Chapter 5
Teachers' Use of Questions and Responses to Students' Contributions During Whole Class Discussions: Comparing Language Arts and Science Classrooms

Emilia Andersson-Bakken and Kirsti Klette

5.1 Introduction

The aim of this chapter is to explore how teachers use questions as an instructional tool in science and language arts classrooms, and how these questions enable dialogue between teachers and students and support student learning. The focus will be on investigating teachers' use of questions and responses as an instructional tool during whole class sessions. There are many research reports on teachers' use of questions as a key instructional tool (Barnes 2008; Chin 2007; Croom 2004; Mehan 1979) and also on how classroom dialogue is crucial to facilitate learning (Alexander 2008; Juzwik et al. 2008; Lemke 1993; Mercer and Littleton 2007; Nystrand et al. 1997). In this respect, scholars agree that teachers' questioning can significantly improve the students' performance. The analyses presented in this chapter draw on video recordings from teacher-led whole class instruction in lower secondary language arts and science classrooms. We are interested in exploring the *role* and *type* of teacher questions in these two distinct, and rather different, subject areas.

There is a growing consensus among researchers that dialogue, and especially open-ended questions and discussions, makes a difference to student engagement and learning (Alexander 2008; Juzwik et al. 2008; Mercer and Dawes 2008). Although the relationship between question types and the following discussions during whole class sequences is well documented (Almeida and Neri de Souza 2010; Applebee et al. 2003; Mortimer and Scott 2003; Myhill 2006; Nystrand et al. 1997), the use and functions of the different types of teacher questions during whole class sessions are less well studied. Croom (2004) argues that teacher questioning is the most widely used instructional tool during whole class sessions. According

E. Andersson-Bakken (✉) • K. Klette
University of Oslo, Oslo, Norway
e-mail: e.i.andersson-bakken@ils.uio.no

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to Chin (2007), the purpose of teacher questioning in whole class sequences is to assess what the students know. The teacher mainly asks closed questions, Chin argues, and they are mostly information-seeking and require predetermined and/or rather short answers. Lemke (1993), on the other hand, shows how a series of teacher questions in science classrooms build semantic links that are crucial for the students' understanding of the topic. Recently, Juzwik et al. (2008) and Ødegaard and Klette (2012) have emphasized how teacher-led instruction and teachers' careful use of different question types can optimize the dialogic potential of classroom discourse by opening the floor to students' ideas and responding to competing voices. In this chapter, we will explore the potential for student engagement and learning through teacher questioning and student response in whole class sessions in language arts and science lessons. We start by giving a general overview of discourse features and the role and function of teacher questioning during whole class sequences, followed by a short summary of the role of questioning in language arts and science classrooms. Building on this overview, we present our analytical framework for analysing teachers' use of questions in the videotaped classrooms. We then present methods, data, and results, along with a final discussion on how teachers' questions might support and optimize student learning.

5.2 Question–Answer Sequences in the Classroom

Question–answer exchanges between teachers and students clearly dominate whole class instruction in most subject areas; including science and language arts classrooms (Almeida and Neri de Souza 2010; Lemke 1993; Mercer and Dawes 2008; Myhill 2006; Nystrand et al. 1997: Osborne and Chin 2010). Cazden (2001) argues that, at their best, teacher questions can both assist and assess student learning. Questions play a key role in illuminating, explicating, and legitimating student voices in the classroom conversation. As such, questions significantly regulate the extent to which teacher–student interaction can be dialogic and show how responsive teachers are to students' utterances (Mortimer and Scott 2003; Nystrand et al. 1997). Croom (2004) shows that teachers use questions as one of their main tools in the classroom. According to Croom and Stair (2005), teachers use questions primarily as a tool for classroom management, despite the fact that questions are not well suited for this purpose. Teacher questions, these scholars argue, are best used as a diagnostic tool to indicate a student's academic progress or to assess a students' critical thinking (Croom and Stair 2005).

As indicated above, a number of scholars claim that the quality of classroom conversation is crucial for student learning (Cazden 2001; Lyle 2008; Mortimer and Scott 2003; Nystrand et al. 1997). However, research suggests that teachers may find it difficult to promote the type of high quality questions that contribute to student learning (Barnes 2008; Littleton and Mercer 2010). Mercer and Littleton (2007) distinguish between authentic questions, which are questions without pre-specified answers and are open to different interpretations, and closed questions or test questions, where the teacher knows the answer beforehand. They argue

that authentic questions are particularly suited for developing students' thinking in specific subject areas. Nystrand et al. (1997) posit that authentic questions are questions to which the teacher does not have a pre-specified answer, signalling to the students that he or she is interested in what they think and know about a certain topic. Furthermore, these questions are used by the teacher to draw out the students' ideas and initial levels of understanding, and the interactions with the students are used as opportunities to encourage them to make explicit their own thought processes (Alexander 2000; Mercer and Littleton 2007).

Several studies describe the most frequent communication structure in classrooms as 'initiation response–evaluation/feedback' (IRE/F) patterns (Cazden 2001; Mehan 1979), triadic dialogues (Lemke 1993; Nassaji and Wells 2000), and reciting conversations (Nystrand et al. 1997; Wertsch 1998). The IRE/F pattern has often been described as the ultimate example of a non-dynamic and non-interactive form of teacher–student communication. However, recent studies challenge this assumption. Emergent studies from Nordic and North Atlantic classrooms suggest that whole class instruction within an IRE/F format provides possibilities for student initiatives and questions, thus giving the students a more active and engaged role (Emanuelsson and Sahlström 2008; Klette 2010; Ødegaard and Klette 2012), facilitating student participation (Aukrust 2003; Bjørnestad 2009; Nassaji and Wells 2000), and providing opportunities for building on the students' perspectives and understanding (Juzwik et al. 2008; Lemke 1993). Thus, IRF/E patterns provide the students with a more active and less restricted role than suggested in earlier studies. Scholars also emphasise how IRE/F patterns serve as semantic lenses for content-focused learning (Alexander 2000; Lemke 1993), and argue that teachers' use of 'revoicing' (Stein et al. 2007) and 'recapturing' (Furtak and Shavelson 2009) serves as a powerful scaffolding technique to ensure substantial learning in subject areas such as science.

Croom and Stair (2005) suggest that teachers use questions as their main tool for managing the classroom, even though questions are not suited to this function. Teachers are concerned with making certain that the class is engaged in the lesson and preventing disciplinary problems; hence, they turn to questions as a tool to manage the classroom discourse. Thus, teachers often fling question after question at the class in the hope of engaging the students. Croom and Stair argue that this often has the opposite effect. They contend that three things may happen when a teacher poses a question to the class. First, the student who knows the answer may blurt it out before anyone else has had a chance to think about it. Second, a student who craves attention may offer an answer even though he or she is ignorant about the correct answer. Third, students who are insecure about their academic ability, or who have difficulty understanding the subject matter in question, will not attempt to answer.

Questions of wait-time – the amount of time teachers should wait for students to provide responses to their questions – have been studied by Tobin (1986) and others. Tobin suggests that extended wait-time reduces the utterances per time unit and the number of times the teacher interrupts the student discourse. Furthermore, his study showed a difference in teacher questioning, with teachers in extended wait-time classes asking more appropriate questions and their students being more likely

to respond to teacher solicitations. Following Rowe (2003), the average wait-time for a response to a question is one second and the teacher's response to the student's answer is usually less than a second.

Thus far, we have discussed the role of discourse features and teacher questions in relation to lower secondary classrooms in general. We now turn to teacher questions in science- and language arts classrooms. From studies of language arts classrooms, Nystrand et al. (1997) claim that if we change the discourse pattern from IRE to IRF, there is a greater potential for dialogue, but this requires that the teacher gives feedback (F) that pushes the student's contribution further, rather than simply saying "good" or "good idea". The teachers' follow-up must be validated in such a way that it affects the direction of the discussion that follows, Nystrand et al. argue. In a more recent study, Juzwik et al. (2008) show that teacher monologues can be transformed into dialogues by giving a more substantiated evaluation and opening the floor to students' ideas. Nystrand et al. (1997) emphasise that much can be learned about teacher–student interaction in the classroom by looking more closely at the type of questions that are asked, the extent of authenticity in the questions, how they support student participation, and whether they allow for alternative interpretations or provide disagreement.

Lemke (1993) claims that the most common activity structure in science classrooms is the triadic dialogue, which consists of a three-part question–answer–evaluation pattern. He argues that the most important and clear thematic development strategy used in triadic dialogue is that of the teacher question series. In using this strategy, Lemke states, the teacher plans a series or sequence of thematically interconnected questions, which, as a whole, build a set of semantic links that are important to the thematic focus. As long as the students provide the thematically correct answers, the triadic dialogue provides efficient descriptions of thematic relations. It is the teacher, however, who decides which questions are asked and which answers are accepted, and students have few opportunities for posing their own thematic initiatives in this communication structure (Lemke 1993).

Drawing on the work of Bakhtin (1953), Vygotsky (1978), Lemke (1993) and others, Mortimer and Scott (2003) distinguish between four dimensions of communicative approaches in science classrooms: (a) interactive/dialogic; (b) non-interactive/dialogic; (c) interactive/authoritative; and (d) non-interactive/authoritative. In the interactive/dialogic pattern, the teacher and students explore different ideas and work together. In non-interactive/dialogic communication, the teacher, as the primary agent, reviews and summarizes ideas and views that have been pointed out during the lesson, but also provides time for disagreements and competing perspectives and questions. In the interactive/authoritative dimension, the teacher has a set agenda for the lesson and this often leads to an IRE/F-structured question–answer pattern. In the non-interactive/authoritative dimension, the teacher presents a view through lecturing and there are limited possibilities for students to raise their voices and posit alternative viewpoints and questions. Using these dimensions, Mortimer and Scott show that any effective teaching lesson should include both dialogic and authoritative discourses, achieved in both interactive and non-interactive ways. Mortimer and Scott (2003) argue that when the teacher is

teaching in an interactive/dialogic communication pattern, the chains of interaction between the teacher and students lengthen. This means that the teachers ask more open questions and give more responses that are aimed at giving feedback, rather than evaluating the students' answer.

As outlined in this short overview, teachers can use questions for several purposes. One purpose is to legitimize a student's voice by asking follow-up questions. A teacher can also ask questions in order to probe students' interpretations. Another form of questioning is when the teacher asks test questions, which are aimed at determining what students know about the subject. Questioning can also be used as a method of classroom management. Finally, questions are used to probe the students' understanding and gather information about what and how students are thinking.

Despite teachers' use of questioning as a major instructional tool, we still know little about the form and function of teacher questions in the classroom, both in general and in relation to the different subject domains. In this article we have chosen to use science and language arts classrooms as lenses to investigate teachers' use of questions based on the distinct differences in teaching traditions in these two subject areas. In the language arts classrooms, many activities are related to the interpretation of different texts and genres (Applebee et al. 2003; Grossman and Stodolsky 1995; Hultin 2006; Skarðhamar 2011), while science teaching is closely linked to working methods central to science as an academic discipline such as the 'nature of science', inquiry methods and scientific argumentation (Mortimer and Scott 2003; Newton et al. 1999). Science, as a field of expertise, is also often described as a predefined and fixed body of knowledge (Newton et al. 1999), nurturing test questions and questions that require a yes or no answer. The differences in these two subjects can also be traced in their textbooks. Maagerø and Skjelbred (2010), for example, show how textbooks for eighth grade science students are dominated by yes–no questions. Knudsen and Mortensen-Buan (2010) claim that in language arts textbooks the questions and tasks have a rather open form. An open inquiry form is used, they argue, to allow the reader to interpret and reflect upon different types of texts and text genres.

Drawing on the overview presented above, we are interested in exploring the following research questions with regard to teachers' use of questions during whole class instruction:

1. What type of questions do teachers ask in science and language arts classrooms?
2. Is there a typical pattern for the use of 'open' or 'closed' questions?
3. What patterns of teacher responses during question–answer sequences can be identified?
4. What are the differences between the roles of questions in the two subject areas?

5.3 Methods and Data

The data sources build on videotaped classroom observations from the lower secondary level. The video material is drawn from the PISA+ Video Study (see Introduction to this book). The material constitutes 45 videotaped lessons from

science classrooms and 44 videotaped lessons from language arts classrooms. The current analyses draw on video observations from eight science lessons and 10 language arts lessons ($n = 18$). The 18 ($8 + 10$) lessons selected were chosen on the basis of the extent of whole class teaching implemented in these classrooms. Whole class teaching is defined as an instructional process wherein teachers pose questions, deliver lectures and conduct other related activities to an entire class. More lessons in language arts were selected because whole class teaching was generally implemented to a lesser extent in language arts classrooms than science classrooms (Ødegaard and Klette 2012). So, to equalize time spent on whole class teaching in both subjects, two more lessons were selected from language arts. In the 18 lessons (810 min) analysed, 430 min were devoted to whole class teaching (i.e. altogether approximately 53 % of these lessons).

The data were coded with reference to an applied version of Furtak and Shavelson's (2009) coding manual from science classrooms (see next section for a presentation of this framework). This manual was developed for analysing the use of inquiry-based methods in science classrooms, while we have used it for analysing teachers' use of questions in both science and language arts classrooms during whole class interaction. With reference to Mortimer and Scott (2003), Furtak and Shavelson also make the distinction between dialogic and authoritative teaching moves. Within these two main teaching styles, patterns of teachers' response and questions to students were investigated.

5.4 Analytical Framework

Our analytical framework builds on the dialogic and authoritative teaching moves as outlined by Scott (1998) and Mortimer and Scott (2003), and later developed by Furtak and Shavelson (2009). In the analyses we use '*Dialogic Teaching Moves*' and '*Authoritative Teaching Moves*' as two main categories when analysing teachers' use of questions and responses during whole class sequences. '*Dialogic Teaching Moves*' covers issues such as 'asking 'real' and open questions', 'revoicing/reflecting student responses', and 'providing neutral responses to students', while '*Authoritative Teaching Moves*' conveys responses from teachers such as 'sequence of repeated questions', 'reconstructive paraphrase or recap', and 'cued elicitation of students' contributions'. Tables 5.1 and 5.2 describe the categories in more detail.

We do not choose to use the terms dialogic and authoritative as binary concepts (Clarke 2006; Andersson-Bakken in press), but are interested in the teachers' use, pace, and rhythm when organising whole class learning through questioning. Like Mortimer and Scott (2003), we see the dialogic and authoritative teaching moves as two different teacher activities; hence, they are used as distinctions and not as dichotomies.

Table 5.1 Dialogic teaching moves

Dialogic teaching moves – teacher and students jointly construct narrative/discussion	
Asking 'real' or open questions	Teacher asks a question of a student or entire class to which the answer is not necessarily known or expected by the teacher
Revoicing/reflecting student responses	Teacher repeats verbatim what a student has responded without changing or altering the meaning of the statement. Includes when a teacher repeats in a question-style format or asks student to clarify what she/he said, or to refer that comment to another student
Providing neutral responses to students	Teacher repeats student responses, or provides comments that do not indicate whether students' statements are correct or incorrect

Table 5.2 Authoritative teaching moves

Authoritative teaching moves - teacher controls course of narrative/discussion	
Cued elicitation of students' contributions	Teacher asks questions while simultaneously providing heavy clues, such as the wording of a question, intonation, pauses, gestures, or demonstrations, to the information required
Sequence of repeated questions	Teacher asks the same/similar questions repeatedly to seek a particular answer, and continues asking the question/s until answer is provided by students
Reconstructive paraphrase or recap	Teacher recasts or paraphrases what students has said in a more complete or acceptable form, or in preferred terminology, including when teacher adds to or changes the meaning of what the student has said
Providing evaluative responses	Teacher clearly indicates, through words or intonation, that a student's comment is correct or incorrect

5.5 Analysis

The videos were coded using the Videograph software program (Rimmele 2002) and were coded at 5 s intervals. Videograph allows the researcher to see the videos of the teacher and the students simultaneously. The software also allows for stopping the coding and re-coding as often as necessary. In addition, using a video camera and a software program, such as Videograph, provides opportunities to test the codes with others and see if several researchers have coded the same segment with the same codes. This enhances reliability and transparency in the current analyses.

The codes we used in Table 5.1 to capture dialogic teaching moves are: 'asking 'real' or open questions', 'providing neutral responses to students', and 'revoicing/reflecting student responses'. While the first code addresses questions directly, the others focus on teachers' responses to students. The codes that we have selected to illustrate authoritative teaching moves in Table 5.2 are: 'cued elicitation of students' contributions', 'sequence of repeated questions', 'reconstructive paraphrase or recap', and 'providing evaluative responses'. All of the codes address questions and responses to students by the teacher. As we coded at 5 s intervals, each question is not accounted for; rather, the code that takes up most of the interval is coded. We chose to code at 5 s intervals because most codes can be delivered

by the teacher or the student in this time frame. If we had chosen a longer time frame, we would have missed several teaching moves, for example, where two codes occurred in rapid succession. On the other hand, with a shorter timeframe we would not have been able to catch what was said in the utterance. As a starting point, we looked at the whole sequence of one lesson to identify possible sequences for further analysis. We used the entire 5 s interval to apply the appropriate code, if any, for that statement. For example, if the teacher in those 5 s asked the students "What kind of books do you read?" this was coded as 'asking 'real' or open questions'.

The sequence below illustrates an example of our coding method. It is from a science lesson and the class is talking about the skeleton and the muscles. This incident is at the beginning of a lesson, and the teacher asks the students how they think human beings evolved (all direct quotes translated by the authors).

Excerpt	Code
Teacher: If we imagine how human beings were from the beginning of evolution, what do you think a human being was like then, where do we come from? How have we become the way we are? Is there anyone who has any ideas about that? The earth has not always been populated by people like us. Yes Andreas?	Asking 'real' or open questions
Student 1: We were monkeys	
Teacher: You imagine that we used to be monkeys, yes, that they are our ancestors?	Revoicing/reflecting student responses
Student 1: Yes	
Teacher: Mmm, yes?	Reconstructive paraphrase or recap

Based on the detailed coding procedures, the findings are presented as graphs of the time used on the different questions and responses shown as a percentage of total time. We also illustrate the findings using excerpts that represent typical examples of the different questions and responses shown in the graphs.

5.6 Teacher Questions in the Classroom

A large amount of time is spent on whole class teaching and teacher questions in both science and language arts classrooms; however, the teachers in language arts spend less time on whole class teaching compared to science classrooms (Ødegaard and Klette 2012). Language arts lessons usually begin with a whole class teaching sequence for the first 20 to 30 min, where the class talks about, and around, the different types of texts the students are reading. These include fiction and non-fiction, as well as poems, newspapers, articles, and various other materials. In the observed science lessons, a lot of the time is devoted to teacher-led whole class teaching, like checking the students' understandings of an ecosystem,

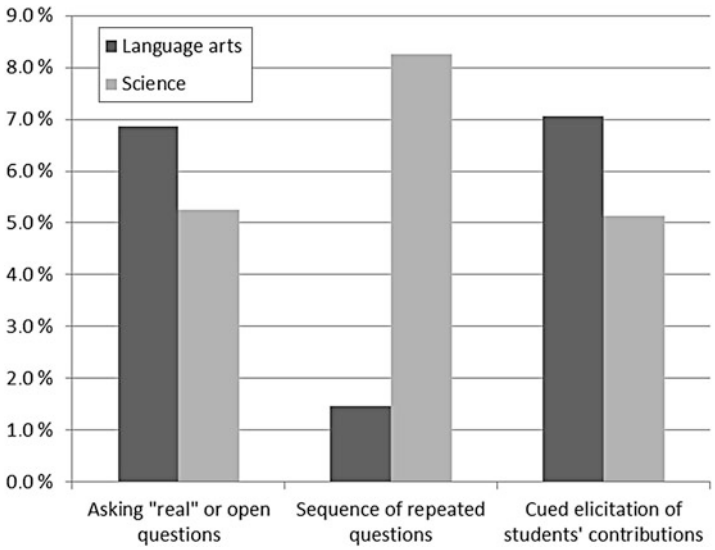

Fig. 5.1 Percentage of time spent on different types of teacher questions during whole class instruction in science and language arts

summarising a visit to a farm, or discussing issues related to smoking and drugs as part of knowledge about the human body. Thus, teachers in both science and language arts classrooms spend a quite a lot time on question–answer sequences. However, the type of questions that the teachers ask varies between these two subjects. We distinguished between dialogic teacher questions (e.g. 'asking 'real' and open questions') and authoritative teacher questions (e.g. 'sequence of repeated questions' and 'cued elicitation of the students' contributions'). Figure 5.1 displays the percentage of time used on different types of teacher questions during whole class instruction in each of the subjects. In science the time used on whole class instruction is 219 min and in language arts it is 211 min.

As illustrated in the figure, the science teachers spend more time on sequences of repeated questions, while the language arts teachers spend more time on asking 'real' or open questions. The language arts teachers appear to spend more time on cued elicitations. However, this is mainly due to one of the lessons, where the teacher spent about six minutes on cued elicitations, while in the other nine lessons on average only one minute was spent on this particular code. Below, we explore in more detail how these types of questions are played out in the two subject areas.

5.6.1 Asking 'Real' or Open Questions

As shown in Fig. 5.1, the language arts teachers spend more time on 'asking 'real' or open questions' compared to their colleagues in the science classrooms. The following excerpt from a language arts classroom serves as a typical example of

how this is played out in our material. In this excerpt, the language arts teacher wants to know about the students' reading habits and begins with an open question.

Excerpt 1

1. Teacher: What kind of books do you read? Let's take a round and hear what you read and why. What do you read?

(A student shows the teacher her book, 'Butterfly Effect', by the Norwegian author Pernille Rygg.)

2. Teacher: What is it about?
3. Student: It is a crime novel.
4. Teacher: Who of you has read a crime novel?
5. Student 2: Crime novel?
6. Teacher: Yes, most of you have read crime novels. Why do we read crime novels?
7. Student 3: I think it is exciting.

Here the teacher asks a question that evokes more than a 'yes' or 'no' response, and he continues this questioning pattern throughout the whole lesson. He starts with an open question that can be answered in several different ways, and he continues to ask open questions throughout this sequence. As we can see in line 2, the teacher accepts the answer from the student even though we might assume that the teacher was expecting an answer about the book's literary genre or storyline. The teacher probes the students' thinking, building on their answers, asking them for reasons why they read crime novels (line 6). This type of question–answer sequence is quite common in the language arts lessons devoted to literature and literary texts in our material. However, these discussions are seldom related explicitly to a specific concept or terminology (e.g. literary genres).

The next excerpt is from a science classroom. Here they are talking about drugs, specifically steroids. They have gone through a text that describes some of the side effects from using steroids, and one of the students says that he knows some people that use them.

Excerpt 2

1. Teacher: Do you think they know about the side effects?
2. Student: I know many people that take steroids, they are healthy.
3. Teacher: They haven't lost their hair? Do you know for how long they have used them?
4. Student: No.
5. Teacher: No, here it says that if one uses them for a short period of time, one would not notice the side effects, so this happens if you use them over a longer period of time. But do you think that they know that it is dangerous? Do you think that the people that use them know that it is dangerous?
6. Student: No, but you can get sick from eating bad food as well.
7. Teacher: But you see if you put a lot of steroids into your body, it does not matter how healthily you eat.

As we can see, the teacher starts out with an open question, which is directed to this one student who knows people that use steroids. When the student does not

directly answer the teacher's question, he asks some other more specific, but still open questions. In line 5, he gives the students some more background information about the side effects, suggesting that one may not see these effects after only having used steroids for a short time. He then directs yet another open question to the student about whether he thinks that the steroid users are aware of the dangers of using steroids. As can be seen from both theses excerpts, the teachers are attentive to student perspectives by using open questions to explore the students' understanding and interpretation.

5.6.2 Sequence of Repeated Questions

The teachers in science classrooms spend far more time on repeated questions and are, to a large extent, searching for a specific answer. The excerpt below from a science classroom illustrates this. This lesson is about smoking and tobacco, and the class is discussing tobacco and the risk of getting cancer.

Excerpt 3

1. Teacher: A lot of people who die of cancer, where do they go?
2. Student: Before they die?
3. Teacher: Yes, before they go to Heaven, before they die. Where do these patients get treatment? At the hospital? Is there a special hospital in our city that has a lot of people sick with cancer, which specialises in cancer treatments?
4. Students: Yes.
5. Teacher: And the name is? Just say "Rikshospitalet" as that is what it is called now, but it is a subdivision to the "Rikshospital" that is called ....?
6. Student: Cancer ward.
7. Teacher: Well – that would be the one ... the cancer hospital has a name that is connected with something, they get radiated with something, and then they use raaa, raad.
8. Student: The Radium hospital.
9. Teacher: Yes, the Radium hospital.

In this sequence, the teacher is searching for a particular answer – the Radium hospital – and tries to ask the same question in many different ways to get the students to give the name of the institution. When the teacher is asking this type of questions, the students' contribution to the discussion is not followed-up by the teacher, but rather overlooked in the teacher's search for this very specific answer. The teacher starts out with an open question in line 1, but is after something very specific and the student who responds in line 2 does not seem to perceive this. In line 6, one of the students answers "cancer ward", which is an accurate proposal that is not, however, taken up by the teacher. The teacher has something else in mind and continues the questioning in an effort to get the students to understand the exact hospital he is searching for. In this question pattern, there is a lack of progress in the

discussion, since the teacher's focus is on his predefined answer (e.g. the name of the hospital) rather than the proposals and ideas the students bring to the discussion.

The next, very short excerpt is also from a science lesson, in which the class has been on a farm visit the previous week, and the teacher wants to check what they have learned from this visit.

Excerpt 4

1. Teacher: Do you remember the definition of organic farming, what characterises organic farming? What was so special about that?
2. Student: It was better and it was not as polluting.
3. Teacher: I am thinking like very specific, what it takes for us to call it organic farming?

In this sequence, coded as a 'sequence of repeated questions', the teacher starts out with a question that can be answered in different ways; there is more than one right answer and/or proposal that characterise organic farming. However, the teacher in this excerpt has something particular in mind, and is not satisfied with the answer she gets from the student. Thus, she asks once again, but with a more targeted question to get the answer she is looking for. The teacher is not expanding on the students' ideas nor is she pursuing their answers or comments, such as the one proposed in line 2: "It was better and it was not as polluting." As can be seen from both these illustrations, sequences of repeated questions are used when the teacher is searching for a predefined, and often rather narrow, answer.

5.6.3 Cued Elicitation of Students' Contributions

When we consider questions leading to cued elicitation, the two subjects are more alike. The science teachers, however, invest more time on 'cued elicitation of students' contributions' compared to their language arts colleagues. The science teachers seem to help their students to arrive at 'the right answer' by giving cues to where the teacher is heading. A typical example is seen in one science classroom discussion devoted to smoking.

Excerpt 5

1. Teacher: If you think about the whole school, how many do you think smoke?
2. Student: Twenty per cent.
3. Teacher: Don't say it in per cent, I want it in numbers. There are about four hundred and thirty students in this school, and how many do you think are smoking?
4. Student: One-hundred and sixty-three.
5. Teacher: How many have you seen smoking then? Really seen?
6. Student: One.

When asking questions coded as 'cued elicitation of students' contributions', the teacher is giving the students cues to guide them in the direction the teacher wants the conversation to go. As shown in line 3, the teacher is not satisfied with the

answer the student gives, so he tries to make the question more specific to give the student a hint about the answer he wants. In this excerpt, too, the teacher begins with an open question. However, when he does not get the answer he is seeking, the teacher continues with a cued questioning form. One can assume that he wants the students to think about the question a little longer before answering to get a more likely and/or correct answer. As we can see, the student first answers 20 %, and then suggests 163 students, which is approximately 40 %, and finally, after the teacher asks how many people the student has actually seen smoking, the answer is one. The teacher continues this conversation, however, by asking some of the other students how many students they have seen smoking and the highest number given is four. By insisting on the number of smokers – "Don't say it in per cent, I want it in numbers" (line 3) – the teacher uses cued elicitation to get the students to look beyond a percentage and realize how many of their school mates might actually smoke.

Thus far, we have discussed the teachers' use of questions. We now turn to how teachers respond to student utterances and questions during whole class sessions, including utterances based on the teachers' questions.

5.7 Teacher Responses to Students' Utterances

In our analysis of teachers' responses to students' contributions, we distinguished between 'revoicing or reflecting students responses'; 'providing neutral responses to students'; 'reconstructive paraphrase or recap'; and 'providing evaluative responses'. The differences in teacher responses between science and language arts lessons are more subtle than the differences in the way the teachers ask questions. The two response types that differ the most between the two subjects are 'revoicing or reflecting students responses' and 'reconstructive paraphrase or recap' In the case of the response types 'providing neutral responses to students' and 'providing evaluative responses 'the two subjects show a similar response pattern. Figure 5.2 summarises the percentage of time used on the different types of teacher responses in the classrooms analysed.

Below, we elaborate on and illustrate the teachers' use of 'revoicing/reflecting student responses', 'providing neutral responses to students', 'providing evaluative responses', and 'reconstructive paraphrase or recap' in responding to student utterances.

5.7.1 Revoicing or Reflecting Student Responses

'Revoicing or reflecting student responses' is the most frequently used response to the students in both science and language arts classrooms. However, the science teachers invest more time than their language arts colleagues on 'revoicing or reflecting student responses'. The excerpt below is an illustration from a science classroom. This example is from the same lesson as Excerpt 4, where the class discusses their experiences after a visit to a farm.

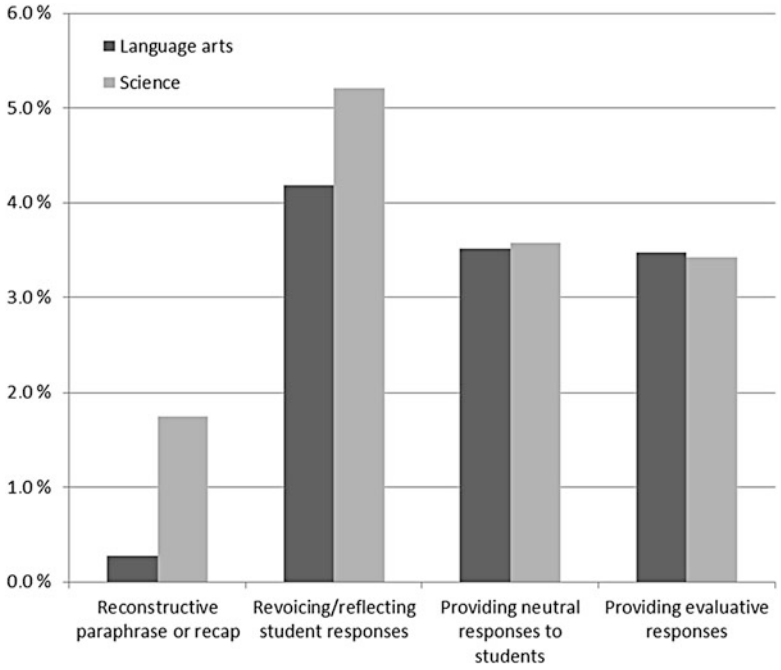

Fig. 5.2 Percentage of time spent on different types of teacher responses during whole class instruction in science and language arts

Excerpt 6

1. Teacher: Is it something that you would like to bring up?
2. Student: The care of the animals.
3. Teacher: The animals, care of the animals, mmm. Yes.
4. Student: Harvesting.
5. Teacher: Harvesting. Is it the flax you thought about then or other things as well?
6. Student: Both.
7. Teacher: Both yes.

When a teacher is revoicing or reflecting on a student's response, he or she repeats what the student has said without changing or altering the meaning of the statement. As we can see from this excerpt, the teacher is revoicing the students' contributions for every new answer she gets. Sometimes the teacher revoices or repeats the student's statement in a question-style format to clarify what the student means, such as in line 5 where she wants to determine exactly what the student was thinking about. Or she simply repeats verbatim what the student has said, as shown in lines 3 and 7. However, the teacher also confirms that the students' answers are correct, so she is not only revoicing the students, but also providing evaluative responses.

5.7.2 Providing Neutral Responses to Students

Another frequent teacher response is 'providing neutral responses to students'. The science and language arts teachers in our analysis spent about the same amount of time on this response. When providing a neutral response the teacher repeats the students' comments or provides a comment that does not suggest whether the students' statements are correct or incorrect. The first excerpt below is from a language arts lesson, where the students are discussing a text they have read in preparation for a visit from the author of the text.

Excerpt 7

1. Teacher: Do boys talk together about love stuff and girls?
2. Student: Yes.
3. Teacher: Ok, they do, but do they talk about everything then, like that girls are a little bit weird and so on, as he says here or? (Refers to the text)
4. Student: In a way.
5. Teacher: In a way they do.

Here the teacher starts with an open question and after a short "yes" from the student, she elaborates on the student's answer by referring to the text. In the last line, the teacher revoices the student's answer.

This next excerpt is from a science lesson, involving the same teacher as in Excerpt 5, but from a different lesson. They are still discussing tobacco and smoking.

Excerpt 8

1. Student: Are there many tobacco factories in Norway?
2. Teacher: That is a clever question because at least we have Tiedemann's Tobacco factory; it is the one with the fox, and I think it just closed. I assume that tobacco factories still exist in Norway; in general, I think they get the tobacco plant delivered from other places, but they make the brands and mix the tobacco here and what they put in it one can only imagine.

This sequence starts with a question from a student, and the teacher replies to the question by providing a comment. The teacher's response does not indicate whether the student's question is valid or invalid, since the teacher only gives the student a neutral response to the question that is asked.

5.7.3 Providing Evaluative Responses

The response type 'providing evaluative responses' is used to the same extent in science and language arts classrooms, and for the same amount of time as the previous response in both subjects. When the teacher provides evaluative responses to students, they can both confirm and refute what the students have said. The following excerpt is from a language arts lesson, which focused on how to write a text.

Excerpt 9

1. Teacher: What is it that all texts, no matter if you write a story or a chronicle, as you did in the spring or another type of text – what is it that all texts consist of, what parts do we find in all texts?
2. Student: Introduction, body, and conclusion.
3. Teacher: Yes, those are the large parts, and we know that it involves either our imagination as in the case of a story, or our thoughts and opinions, as in the case of a chronicle, an argumentative text. Whatever we try to write about, we have to divide our thoughts a bit .... We also divide it into some larger parts, as in this text. What do we call that?
4. Student: Sections.
5. Teacher: Sections and this is important.

As shown in line 3, the teacher provides the students with a confirmative response, but she also clearly searches for another answer that is more specific. The teacher receives the answer she is looking for in line 4, namely "sections", and in line 5 the teacher revoices the student, but also clearly indicates that this is correct by underscoring that it is important.

5.7.4 Reconstructive Paraphrase or Recap

As shown in Fig. 5.2, 'reconstructive paraphrase or recap' is the least used response type to students' utterances in both the science and language arts classrooms. However, this response is more common in the science classrooms than in the language arts classrooms. The following excerpt from a science lesson, talking about the ecosystem, may illustrate this:

Excerpt 10

1. Teacher: Can anyone give me an example of things that are not alive that are of significance for the ecosystem?
2. Student 1: Soil.
3. Teacher: Soil, yes! I will write topsoil as that is what we often call it. Yes?
4. Student 2: Water.
5. Teacher: Ok, should we say landscape? Then it covers whether it is by the water, a mountain peak, a valley, in a sunny side and so on. Landscape embraces much more.
6. Teacher: Anyone else have an example?
7. Student 3: Air.
8. Teacher: Yes, should we say climate, since it is about the air around?

In this response pattern the teacher alters the original statement of the student to a more acceptable form and preferred language. This most commonly occurs when the teacher is asking for something, but has already decided the kind of answer that he or she wants. As we can see, the teacher is asking the students open questions;

however, she is not satisfied with the students' answers, and alters them into her preferred language and conceptual format.

In summary, there is a difference between science and language arts teachers in the way that they ask questions, but the difference between the subjects is not as distinct when we analyse how teachers respond to students' answers.

5.8 Discussion

The basic purpose of these analyses has been to investigate if there is a difference in the way that teachers ask questions and give responses to students between the two, rather different, school subjects of science and language arts. As summarised in the theory section above, teachers use questions as one of their most frequent instructional tools, despite the fact that questions can serve different functions and purposes. We were interested in the role of 'dialogic' and 'authoritative' questions and responses in the two subject areas and possible patterns and differences. Our analyses indicate that a great deal of time is spent on question–answer exchanges in both subject areas; however, these exchanges differ between the two subjects, especially with regard to patterns of teacher questioning.

The findings suggest that the language arts teachers spend more time on asking 'real' or open questions than their science colleagues. The science teachers, on the other hand, spend more time on sequences of repeated questions; this can indicate that the science teachers are more concerned with getting a correct answer from the students. In both subjects the teachers in our analysis spent quite a lot of time on cued elicitations; however, in language arts this result is largely dependent on one lesson where the teacher spent six minutes on this code, compared to the average of one minute in the other nine lessons. In science the time spend on cued elicitations was more equally divided between the lessons.

Like Mortimer and Scott (2003) and Furtak and Shavelson (2009), we argue that questions asked in a more authoritative way can be of great importance to students' learning. As such, the dilemma is *how* teachers combine these different question types in order to involve the students in the classroom conversation, rather than privileging one specific question style. Teachers need to use questions to test students' understanding, as well as to involve the students in the classroom conversation and/or focus on or emphasise a particular phenomenon. We will argue that teacher questions serve many purposes, and teachers need all question types in their toolkit when trying to stimulate discourse, engagement and participation in classroom conversations. With this in mind, we discuss our findings in more detail below.

As shown in the theory section, one of the reasons why more time is spent on asking open questions in the language arts classrooms may be that the teachers are working with a lot of different types of texts and text genres as a main topic in these classrooms. This provides an opportunity for competing interpretations, which introduce different perspectives and views, including personal impressions

and interpretations of the text. The working methods of science, i.e. the nature of science and inquiry, however, stress critical reflection and argumentation, although it may seem that the teachers in science classrooms are more focused on checking the students' knowledge and asking for specific conceptual terms. Osborne and Patterson (2011) stress the importance of students being able to separate between explanation and argumentation, and claim that students are often not trained in this as part of their science education. One of the reasons, they argue, may be that the construction of knowledge is given priority over the costs of argumentation and critical reflection. Another reason for less time being spent on asking 'real' or open questions in the science classrooms might be the topic covered; the topics covered in our data were 'the ecosystem', 'smoking, drugs and the human body' and 'pollution/organic farming', all themes which require factual knowledge and which might provide less opportunity for interpretation and personal thoughts. It is not possible for us to establish whether our science teachers are restricted by the textbooks or the existing teaching traditions. However, one could assume that they are influenced by both; and, this would also apply to the language arts teachers who tend to ask more open questions.

This argument is also corroborated with findings from one lesson in language arts that had grammar as a topic. This lesson had fewer open questions and more of an authoritative questioning pattern; hence, the differences between science and language arts may be linked to the topics that are being taught and discussed, as well as differences in teaching traditions. The language arts lessons in Norway have a tradition of emphasising students' interpretations of text and text genres in this subject. The PISA results from Norway in reading, for example, show that the students (and especially girls) do well in reading assignments when they are asked to interpret and think about the meaning of the text, especially for fiction and literary texts (Roe 2010).

This is not necessarily the case in science. In the results from the science tests in the PISA 2006 survey, three different competency areas were emphasised, the third of which was 'to be able to use scientific evidence'. Norwegian students clearly lacked competence in scientific argumentation. This may be linked to the fact that their science teachers ask quite a lot of closed questions that require a specific, predetermined answer, so that students do not have an opportunity to develop their own reasoning and to actually test out their thoughts using scientific evidence (Kjærnsli et al. 2007). This is also in line with Osborne and Patterson's (2011) argument that the construction of knowledge seems to be given priority over the value of learning to argue.

According to Alexander (2008), students are frequently encouraged to provide extended answers. Alexander also argues that these answers are seldom responded to in a way that helps the students to move forward in their learning. In our study, the teachers' responses to the students were to a large extent dialogical, meaning that they either 'reflected or revoiced the students answers', and/or provided them with 'neutral responses'. The response type 'reconstructive paraphrase or recap'

was seldom used by our teachers. Scholars agree that, in order to be productive for students' learning, teachers' responses should build and/or elaborate on the students' answers, and not only evaluate the students' answers by restating and/or revoicing their arguments. Teachers' careful use of reconstructive paraphrase in combination with their capacity to explain why something is right or wrong, can provide competing perspectives and voices. This kind of teacher response has proven to stimulate student engagement and student participation during whole class conversations (Alexander 2000; Alpert 1987; Emanuelsson and Sahlström 2008; Nystrand et al. 1997; Stein et al. 2007). These teachers are not simply accepting the answer from the students, thereby putting a possible dialogue to rest; rather, they engage with the students around the answer and prolong the possible dialogue (Juzwik et al. 2008).

Our analyses indicate that teachers' responses during whole class discussion are, to a fairly large extent, dialogic, thus providing opportunities for dialogue and student engagement. A side effect of this may be that student participation in dialogues reduces their ability to acquire the content matter involved, thus privileging participation (Emanuelsson and Sahlström 2008) over academic clarification. Chin (2007) argues that teachers who focus more on dialogue want to find out what students think, and encourage them to elaborate on their previous answers and ideas.

5.9 Conclusions

Our results indicate that there is a difference in the way teachers question students between the two subjects of science and language arts. These differences may be due to a range of reasons, as we have proposed in our discussion. One of the reasons may be the different teaching traditions between these two subject areas as school subjects. On the other hand, it may be that the topics discussed in these lessons were quite different – the language arts topics were more open to interpretation, and the topics in the science lessons were more factual. However, this might be a little simplistic. It is most likely that a combination of the teaching tradition of the subjects and the topic in focus regulates the type of conversations and teacher questions in these subject lessons. These differences might appear in this way in this study because we have analysed whole class teaching, and they might present differently in an analysis of individual and/or group work. It may also be that these differences become more distinct during whole class sessions, and might not be as prominent during other instructional formats such as individual seatwork and group work.

As we have discussed in this chapter, questions can be used in a range of different ways and for different purposes. Most important for teachers to consider, however, is how to make use of the different questions and responses in order to facilitate students' classroom participation and contribute to student learning.

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