus on the definition of educational dialogue, as it can be seen to occur between the teacher and students, or between students, and an emphasis can be placed on the exchanges and involvement of the participants in the dialogue or on the teacher's orchestration of the resources and scaffolds that contribute to dialogue. There is considerable variation in the terms used to refer to forms of educational dialogue, such as dialogical pedagogy (Skidmore, 2006), dialogic teaching (Alexander, 2006), dialogic inquiry (Wells, 1999), dialogic instruction (Nystrand, 1997), exploratory talk (Mercer & Dawes, 2008), accountable talk (Wolf, Crosson, & Resnick, 2006) and collaborative reasoning (Rheznitskaya et al., 2001). Wegerif's

work (2007) proposes the idea of a 'dialogic space' within which teachers and students can negotiate, explore and confront different ideas in an open and constructive environment. Because the present study focuses on whole-class dialogue between the teacher and students, we see teachers as playing a vital facilitating role in educational dialogue. Consequently, in this study, we construe educational dialogue as reciprocal interaction in the classroom, in which both the teacher and students are present, exploring different ideas and views in an attempt to build shared understanding in accordance with Alexander's (2000, 2006) criteria for dialogic teaching.

The concept of dialogic teaching, according to Alexander (2000, 2006), describes five principles of interaction that harness the power of talk to stimulate and develop students' thinking, learning and understanding and also extends interaction between students. Classroom interaction can be considered dialogic when it meets the criteria of being: 1) collective (participants, here teacher and students, address learning tasks together); 2) reciprocal (participants listen to each other, share ideas and consider alternative viewpoints); 3) supportive (students articulate their ideas freely without fear of embarrassment, and they help each other to achieve shared understanding); 4) cumulative (participants build on their own and each other's ideas and link them to coherent lines of thinking and enquiry) and 5) purposeful (the teacher plans and steers discussion with specific learning goals in mind). Two additional features have been suggested by Lefstein (2006) to complement the existing criteria for dialogic teaching. According to Lefstein, dialogue should also be: 6) meaningful (the teacher and students bring their own views to the discussion of a topic of mutual interest) and 7) critical (the teacher and students identify different points and explore questions related to them). Alexander (2013) suggests that by acknowledging and utilising the educational functions of talk (for thinking, learning, communicating, democratic engagement, teaching and assessing) in dialogic

interactions, teachers can facilitate the development of students' cognitive and communication skills. Despite the important role of teachers as facilitators of educational dialogue, it is important to acknowledge the educational student-to-student dialogue that can be observed in dialogical classroom (Alexander 2008).

A number of studies have linked the quality of dialogue to how students learn. Nystrand (1997) proposes the following aspects as reflecting the quality of a teacher's dialogic instruction: 1) the use of authentic questions, 2) the incorporation of students' responses into subsequent questions and 3) allowing students' responses to modify the topic of discourse. Although it is the teacher who predominantly initiates and manages classroom dialogue (Wells, 20009), also students can provide turns that initiate sequences that the teacher or other students contribute to with their responses (Lemke, 1990; Nassaji & Wells, 2000). For younger students it can be difficult to engage in sustained discussion of a certain topic and they easily go off on side-tracks (Wells, 2009). Even these side-tracks can, however, turn into meaningful educational dialogues if the teacher sensitively responds to students' initiatives and ideas and scaffolds the shared knowledge-building process. Cazden (2001) suggests that it is only by allowing more time for students' answers and elaborations that the teacher can create a more dialogic atmosphere and classroom dynamic where students respond to and build on each other's comments. Muhonen et al. (2016) defined the quality of dialogue through differences in a teacher's scaffolding strategies and initiation of the dialogue. In student-initiated dialogues the student asks a question or presents an idea, which the teacher extends to whole class discussion or allows space for students' independent discussion, and the focus of the discussion is on the ideas that rise from students' interests. In teacher-initiated dialogues, teacher's involvement and questioning is typically planned a priori, and the teacher uses a wide variety of scaffolding strategies. Patterns

showing different qualities of dialogue and turn-taking have also been documented by, e.g. Chin (2001), and Rasku-Puttonen, Lerkkanen, Poikkeus and Siekkinen (2012).

1.3. *Associations between educational dialogue and learning outcomes*

The literature on educational dialogue has provided some evidence to support its contributions to students' reasoning and learning (Littleton & Howe, 2010; Mercer & Littleton, 2007; Nystrand, 1997). In science lessons, for instance, instructional practices involving students proposing ideas and explaining their reasoning to peers have been documented as dialogical characteristics that are beneficial to their intellectual growth (e.g. Howe et al., 2007). In addition to these findings, however, the empirical literature on concrete learning gains in relation to educational dialogue, especially between teachers and their students, is surprisingly scant (Howe, 2017; see Howe & Abedin, 2013 for a meta-analysis). The majority of studies in the field concentrate on collaborative peer group interaction and its effects on student development (e.g. Barnes & Todd, 1977; Howe, 2010; Underwood & Underwood, 1999).

Previous studies have suggested that collaborative classroom discussion can support students' academic performance and contribute to the positive development of motivation and self-esteem (e.g. Mercer, 2008; Slavin, 1980). For example, Azmitia and Montgomery (1993) show that dialogue was an important predictor of children's success in problem solving. Expressing contrasting opinions in group work has been shown to predict learning gains (Howe et al., 2007). In their dialogue-based intervention approach, Mercer and colleagues (Dawes et al., 2000; Mercer & Littleton, 2007) utilise exploratory talk in teacher-led sessions and group activities to portray dialogue as a tool for teaching, learning and the development of students' understanding. Students participating in their programme made gains in math and science tests

and improved their individual reasoning and collective thinking skills (e.g. Mercer, 2008). In their examination of students' problem-solving skills in computer-based settings, Underwood and Underwood (1999) found that pairs of students which analysed the situation verbally and expressed their views, opinions, agreement and disagreement achieved the best outcomes. Research on cooperative learning methods has also demonstrated that cooperative efforts result in higher individual achievement compared to competitive or individualistic efforts (Johnson & Johnson, 2000).

Scaffolding provided by the teacher in both whole-class and small-group interactions is considered critical in supporting effective educational dialogue in the classroom and can promote the development of individual reasoning and the advancement of learning and understanding (Rojas-Drummond & Mercer, 2003). Wolf and colleagues (2006) show that dialogic classroom interaction, in particular, the fostering of accountable talk, is positively related to reading comprehension. They found that when teachers encouraged students to express their thoughts and ideas in their own words, the students' reading comprehension skills developed, whereas when teachers used closed questions to check students' comprehension, no development in high-level reading skills was identified. Likewise, in their review, Kyriacou and Issitt (2008) conclude that students' good mathematics outcomes were associated with the teacher seeking to elicit reasons and explanations instead of only correct answers.

1.4. Aims of the study

Although the body of research on educational dialogue has increased, evidence of its contribution to learning outcomes remains scant. There is an obvious need for empirical evidence on the associations between educational dialogue in the classroom and students' academic

performance. In order to capture both the effects of educational dialogue on achievement and the indicators of different patterns of quality across school subjects, a mixed-methods approach is needed. With respect to the quantitative analysis, it is also imperative to control for previous academic performance, gender, parental education, group size, and teachers' professional experience. The present study consisted of the following research questions:

1) To what extent is the quality of educational dialogue (as assessed by the CLASS-S) associated with students' grades in academic subjects in Grade 6?

2) What kinds of dialogic teaching patterns of different levels of quality can be identified in language arts and physics/chemistry lessons?

2. Method

2.1. Participants

The present study represents a subsample of a large-scale longitudinal follow-up study of approximately 2,000 children, their parents and teachers from preschool to upper secondary education in four Finnish municipalities (Author et al., 2006–2016). The sample of the present study consists of 46 teachers (24 female and 22 male) and their students in Grade 6 (608 12-year-old students: 330 boys and 278 girls) who participated in classroom video-recordings. The participating teachers were selected on a voluntary basis from a total of 98 teachers participating in the larger Grade 6 follow-up study. The teachers were asked for their written consent to participate in the study, and the parents gave consent for themselves and their children. A total of 158 lessons were video-recorded (from two to four lessons per teacher). The lessons represented typical school days and Grade 6 lessons. All classrooms were Finnish speaking, and all the

teachers had at least a master's degree. The teachers' work experience ranged from a minimum of 1 to 5 years to more than 15 years (*Mode* = more than 15 years). The class size ranged from 7 to 30 students ($M = 20.64$, $SD = 5.93$; information was missing for 4 classes). Parents' (n = 493) vocational and higher education represented the average level of education in Finland, ranging from no vocational education to a licentiate or doctorate (*Mode* = master's degree).

2.2. Teacher measures: observed classroom interaction and quality of educational dialogue

The quality of teacher-student interactions in the 158 video-recorded lessons was assessed using the Classroom Assessment Scoring System-Secondary (CLASS-S), an observational instrument based on the Teaching through Interactions (TTI) framework (Pianta, Hamre, & Mintz, 2012). The CLASS-S is designed to measure the quality of the following three domains of teacher-student interaction along 12 dimensions: 1) Emotional Support (three dimensions: Positive Climate, Teacher Sensitivity and Regard for Student Perspectives); 2) Classroom Organisation (three dimensions: Behaviour Management, Productivity and Negative Climate); 3) Instructional Support (five dimensions: Instructional Learning Formats, Content Understanding, Analysis and Inquiry, Quality of Feedback and Instructional Dialogue), with the twelfth dimension being Student Engagement. Each 45-minute lesson was divided into three segments lasting approximately 15 minutes. These were coded from the videotapes by a trained observer on a 7-point scale of low (1–2), moderate (3–5) or high (6–7) quality. The coding process was guided strictly on the basis of the CLASS-S manual (Pianta et al., 2012), which provides detailed descriptions of behavioural indicators for each dimension and examples of the classroom interaction for the ratings. In order to estimate the level of agreement between raters, inter-rater reliabilities were calculated as intraclass correlation coefficients (ICCs) for 20% of the lessons

that were rated by the two observers. The ICCs ranged between 0.57 and 0.75 (for more detail, see Author et al., 2017).

As the present study focused on examining the association between educational dialogue (between teacher and students) and students' academic performance, the analysis utilised the following two CLASS-S dimensions to measure the quality of educational dialogue in the classroom: *Instructional Dialogue and Quality of Feedback*. The definition for the dimension of *Instructional Dialogue* and its indicators in the CLASS-S are based on Alexander's (2006) concept of dialogic teaching: engagement in deep and meaningful conversations with clear learning content leads to better student learning. According to Wolf and Alexander (2008), purposeful questioning and chaining of ideas into 'coherent lines of thinking and inquiry' are characteristics of productive educational classroom talk which the CLASS-S assesses with concrete indicators and their behavioural markers. The *Instructional Dialogue* dimension captures the quality of purposeful content-focused discussion between the teacher and students, i.e. their engagement in structured, cumulative questioning and discussion in the classroom, which is aimed at supporting students' content understanding. When rating the dimension on a 7-point scale, the coder pays attention to and makes a judgement of quality based on evidence of the following three indicators: 1) cumulative content-driven exchanges (e.g. exchanges that build on one another); 2) distributed talk (e.g. student-initiated dialogues, balance of teacher and student talk and peer dialogue) and 3) facilitation strategies (e.g. open-ended questions and statements, active listening).

The *Quality of Feedback* dimension is based on the notion that high quality of feedback enhances student learning by lessening the gap between student's own level and the targeted goal and by encouraging deeper processing of information and independence in thinking (Rogoff,

1990; Wood, Bruner & Ross, 1976). The dimension captures the teacher's extending and expanding of students' learning. When rating the dimension, the judgement of quality is based on evidence of: 1) feedback loops (e.g. back and forth exchanges and follow-up questions; 2) scaffolding (e.g. hints, prompting of thought processes); 3) building on student responses (e.g. expansion, clarifications) and 4) encouragement and affirmation (e.g. recognition of effort). The CLASS-S dimensions and their behavioural markers are described in more detail in the CLASS-S manual (Pianta et al., 2012).

2.3. Student measures

2.3.1. Grades in academic subjects

The study utilised students' grades (on a scale from 4 to 10), computed by their class teacher at the end of the school year in Grade 6, for the following academic subjects: 1) language arts, 2) physics/chemistry, 3) religion, 4) history and 5) biology/geography. Physics/chemistry and biology/geography are taught as integrated subjects in Grades 5 and 6 by the class teachers (see the Finnish National Core Curriculum for Basic Education, 2004).

2.3.2. Previous academic performance

The students' previous academic performance in reading comprehension and arithmetic fluency in Grade 4 was controlled in the analysis. Reading comprehension was assessed using the nationally normed reading comprehension test (ALLU; Lindeman, 1998), which involves children silently reading a factual story and answering 12 multiple choice questions at their own pace, but within the maximum allotted time of 45 minutes. For each correct answer, 1 point is given, producing a maximum score of 12 (Kuder-Richardson reliability = .76).

Arithmetic fluency was assessed using the Basic Arithmetic Test (Aunola & Räsänen, 2007). The test consists of 28 items containing 12 addition, 13 subtraction, 1 multiplication (e.g. 12 × 28 = ?) and 2 division problems (e.g. 240/80 = ?) that can be attempted within a 3-minute time limit. The test indexes a combination of speed and accuracy in math performance (e.g. Zhang et al., 2014). For each correct answer, 1 point is given, producing a maximum score of 28 (Kuder-Richardson reliability = .85).

2.4. Analysis strategy

2.4.1. Multilevel modelling

As the first step in the analysis, intraclass correlation coefficients were calculated to determine what proportion of the variance in students' grades was due to the classroom level (i.e. classroom differences and between-classroom variation) and what was due to the individual level (i.e. differences between individual students and within-classroom variation) (Heck & Thomas, 2009; Raudenbush & Bryk, 2002). Second, classroom-level correlations between the quality of educational dialogue and students' grades were calculated.

Third, separate multilevel path models for the students' grades were conducted to investigate the association between the quality of educational dialogue and students' grades, while accounting for a number of structural control variables (i.e. previous academic performance in Grade 4, gender, class size, teacher's work experience and the level of parental education). These structural variables were controlled for in line with findings showing their associations with student learning (e.g. Blatchford, Bassett, Goldstein, & Martin, 2003; Connor, Son, Hindman, & Morison, 2005; McClelland & Morrison, 2003) and following the choice of control measures in some previous classroom studies (see review of Wayne & Young, 2003). The multilevel

modelling technique (Heck & Thomas, 2009; Muthén & Muthén, 1998-2012) enables one to enter various predictors both at the class level (*between-level*) and at the level of individual students (*within-level*). Since the focus of the present study is at the classroom level, we used the quality of educational dialogue to predict between-level variation in students' grades. The analyses were performed using the Mplus statistical package (Version 7.3).

2.4.2. Identifying episodes of educational dialogue and dividing them into dialogic teaching patterns

Based on the findings from the multilevel modelling, the subjects and lessons showing associations between grades and quality of educational classroom dialogue were selected for a qualitative analysis of the dialogic teaching patterns. The mid-range score of 4 in the CLASS-S ratings of both Instructional Dialogue and Quality of Feedback was used as the cut-off for selecting lessons for the analysis (i.e. only lessons in which CLASS-S ratings for those two dimensions exceeded the value of 4 were included in the qualitative analysis). The reasons for using this cut-off included our interest in classroom interactions with a high likelihood of dialogic exchange and the need to restrict the sample to a manageable size (from a total of 158 lessons).

The selected lessons were read several times to identify episodes of educational dialogue (the selected school subjects and number of lessons and episodes are presented in the results, section 3.2.). An episode of educational dialogue was defined as continuous exchange between the students and teacher in which the topic under discussion remained essentially unchanged. If the topic of focus changed either based on teacher's or a student's initiation, a new episode would ensue. A change in classroom activity could also mark the end of an episode (for example,

the discussion ends and students move on to independent work). Although the overall topic of the lesson is almost always determined by the teacher, subtopics starting new episodes can be introduced either by teacher's or students' initiatives (e.g. turns consisting of questions, opinions, sharing experiences or factual information). To be identified as dialogic, each independent episode had to fulfil the five principles of dialogic teaching, as defined by Alexander (2006), i.e. interaction in the episode had to be: 1) collective; 2) reciprocal; 3) supportive; 4) cumulative and 5) purposeful. For instance, exchanges consisting of question-answer sequences without any follow-up (an IRF-pattern) were not included in the dialogic episodes. Since the focus of the study was on the interaction between teachers and students, classroom activities that did not involve exchanges between the students and their teacher (e.g. routine or individual work), or learning-related tasks, were excluded from the analysis.

Finally, episodes identified as representing educational dialogue were analysed and categorised into four types of dialogic teaching patterns. The coding was based on criteria described by Muhonen et al. (2016) showing a qualitative difference between two types of teacher-initiated patterns (patterns 2a and 2b) and two types of student-initiated patterns (patterns 3a and 3b) (see Table 1). In the coding by Muhonen et al., patterns 2b and 3b represent higher-quality educational dialogues and versatile and rich scaffolding strategies that are likely to support students' conceptual thinking, joint understanding and synthesis of ideas and information. Patterns 2a and 3a represent moderate-quality educational dialogues with relatively unitary forms of questioning, less support for active participation and lower support for shared content understanding.

3. Results

3.1. The association between the quality of educational dialogue and academic grades

To examine the potential differences between classrooms with regard to students' grades, ICCs and variance estimates were calculated at the between- and within-levels. The results (see Table 2) showed statistically significant differences between classrooms. In language arts 12% ($p < .05$), in physics/chemistry 16% ($p < .001$), in religion 17% ($p < .001$), in history 24% ($p < .01$), and in biology/geography 11% ($p < .01$) of the total variance was due to classroom differences. The rest of the variance in students' grades was due to individual differences between students within classrooms. The between- and within-level correlations between the study variables and descriptive statistics are also presented in Table 2. The quality of educational dialogue was found to correlate positively with students' grades in language arts and physics/chemistry: the higher the ratings of the quality of the educational dialogue (i.e. the latent variable consisting of CLASS-S ratings of Instructional Dialogue and Quality of Feedback), the higher the students' end of school year grades in language arts and physics/chemistry.

In the subsequent step, we ran multilevel models to determine whether the quality of educational dialogue was associated with students' subject grades, while controlling for previous academic performance, gender, class size, the teacher's professional experience and the level of parental education. First, we investigated a model that included the grades of all five academic subjects as a latent variable. This model fit the data adequately: [$\chi^2 51$ ($N_{within} = 608$, $N_{between} = 45$) = 164.86, $p < .001$; CFI = .95; TLI = .92; RMSEA = 0.06; $SRMR_{between} = 0.10$, $SRMR_{within} = 0.04$]. The results (Figure 1) showed that the quality of educational dialogue was significantly related to the latent variable consisting of the students' academic grades.

Lastly, we conducted separate models for each of the five academic subjects. The model for language arts fit the data well [$\chi^2 6$ ($N_{within} = 608$, $N_{between} = 45$) = 5.51, $p = .48$; CFI = 1.00; TLI =

1.01; RMSEA = 0.00; $SRMR_{between}$ = 0.08, $SRMR_{within}$ = 0.00], showing that the quality of educational dialogue was positively related to students' grades in language arts (see Figure 2). The model for physics/chemistry also fit the data well [$\chi^2 5$ (N_{within} = 608, $N_{between}$ = 45) = 5.79, p = .33; CFI = .99; TLI = .96; RMSEA = 0.02; $SRMR_{between}$ = 0.08, $SRMR_{within}$ = 0.01], showing that the quality of educational dialogue was positively associated with students' grades in physics/chemistry (see Figure 3). The models for other academic subjects also fit the data, but the quality of educational dialogue was not significantly associated with students' grades in religion, history or biology/geography in the separate models.

3.2. Episodes of educational dialogue in language arts and physics/chemistry lessons

Based on the findings of the multilevel modelling showing statistically significant associations between the quality of dialogue and students' grades in language arts and physics/chemistry in their separate multilevel models, these two subjects were selected for qualitative analyses. This decision was based on our focus on subjects with strong links between the quality of educational dialogue and student achievement as well as on the need to limit the sample of lessons to which the detailed qualitative analysis could be applied. Next, episodes of educational dialogue in Grade 6 language arts and physics/chemistry lessons were examined with respect to differences in the quality of the patterns of teacher-initiated and student-initiated dialogic teaching.

Using criteria based on the five principles of dialogic teaching (Alexander, 2006), 54 episodes (34 episodes in language arts lessons; 20 episodes in physics/chemistry lessons) of educational dialogue were identified within 11 lessons taught by 11 different teachers (9 lessons in language arts and 2 lessons in physics/chemistry). The next phase involved an analysis of

these episodes with respect to the different types of dialogic teaching patterns (see Muhonen et al., 2016): two types of teacher-initiated and two types of student-initiated patterns. In the present data, five episodes were identified in the language arts lessons that did not match the criteria for any of the four patterns; in these episodes, educational dialogue was initiated and autonomously conducted by the students, and the teacher did not take part in the discussion unless the students needed guidance or help. These five episodes were seen to represent an additional pattern of dialogic teaching, that of pattern 4: peer-centred dialogue. We now describe in greater detail the five patterns of dialogic teaching identified in the present data.

3.2.1. Educational dialogue in language arts lessons

The educational dialogues in the language arts lessons were mostly led and supported by the teachers. The majority of the identified episodes represented teacher-initiated dialogues, especially pattern 2a, showing moderate quality (see Table 3). Both types of student-initiated patterns were more infrequent than the teacher-initiated patterns. Peer-centred dialogue (pattern 4) occurred in language arts lessons in five episodes. As a whole, dialogues indicating a moderate quality were more common in language arts than those indicating a high quality, but in student-initiated dialogues, there were more episodes indicating a high-quality than a moderate-quality of educational dialogue.

Example 1 demonstrates the most common type of pattern identified in language arts lessons: pattern 2a, the teacher-initiated pattern of moderate quality, where the flow of the dialogue relied on the teacher asking questions and prompting student participation. The topic under discussion was based on a novel that the whole class had read. Thus, all students had the necessary information to enable participation in the dialogue. Although the teacher's questions

were primarily open-ended, the questions did not inspire the students to participate in a voluntary discussion beyond answering the questions posed.

Example 1. Teacher-initiated teaching dialogue of moderate quality (pattern 2a)

Context: The teacher and students had all read a youth novel	
Teacher:	Please tell me what the scene of the events looked like. Picture what it looked like in your mind. What is so great about literature is that it does not present you with a complete picture. As we said earlier, a movie based on a book provides you with fully developed thoughts, but when you read a book, you can imagine for yourself what it looks like there and what the apple trees look like, and… So, after reading that text, how do you imagine that the scene of events looks? Danny?
Student 1:	There were those apple trees and that house and…
Teacher:	Yes. Apple trees around the house ruins and an overgrown garden there. Yes, Joe?
Student 2:	So the apple trees were there and then the house was there only with the foundation, so there was like no wood, only that…
Teacher:	Yes, only the stone foundation, so only the base was there. Yes, yes. What else? What kinds of details were you given?
	More students share their views with the teacher's encouragement.
	…
Teacher:	Yes, exactly. What do you think? Why did they choose those apple trees there? Why didn't he say that it was some ramshackle house in our town with only a stone foundation remaining? Why were the apple trees there? Ally?
Student 3:	They were blooming.
	More students share their views with the teacher's encouragement.
	…
Teacher:	Yes. And apple trees have a romantic meaning. For example, when older people read books, they want to envision these nice coffee dates they might have under apple trees on a warm day. And there might be that kind of romantic and beautiful atmosphere. And in Japanese books, they often portray cherry trees.
The discussion about the book continues…	

Example 2 presents the additional pattern identified in the data – peer-centred dialogue (pattern 4). As illustrated through the example, it is the students whose thoughts and opinions are at the centre of the dialogue, and the interaction is mainly occurring between the students (exponents and opponents). The discussion is based on students' contrasting opinions and

justifications regarding whether language arts should be an optional subject, not one based on the teacher's questions. Although the teacher does not have an active role as a participant in the dialogue, she listens attentively, and when needed, she guides students' participation by giving turns and encouraging them to justify their opinions. At the end of the dialogue, the main arguments are discussed together between the teacher and students to summarise the outcome of the debate as a whole.

Example 2. Peer-centred dialogue (pattern 4)

Context: The goal of the lesson is to practice debating.	
Teacher:	… Those who are in favour that language arts should be an optional subject can start.
Student 1:	Well, not everybody gets good grades in language arts, so it could be a kind of remedial instruction to enable you to learn more. And if someone wants to learn more about things that you would later study in secondary school, you could then study them there. And there could be more literacy, more reading of books and stories.
Teacher:	And now the opponents.
Student 2:	But if you don't have it, you will never learn to read or write.
Student 3:	Yes, or if you don't study it and you want to get into a higher position, you might not get there if you didn't …
Student 2:	If you didn't study language arts.
Student 1:	But if you think you won't need it that much in the future…
Student 3:	You do need your own mother tongue.
Student 1:	If you become, for example, a cleaner, you might not need it.
Student 3:	But you need to know how to talk to and communicate with people.
Discussion between the students continues…	
Teacher:	And now your closing words. Please justify your opinions.
After the final words, the main points of the debate were discussed together with the whole class.	

3.2.2. Educational dialogue in physics/chemistry lessons

In the physics/chemistry lessons, the episodes of educational dialogue were also mostly led and scaffolded by the teacher (see Table 3). A total of 17 episodes of teacher-initiated educational dialogue were identified, but in the physics/chemistry lessons, the majority of the episodes represented higher-quality educational dialogues, with students actively participating in the discussion and using their own initiative to share information and ask questions. Student-initiated episodes occurred less frequently than teacher-initiated ones, but all three student-initiated episodes indicated a higher quality of educational dialogue.

Example 3 represents a teacher-initiated pattern of high quality (pattern 2b). This type of dialogue starts from the teacher's question and encouragement, but the discussions are not entirely dependent on the teacher's scaffolding. In fact, there is only one broader question on which the entire discussion is based. Students actively share their knowledge and thoughts but also willingly justify their answers without separate encouragement from the teacher. The teacher actively renders feedback on students' views by ensuring and clarifying their ideas and is open to unexpected answers and justifications. At the end of the discussion, the teacher also summarises the 'expected' correct answers but clearly indicates that other acceptable justifications were presented.

Example 3. Teacher-initiated teaching dialogue of high quality (pattern 2b)

Context: The topic of the lesson: conductors and insulators.	
Teacher:	Which of the following objects conduct electricity? Here we have a wooden stick, a spoon, a marker pen, a pencil, a piece of rock, a chalk, a comb, a sharpener and a strand of hair. Which of these conduct electricity? Joe.
Student 1:	The hair, spoon, pencil, sharpener.
Teacher:	The hair, spoon, pencil, sharpener. Mmm, well hair does not actually conduct electricity. So if you have hair there, please remove it. Ally.
Student 2:	That piece of rock could be either way because you don't know what kind of rock it is.

Student 3:	Is it iron?
Teacher:	That is a good point. It really depends on the rock. So it might be that if there is enough of some iron ore in it, it might conduct electricity. Holly.
Student 4:	And then that comb can also conduct electricity if there is metal in it.
Teacher:	That is true. It didn't say what kind of a comb it was. There are also metallic combs. They surely conduct electricity. Good point. Sammy.
Student 5:	Did someone say the marker pen already? It may conduct electricity
Teacher:	Mmmm…
Student 5:	If there is some kind of liquid inside of it, it may conduct.
	The discussion about other possible objects and their qualities continues…
Teacher:	That is correct too. There are many options. But if we think about an ordinary spoon, it conducts electricity. A pencil conducts electricity and a sharpener. But there are also plastic ones. Those three.

The fourth and final example represents a student-initiated pattern of high quality. In this type of dialogue, the teacher allowed space for students' initiatives but still supported the flow of discussion by actively listening and asking questions to extend or clarify students' comments. In the example above, the teacher shared information and elaborated on the students' thoughts and, importantly, summarised the main point at the end of the episode to clarify the content and the lesson to be learned (e.g. how to handle light bulbs when changing them). Although the teacher followed the students' lead, the dialogue still contained a clear structure and active scaffolding. As is typical of episodes representing pattern 3b, the topic of the discussion was very practical and close to the students' own interests or experience, particularly because the initiative behind the dialogue came from the students.

Example 4. Student-initiated teaching dialogue of high quality (pattern 3b)

Context: The teacher and students have studied devices that generate warmth using the study book and engaged in factual question-answer sequences.

Student 1:	So, my friend has... I mean they have this fireplace on the wall. So, there is like no real fire, but it looks like there is fire.
Teacher:	Okay. What kind of a fireplace is it?
Student 1:	I don't know, some kind of an animation or something. But real looking. But it doesn't heat up at all.
Teacher:	Okay. For sure, there are people who have the strangest devices at home. Tommy?
Student 2:	Well, my desk lamp, so there is that kind of a metallic cover on it. And it always heats up a lot.
Teacher:	Yes, they heat up very much. And that's right, you need to be careful when you change that kind of lightbulb. When it blows and breaks and you have to change it, you need to remember to wait for a while for the bulb to cool down. Because it's sizzling hot, you will surely burn your fingers if you go and change it straightaway. Even if I need light right now, straightaway, and I need a new bulb quickly, I always wait for it to cool down first.

The discussion continues…

4. Discussion

The present study applied a mixed-methods approach to examine the association between educational dialogue in Grade 6 classrooms and students' academic grades as well as the quality differences between teacher-initiated and student-initiated dialogic teaching patterns. The results of the multilevel modelling showed that educational dialogue was positively associated with student grades in language arts and physics/chemistry. The qualitative analysis of the language arts and physics/chemistry lessons indicated that while teacher-initiated dialogic teaching patterns were predominantly identified in the studied classrooms, student-initiated patterns were also identified. In the language arts lessons, the majority of the episodes of educational dialogue were of moderate quality, whereas in the physics/chemistry lessons, the majority of the episodes represented high-quality patterns. Moreover, an additional pattern of peer-centred dialogue was

identified in the language arts lessons.

4.1. The association between educational dialogue and grades in academic subjects

The multilevel modelling indicated that the quality of educational dialogue in Grade 6 classrooms was associated with the students' grades. This novel empirical finding suggests that higher-quality dialogue in the classroom is linked to better student performance in language arts and physics/chemistry in terms of grades. Exchanging ideas and opinions is conducive to shared understanding (Alexander, 2006) and contributes to thinking and learning in ways that students may not have been able to attain on their own by reasoning or reading a book (Game & Metcalfe, 2009). For this reason, listening in classroom dialogue, and ideally through active participation by sharing one's own thoughts, offers students richer opportunities for shared knowledge-building and self-regulation (Lonka, 1997) compared to traditional teacher-led lecturing that typically provides the correct responses (Vermunt & Verloop, 1999).

Prior research reports that the amount of dialogue in classrooms is scant and that dialogue in science lessons, for example, is typically teacher-led (Mercer, Dawes, & Staarman, 2009). This study examined associations between the quality of educational dialogue and students' grades in lessons on five subjects: language arts, religion, history, biology/geography and physics/chemistry and found associations, particularly for language arts and physics/chemistry. These five subjects and their topics do not only deal with the sharing of factual knowledge, but also allow for the sharing of personal experiences or views (Muhonen, Rasku-Puttonen, Pakarinen, Poikkeus, & Lerkkanen, 2017). Students are likely to have frequent personal experiences with natural phenomena and objects in their everyday lives, which support their participation in educational dialogue in their lessons. However, in every subject, there is a wide

variation of learning goals and topics, and some topics are likely to be better suited for a dialogic approach than others. The topic or learning goal might have an impact on the kinds of questions (open or closed) that the teacher may ask or how students are able to participate in sharing their thoughts. A variety of techniques and approaches, in addition to dialogue, as defined here, may be beneficial for learning in diverse subjects (see Scott, Mortimer, & Aguiar, 2006). For example, religion lessons are typically characterised by sharing different views and can often be linked with moral dilemmas such as what is right or wrong. Language arts includes a wide variety of learning content that allows teachers to employ a range of teaching methods and means of promoting student participation. Language arts is also a subject that supports the study of other subjects, and opportunities for active dialogue among students and teachers and among peers are highly valuable for the development of communication and argumentation skills. Nevertheless, it was surprising that religion, history and biology/geography were not statistically significantly associated with the quality of educational dialogue in their separate multilevel models although a similar pattern of results was identified for the subjects (i.e., the higher the quality of educational dialogue was, the higher the students' grades were), and the link between the quality of educational dialogue and the latent factor consisting of all the five subjects was statistically significant.

In our study, students' grades in each subject were given at the end of the school year, capturing the accumulated academic performance at that point. In prior studies, outcome measures have been primarily associated with gains in learning assessed using immediate or follow-up tests (Mercer & Howe, 2012). For example, Howe, Tolmie and Rodgers (1992) found that the positive effects of collaborative group work and interaction are often delayed and that post-tests conducted within hours of group work show no significant learning gains when

compared to pre-test results. It has also been argued that educational dialogue primes students to make meanings of their later experiences (Howe, McWilliam, & Cross, 2005).

4.2. The quality of teacher-initiated and student-initiated educational dialogues in language arts and physics/chemistry lessons

The results of the qualitative analysis revealed somewhat different patterns of dialogic teaching in language arts and physics/chemistry lessons. In language arts lessons, teachers used relatively unitary forms of questioning and provided little support for active participation and shared content understanding compared to physics/chemistry lessons, which appeared to contain higher-quality educational dialogues and demonstrated more versatile and richer scaffolding strategies. The teacher's scaffolding strategies in high quality dialogues were in line with the previous research, especially with Nystrand's (1997) concept of dialogic instruction including the use of authentic questions, incorporating students' responses into subsequent questions, and allowing students' responses to modify the topic of discussion. It is possible that the topics studied in the physics/chemistry lessons afforded diverse opportunities for discussions to take place because the students had more prior knowledge of, concrete experiences with and views on these topics (e.g. electricity plugs). In language arts lessons, discussion may sometimes be thwarted by challenging and rather academically-oriented content about which students do not necessarily have prior knowledge or thoughts. For instance, in Example 1, it may have been that the teacher's talk did not fully match the students' level of conceptual understanding. Although the novel was directed at young readers, discussions on literary interpretation can be challenging. Moreover, the topic and romantic tone of the novel could have decreased the level of comfort or interest that the students had when it came to voluntarily sharing their thoughts.

Revealing the distinctive features of the quality of teacher-initiated and student-initiated educational dialogues in the two subjects required fine-grained qualitative analyses of a data set that could be narrowed down by utilising the results of the multilevel analysis. The importance of and need for rigorous analysis of educational dialogue has been highlighted, especially in relation to studying students' learning and conceptual change (Mercer & Howe, 2012). It is important to acknowledge that several types of patterns of educational dialogue may contribute to effective classroom discussion. The results of the present study concur with Cazden's (2001) suggestion that dialogic space can be created by allowing time for students' answers, elaborations and initiations. Time, space and scaffolding that teachers afford for student-initiated talk may be as strong facilitators of beneficial learning experiences contributing to student outcomes as prior-planned teacher-initiated dialogues. Scaffolding of dialogue requires teachers to be sensitive for students' initiative turns, even sometimes those that seem side-tracks, in order to foster students' active participation and integrate their input into productive learning goals and contents. In student-initiated dialogue, teacher's role is nevertheless needed for in supporting of students' knowledge-building process. In the future, more mixed-methods studies in different school subjects are needed to capture both the quality and effect of educational classroom dialogue. There is also little research on students' initiative turns in whole class interaction (Sunderland, 2001). Although teachers are documented to predominantly initiate and manage classroom dialogue (Wells, 2009) more research is needed on students' initiative turns and how they contribute to the actual learning process.

4.3. Implications and limitations

The importance of dialogue in the classroom has been highlighted by scholars for quite some

time, but there has been scant evidence of its empirical associations with student achievement outcomes. Based on the results of the present study, we argue that promoting diverse patterns of educational classroom dialogue is the key to productive classroom interaction and learning outcomes. An accumulation of evidence-based information about the concrete benefits of educational dialogue is critical for motivating teachers to use dialogue in their own classrooms. Recent research indicates that student teachers, especially in the sciences, worry about their competencies in content knowledge and the organisation and management of their lessons, and they see the orchestration of educational dialogue as both challenging and time-consuming (Lehesvuori, Viiri, & Rasku-Puttonen, 2011). Building the skills required to foster dialogic classroom interaction needs to start in teacher education and continue during in-service training. Teachers and student teachers need concrete tools to use and examples of how to support both teacher- and student-initiated dialogues in order to foster students' participation, engagement in argumentation and shared understanding (Muhonen et al., 2016). By acknowledging the different phases of scaffolding, such as contingency, fading and transfer of responsibility (Van de Pol & Beishuizen, 2010) and the strategies for reaching these phases, the teacher can guide students towards becoming more independent participants, as reflected in the pattern of peer-centred dialogue. For instance, in the future, professional development programmes and interventions could be one way of enhancing the role of dialogue as a teaching method.

The current study has certain limitations that need to be considered before making any attempt to generalise the results. First, the number of Grade 6 teachers and their class sizes (n = 46) were relatively small, which may have decreased the power of the statistical testing. Therefore, it is important to replicate the findings in a larger sample in the future. Second, although we found an association between the quality of educational dialogue and students'

academic performance, our study did not have a cross-lagged longitudinal design. Consequently, we cannot claim that the quality of educational dialogue predicts students' improved learning, and caution is needed before making any direct causal inferences. Third, students' grades in the academic subjects were given by the class teachers, who were also responsible for classroom instruction. Thus, in future studies, more objective measures of achievement could also be used. Fourth, a clear limitation of the study is that only structural control variables were employed in the multilevel modelling. In his meta-meta-analysis, Hattie (2008) documented that structural factors, such as class size and teacher qualification, typically show only a minor effect on students' achievement, whereas factors such as teacher-student relationship, student engagement, motivation and classroom management tend to have a significantly stronger effect on students' achievement. In future research, these process quality variables, important for both learning and dialogue, should also be controlled for when examining educational dialogue.

Fifth, the number of language arts lessons available for the qualitative analysis was greater than that of physics/chemistry lessons available. Although the sample of lessons was restricted to language arts and physics/chemistry lessons with mid-range to high CLASS-S scores on dimensions of Instructional Dialogue and Quality of Feedback, it is important to acknowledge that similar patterns of educational dialogue are likely to be evidenced in the other three subjects. For example, prior studies (e.g., Muhonen et al., 2016) indicate that subjects such as religion and science can provide diverse opportunities for dialogic interaction. It would have been interesting and informative to conduct qualitative analyses on all five subjects. However, the decision was made to concentrate only on subjects with statistically significant associations with students' grades in the final model. Sixth, differences between individual teachers may, to some extent, explain the findings as it may be that some teachers are more inclined to use dialogue as a

teaching method than others. Seventh, both the statistical and qualitative analyses focused on educational dialogue where the teacher's support was actively involved. However, other coding schemes (e.g. Michaels & O'Connor, 2011; Resnick, Michaels, & O'Connor, 2010; Wells, 1999) could have been utilised to capture a wider variety of educational discussion. For example, Hennessy and colleagues (2016) recently developed the Scheme for Educational Dialogue Analysis (SEDA) for analysing educational dialogue across various educational contexts as well as for applying to observations of whole class, group and paired work.

5. Conclusion

The present study showed that educational dialogue is indeed associated with students' academic performance in language arts and physics/chemistry. The qualitative analysis identified dialogic patterns representing both teacher- and student-initiated dialogic teaching, along with peer-centred dialogue. In the language arts lessons, educational dialogues were more likely to be characterised by their moderate quality, whereas in the physics/chemistry lessons, high-quality educational dialogues were more common. The results suggest that both the quality and amount of dialogue in the classroom need to be increased in order to support student learning. It is important that teachers have more access to evidence-based knowledge about the concrete benefits of educational dialogue and the models of how to utilise their diverse patterns in the classroom.

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Table 1

Patterns of dialogic teaching (Muhonen et al., 2016).

Pattern 2a: Teacher-initiated teaching dialogue of moderate quality	**Pattern 3a: Student-initiated teaching dialogue of moderate quality**
The teacher asks many short/closed questions to keep the dialogue going. He/she makes expansions and draws together what is being learned. Students do not participate without the teacher's help or encouragement.	The student asks a question or presents an idea, which the teacher broadens at the whole-class level or allows space for more independent discussion among students. The teacher might ask follow-up questions but does not make expansions or draw summaries that would collate what has been learnt.
Pattern 2b: Teacher-initiated teaching dialogue of high quality	**Pattern 3b: Student-initiated teaching dialogue of high quality**
The teacher asks fewer but mostly open-ended questions. He/she makes expansions and draws together what is being learnt. With the help of scaffolding, students participate and formulate their own initiatives and questions.	The student asks a question or presents an idea, which the teacher broadens at the whole-class level or allows space for more independent discussion among students. The teacher actively supports the discussion, makes expansions and brings together the main idea of the dialogue.

Table 2

Correlations between the study variables (within-level below the diagonal, between-level above the diagonal), means, variances and ICCs ($N_{between} = 46$; $N_{within} = 608$).

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	*Var between*	*M*	*ICC*
1	Quality of Educational Dialogue(G6)[3]	1.00	.31[c]	.21	.17	.28[c]	.11	---	.04	-.26	.03	.01	-.05	.47	2.89	---
	Students' Grades in Grade 6															
2	Grade in Language Arts[1]	---	1.00	.68[a]	.56[b]	.65[a]	.52[b]	---	.34	.03	.46[d]	.71[a]	.03	.10[d]	8.26	.12[c]
3	Grade in Biology/Geography[1]	---	.67[a]	1.00	.56[b]	.66[a]	.59[a]	---	.54[c]	.26	.52[c]	.67[a]	.02	.12[b]	8.27	.11[b]
4	Grade in History[1]	---	.66[a]	.74[a]	1.00	.56[a]	.52[b]	---	.38[d]	.41	.50[b]	.32	.03	.27[b]	8.20	.24[b]
5	Grade in Physics/Chemistry[1]	---	.59[a]	.71[a]	.64[a]	1.00	.69[a]	---	.34	-.23	.01	.55[b]	.23	.12[b]	8.45	.16[c]
6	Grade in Religion[1]	---	.64[a]	.71[a]	.72[a]	.63[a]	1.00	---	.29	.07	.24	.34[d]	.19	.22[a]	8.22	.20[a]
	Control Variables															
7	Student's Gender[2]	---	-.34[a]	-.18[a]	-.12[b]	-.02	-.19[a]	1.00	---	---	---	---	---	.00	1.54	.003
8	Parental Education[1]	---	.26[a]	.31[a]	.34[a]	.34[a]	.27[a]	.10[c]	1.00	.93	.39	.59[b]	-.13	.14	4.79	.07[c]
9	Reading Comprehension (G4)[1]	---	.45[a]	.43[a]	.44[a]	.47[a]	.46[a]	-.12[c]	.21[a]	1.00	.84[a]	.55[b]	.25	.19	8.21	.03
10	Arithmetic (G4)[1]	---	.29[a]	.24[a]	.27[a]	.25[a]	.22[a]	.12[c]	.15[a]	.24[a]	1.00	.57[b]	.09	1.60[c]	17.37	.11[c]
11	Class Size[3]	---	---	---	---	---	---	---	.45[a]	---	---	1.00	.06	35.09[a]	20.62	---
12	Teacher Experience[3]	---	---	---	---	---	---	---	-.02	---	---	---	1.00	1.45	3.93	---
	Var_{within}	---	.73[a]	.91[a]	.88[a]	.63[a]	.87[a]	.25[a]	1.90[a]	5.71[a]	12.82[a]	---	---			
	M	---	8.30	8.31	8.25	8.48	8.26	1.54	4.78	8.18	17.53	---	---			
	Min	---	6	5	5	5	5	1	1	1	4	---	---			
	Max	---	10	10	10	10	10	2	7	12	26	---	---			

Note. [a] $p < .001$, [b] $p < .01$, [c] $p < .05$, [d] $p < .08$. [1] variable both at between-level and within-level, [2] within-level variable, [3] between-level variable, --- not estimated, [4] gender *1* = girl, *2* = boy.

Table 3

Identified episodes of educational dialogue in language arts and physics/chemistry lessons: patterns of dialogic teaching.

Patterns of dialogic teaching	Language arts Number of episodes *	Physics/chemistry Number of episodes **
Pattern 2a: Teacher-initiated teaching dialogue of moderate quality	16	7
Pattern 2b: Teacher-initiated teaching dialogue of high quality	7	10
Pattern 3a: Student-initiated teaching dialogue of moderate quality	2	0
Pattern 3b: Student-initiated teaching dialogue of high quality	4	3
Pattern 4: Peer-centred dialogue	5	0
Episodes in total	**34**	**20**

Note. *The length of an episode in language arts lessons varied from 143 words to 520 in Finnish.
**The length of an episode in physics /chemistry lessons varied from 282 to 596 words in Finnish.