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Discourse Patterns and Communicative Approaches for Teaching Nature of Science

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Abstract

This study aims to determine discourse patterns and communicative approaches utilised for teaching the nature of science (NOS) using an explicit–reflective approach. This study was conducted as part of a research project aiming to support teachers' classroom practices through a long-term professional development program focusing on teaching NOS. Discourse analysis was used to determine classroom discourse patterns and communicative approaches. Audio and video recordings of classroom lectures conducted by 8 of the 22 teachers participating in the project were used for analysis. A total of 505 minutes of teacher–student dialogue was recorded and subsequently analysed. The results indicated that teachers used three different discourse patterns (triadic, chain, and adjacency pair) and three different communicative approaches (*interactive–dialogic*, *interactive–authoritative*, and *non-interactive–dialogic*) for teaching NOS using the explicit–reflective approach. The most common discourse pattern was the triadic pattern (*initiation–response–evaluation*), and the *interactive–authoritative* approach was the most common communicative approach. These findings contribute to the literature in terms of increasing the efficiency of using the explicit–reflective approach by considering classroom discourse to teach students NOS.

Keywords

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Introduction

One of the main aims of contemporary science education is to provide training in scientific literacy for individuals (Next Generation Science Standards [NGSS], 2013; Milli Eğitim Bakanlığı [MEB], 2013). Achieving this aim entails an increasing necessity for individuals to develop a contemporary perspective on the nature of science (NOS) (Allchin, 2011; Cakmakci & Yalaki, 2012; McComas, Clough, & Almazroa, 2000). The extant literature recommends strategies such as explicit–reflective, implicit, and

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historical approaches to provide a contemporary perspective on NOS (Lederman, 2007). However, it is necessary for teachers to possess and apply the specific, essential knowledge and skills in organising qualified classroom environments to ensure that these strategies achieve the aims (Akerson, Buck, Donnelly, Nargund, & Weiland, 2011; Lederman, 2007). Research conducted in this area has revealed that though teachers have informed ideas about NOS, they not demonstrate the use of these aspects in the classroom (Lederman, 1999; Zeidler & Lederman, 1989). The results obtained illustrate that teacher–student communication in the classroom needs to be examined with regards to issues relating to NOS (Herman, Clough, & Olson, 2013). In this context, this study aims to ascertain the discourse patterns and communicative approaches used by science teachers for teaching NOS by analysing discourses.

The phrase NOS, usually used to refer to 'the epistemology and sociology of science, science as a way of knowing, or the values and beliefs inherent to scientific knowledge and its development' (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002, p. 498). One of the most detailed descriptions regarding this issue was outlined by McComas et al. (2000):

> The nature of science is a fertile hybrid arena which blends aspects of various social studies of science including the history, sociology, and philosophy of science combined with research from the cognitive sciences such as psychology, into a rich description of what science is, how it works, how scientists operate as a social group and how society itself both directs and reacts to scientific endeavours. (p. 4)

Several researchers have suggested that an *explicit–reflective* approach is more effective than an *implicit* and *historical* approach among the strategies used to teach NOS (Khishfe & Abd-El-Khalick, 2002). The explicit–reflective approach advocates that features of NOS should be taught directly via discussions held during or at the end of activities as opposed to implicit learning (Akerson, Abd-El-Khalick, & Lederman, 2000; Lederman et al., 2002; Schwartz, Lederman & Crawford, 2004; Lederman, 2007). The implicit approach assumes that simply participating in science-related activities will engender comprehension of NOS and scientific research principles. It is expected that teachers and students can learn NOS via scientific practices and participating in scientific activities (Abd-El-Khalick & Lederman, 2000). In this approach, it is assumed that the learner can obtain a general understanding of the features of NOS via results revealed by conducting research (McComas, 1996; Schwartz et al., 2004). The historical approach aims to develop individuals' concepts on NOS by focusing on the impact of science and the production of scientific ideas from a social and historical perspective (McComas & Olson, 2000). Science educators investigating the use of an explicit–reflective approach have determined that prior to practicing this approach, a majority of the participants possessed insufficient knowledge of many features of NOS. However, after such practice, informed viewpoints had positively developed in both teachers and students. (Akerson et al., 2000; Cakmakci, 2012; Kaya, 2011). In addition, it was observed that authentic-context learning activities were more effective in generating understanding than generic learning activities (Cakmakci, 2012; Duschl & Grandy, 2013; Schwartz et al., 2004). However, teachers' roles and ability to communicate with students as well as teacher support and teacher feedback systems are important factors in achieving this outcome (Herman et al., 2013).

The extant literature includes many descriptive studies in which teachers' and students' opinions regarding NOS were obtained in terms of creating contemporary viewpoints (İrez, 2006; Köseoğlu, Tümay, & Budak, 2008; Lederman, 1992; Moss, Abramsand, & Robb, 2001). Quasi-experimental studies have also been conducted, in which various strategies were applied (Abd-El-Khalick, 2002; Akerson et al., 2000; Cakmakci, 2012; Kaya, 2011; Schwartz & Lederman, 2002). However, on examining the extant literature, the lack of studies investigating dialogue in classrooms becomes apparent (Lederman, 2007). Focusing on teacher–student dialogue in the classroom distinguishes this study from others, and it is deemed that the study will fill this particular gap in the field, as it considers that discourse and communicative approaches, which are used by teacher, are factors that directly affect the quality of the course (Lemke, 1990; Seedhouse, 2004; Walsh, 2006). *Classroom discourse patterns* developed by Sinclair and Coulthard (1975) and *communicative approaches* developed by Mortimer and Scott (2003) constitute the conceptual framework of this study. An examination of the existing literature

reveals the inadequacy of information regarding the application of the explicit–reflective approach in the classroom as well as of records of teacher–student dialogue when using this approach (Lederman, 2007). Thus, this type of analysis and the subsequent findings will contribute to the existing literature in terms of providing a more effective use of the explicit–reflective approach in NOS teaching.

Discourse and Discourse Patterns

Currently, discourse analysis is considered both methodological and conceptual and is used as a framework in many disciplines. In the most simple and general terms, discourse is defined as *language-in-use* (Cazden, 2001; Kelly & Crawford, 1997; Walsh, 2006). However, this definition is mainly found in applied linguistics research (Rymes, 2008), and the lack of context makes this an inadequate definition of discourse in terms of scientific application. According to Phillips and Jorgensen (2002), though discourse is used in several, different areas, its common purpose is the language—that is, the different structured patterns in people's conversations in various areas of social life (e.g. medical discourse, political discourse). Discourse analysis is the analysis of these patterns. On the basis of the literature reviewed, in this study, discourse is the language used in context (in this case, the classroom) and discourse analysis is used to determine how the language interacts with that context.

Discourse analysis is important in terms of contributing to restructuring the educational environment and defining phenomena in the classroom (Cazden, 2001; Rymes, 2008). As the study of science is a social process (Lemke, 1990), the interaction between individuals is the most important factor. If this particular social environment is the classroom, then the interaction between 'teacher and student' and 'student and student' is the most important factor in the process of learning. Lemke mentions that teachers play a significant role in being able to talk *the language of science* in the classroom and how a teacher applies discourse is formative by its virtue of being scientific conversation. Studies that examine the interaction of teachers and students in the classroom classify this process according to different discourse patterns.

Classroom discourse is expressed as a triadic dialogue, which follows *question–answer–evaluation* as described by Lemke (1990), *initiation–response–evaluation* given by Cazden (2001) and *initiation–response–follow up* posited by Sinclair and Coulthard (1975). This basic structure has been utilised up to the present day. Scientists such as Scott, Mortimer, and Aguiar (2006) state that this process sometimes demonstrates a *Chain* structure following the pattern *initiation–response–feedback–response–feedback.* Distinct from these patterns is the *adjacency pair pattern* (Schegloff, 1978), which is reflected as an *initiation–response* pattern in conversation analysis studies.

Communicative Approaches

Apart from discourse patterns, the communicative approaches constituting the conceptual framework of this study are based on classroom interaction models. These models focus on the interactions between teachers and students and can occur in different ways in the classroom setting (Mortimer & Scott, 2003). These communicative models examine the kinds of approaches teachers use to develop students' opinions in the classroom. Developed by Mortimer and Scott (2003), these communicative approaches comprise two dimensions that stem from the conversation between teachers and students. The first dimension comprises *dialogic and authoritative* conversations, and the second dimension comprises *interactive and non-interactive* conversations. When teachers encourage students to produce an idea, there are two approaches taken. The first approach is the dialogic approach, and the second is the authoritative approach. These two approaches constitute a matrix in which they interact with themselves, as shown in Figure 1.

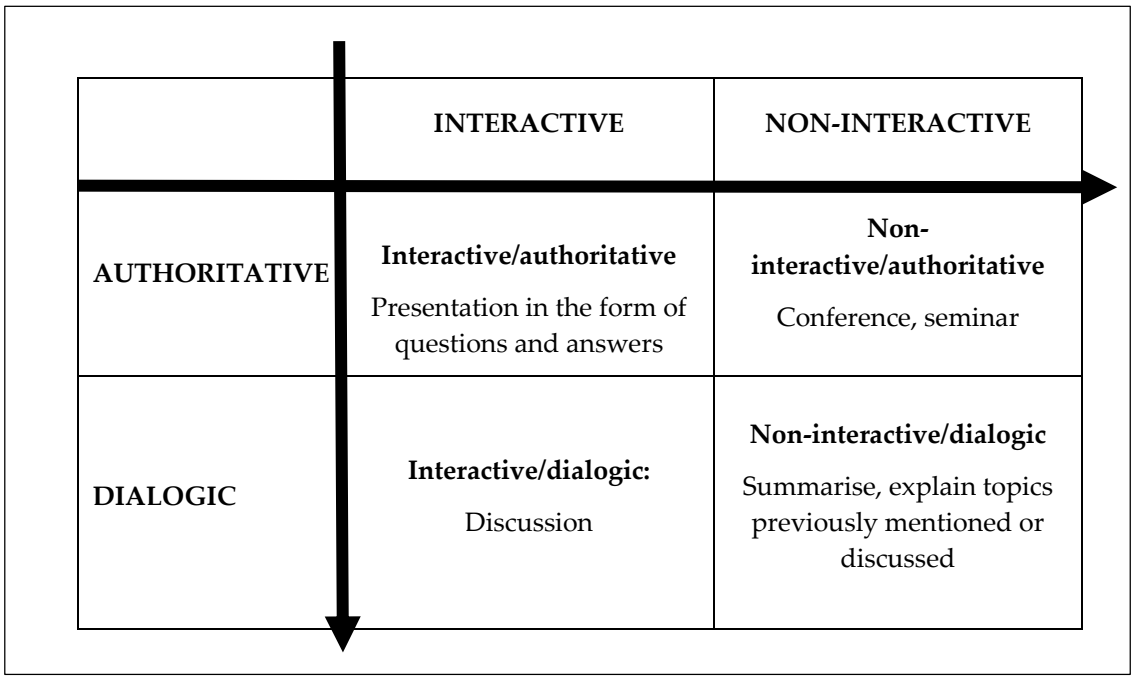

Figure 1. Different Communicative Approaches (Mortimer & Scott, 2003, p. 35)

When teachers are instructing students regarding NOS, they use various patterns. Using ongoing professional development programs to improve teachers' awareness of these patterns will increase the quality of classroom practices in terms of teaching NOS.

When the necessary communication techniques and support are utilised by teachers who possess adequate knowledge regarding NOS, it has been found that students' opinions improve on the topic (Akerson & Hanuscin, 2007; Posnanski, 2010).

Method

This study was conducted as part of a research project pursuing teacher support with regards to their professional development in terms of teaching NOS. The project was funded by Scientific and Technological Research Council of Turkey (TUBITAK) and aims to provide support to science teachers with regards to classroom practices by organising long-term professional development programmes on teaching some NOS themes (BİDOMEG, 2015). The main aim of this paper is to determine the classroom discourse patterns and communicative approaches used by teachers in relation to NOS. This paper only focuses on that aim. Using discourse analysis, this research aims to identify the patterns of discourse and communicative approaches used by science teachers for teaching NOS. Teachers' lessons, selected from among participant groups, were used as case studies for discourse analysis. The lessons of eight teachers who completed four or more data recordings were used as case studies. It should be noted that" as for discourse analysis studies, a minimum of four or five different lesson recordings per teacher is recommended (e.g., Cazden, 2001; Liddicoat, 2007; Walsh, 2006, 2011).

After teachers were provided training on NOS topics within the scope of the project, they were then asked to implement the activities integrated the activities into the current curriculum. Materials were developed in accordance with the feedback provided by teachers from 10 different workshops, which were held at least once per month. In addition, teachers' pedagogical developments were supported by the application of different contexts. One of these workshops concerned on discourse patterns, which constitutes the conceptual framework of this study along with the communicative approaches developed by Mortimer and Scott (2003). Discourse patterns and communicative approaches were taught based on both theoretical reports and case study videos from the project.

Participants

A total of 22 teachers participated in the research project, and eight science teachers constituted the working group of the study. As mentioned earlier, these eight teachers provided an adequate number of videos (20 hours long video) for performing the appropriate analyses. All participants work as science teachers in Bolu city or in the surrounding areas. Five teachers of the participant have worked for 5 or 10 years as a science teacher and remained participant has worked for 10 years or over. Furthermore, three of them have continued their postgraduate education. Some of the teachers had already attended courses/seminars on NOS, whereas others were experiencing NOS training for the first time. All of the teachers who constituted the participant groups of the research had attended all 10 project workshops (a total of 75 hours) over a period of eight months. In addition, they had applied activities that were designed using the explicit–reflective approach for secondary school science level. These teachers contributed extensively to the study by providing important feedback that enabled activities to be developed and updated in the process.

Data Collection Tools and Their Analysis

As mentioned above, the main data sources were video recordings of lessons wherein the teachers implemented NOS activities. Classroom video recordings that were used for data collection were also used as part of the continuing professional development training. These video recordings were subjected to discourse analysis using a qualitative data analysis software package—NVivo 10. In these videos, certain conversations between the teachers and the students were selected and subjected to orthographic transcription. Walsh (2006) named this style of data collection *snapshot recordings* in accordance with discourse patterns. Thus, percentages and analyses were derived from sections of teacher–student dialogue rather than the entire lesson. The length of each teacher's dialogue was assessed along with the discourse patterns and communicative approaches used. Proportioning was utilised to reveal the total overall time of these calculations.

After completing the orthographic transcription, conversations were re-read with the video images and were coded over the top of the existing codes. Coding was done by another researcher to ensure the credibility of the data. When the percentage of compliance was examined between the two codes, a ratio of 83% was found. A common coding was decided upon by discussing and comparing the differing codes. This process was compared with similar cases in the literature by examining any mutual incompatibility. In addition, examples taken from Mortimer and Scott (2003) compared the coding by forming patterns. Analyses were completed with comparisons to these documents.

Results

In this section, findings relating to discourse patterns, communicative approaches and changes noted in the process are listed under separate headings.

Discourse Patterns

Three different discourse patterns seemed to occur in the interactions between teachers and students during NOS teaching. The most observed pattern was *initiation–response–evaluation* (I–R–E) in the form of a *triadic* pattern (Lemke, 1990). Triadic pattern were noted as the most frequently used discourse pattern as a percentage in the lessons of five of the eight participating teachers (Table 1). *Chain* pattern, in the form of *initiation–response–feedback–response–feedback*, was the next most frequently used pattern (Mortimer & Scott, 2003); however, two participants identified this pattern as the most frequently used pattern. In addition, adjacency pair, in the form of *initiation–response*, was the least common pattern (Schegloff, 1978). Percentages of teachers' use of these patterns are shown in Table 1.

Table 1. Percentage of Discourse Patterns Usage by Teachers

Teacher (Time analysed with instant records)	Discourse Patterns (%)		
	Adjacency Pairs (I–R)	Triadic (I–R–E)	Chain (I–R–F–R–F)
Teacher-1 (40 minutes)	-	70	30
Teacher-2 (65) minutes)	11	77	22
Teacher-3 (50 minutes)	26	50	24
Teacher-4 (70 minutes)	-	32	68
Teacher-5 (55 minutes)	15	57	27
Teacher-6 (75 minutes)	23	73	4
Teacher-7 (88 minutes)	8	45	47
Teacher-8 (64 minutes)	10	30	60

Triadic (I–R–E) Pattern

According to the findings, the ***initiation–response–evaluation (I–R–E)*** discourse pattern was used in students' dialogue in relation to teachers' NOS lessons (Table 1). Few conversations that enabled mutual discussions or asking questions by students were observed. Examples of triadic dialogue between teachers and students are provided in Table 2.

Table 2. Examples of Triadic Discourse Pattern Dialogue

Turn	Speaker		Pattern's notions
1.	Teacher-1	Were opinions about the different important environmental problems included in our discussion?	Initiation
2.	Ayşe	They were included.	Response
3.	Teacher-1	Here, your friends discussed air pollution, water pollution, global warming, biodiversity loss, and forest fires. All of them put forward different opinions, didn't they? Well, what are the possible reasons for the different opinions? … Why are they different?	Evaluation/ Initiation
4.	Seda	Due to the environment in which they live.	Response
5.	Teacher-1	The environment in which they live also affects scientists, doesn't it? What is the other factors affecting the presentation of different views by scientists?	Evaluation/ Initiation
6.	Nisa	Their knowledge and experience.	Response
7.	Murat	Their beliefs and cultural activities.	Response
8.	Teacher-1	Yes. If scientists were wanted to do this sort by us, would they make different sorts like you?	Evaluation/ Initiation
9.	Students	Yes.	Response
10.	Teacher-1	They do, don't they? We watch it on TV. They often talk about global warming, don't they? Different scientists are proposing different ideas.	Evaluation

It was observed that teachers used display questions in the discourses, which took the form of the triple cycle. Teachers asked some questions—such as 'Were opinions about the different important environmental problems included in our discussion?' (turn 1) and 'What are the other factors affecting the presentation of different views by scientists?' (turn 5)—to assess students' knowledge of NOS and whether learning is in fact occurring. Moreover, the accuracy of answers is determined by the teacher (turns 3 and 8). In the triadic pattern, the length of conversations and sentences by teachers was observed to be longer than those of students (turns 1, 3, 5, 8 and 10). In contrast, students gave short answers and did not offer explanations (turns 2, 4, 6, 7 and 9).

Chain Pattern

Another pattern obtained from analysis is the chain pattern, which takes the form of *initiation–response–feedback–response–feedback* and offers a more discussion-oriented environment (Mortimer & Scott, 2003) (Table 1). There was dialogue concerning some NOS themes, and the scientific studies guided by teachers are shown in Table 3, which illustrates a chain discourse pattern. Students are observed to be more involved and central than in previous patterns (turn 2, 5, 7, 9 and 12), and the teacher incorporated the given answers in the discussion (turns 6 and 13).

Table 3. Sample Dialog of Chain Pattern

Turn	Speaker		Pattern's notions
1.	Teacher-3	Well, what is a scientist's motivation to undertake new research? Why do they conduct new research?	Initiation
2.	Leyla	To learn something new.	Response
3.	Arif	To meet our requirements.	Response
4.	Teacher-3	Can you give an example?	Feedback

Table 3. Continue

Turn	Speaker		Pattern's notions
5.	Arif	The telephone did not exist earlier. Earlier, for instance, if there was an accident somewhere and you sent a letter, it may not have arrived for months. After that, the telephone was invented…	Response
6.	Teacher-3	Are you saying that scientists invented the telephone?	Feedback
7.	Arif	Yes.	Response
8.	Teacher-3	Could someone else answer? Why do they conduct new research?	Feedback
9.	Hasan	Because they are keen on it.	Response
10.	Sinem	They are open to improvement.	Response
11.	Teacher-3	Do scientists struggle to prove their theories when they generate scientific knowledge? What do they do to prove it to others?	Initiation
12.	Veli	They search for evidence	Response
13.	Teacher-3	Is evidence important?	Feedback
14.	Ahmet	They conduct an experiment.	Response
15.	Selin	Observation.	Response
16.	Teacher-3	They conduct an experiment, make investigations and collect evidence. They collect evidence and show others; they state that 'this is my evidence'.	Evaluation

As seen in the example of the dialogue presented in Table 3, the teacher initiated the discussion as a triadic pattern; however, the teacher did not evaluate students' answers but redirected the question to another student (turn 3). Subsequently, the teacher asked about a student's answer (turn 6), or in other circumstances, the teacher used students' contribution to paraphrase (Seedhouse, 2004) to help the students understand an answer by a student (turn 6). It was observed that teachers usually use chain discourse patterns at the beginning of a lesson but revert to a triadic pattern, especially in the elaboration process during lessons.

Adjacency Pairs Pattern (I-R)

Adjacency pairs, which comprise *initiation–response* and do not involve feedback or evaluation, are parallel with the *question–answer* format by Lemke (1990). In terms of discourse patterns, this pattern was the least observed. Only two teachers of in our participant have used this pattern (Table 1). In this pattern, teachers ask questions about NOS without any evaluation or feedback and students provided responses as seen in Table 4.

Table 4. Sample Dialogue of Adjacency Pair Pattern

Turn	Speaker		Pattern's notions
1.	Teacher-5	Are models used in science?	Initiation
2.	Ayşe	Yes	Response
3.	Teacher-5	Could you give an example of these models that we use in science?	Initiation
4.	Ali	For instance, we use these models in schools; my teacher uses them.	Response
5.	Teacher-5	Which science units do we use?	Initiation
6.	Can	We were using a skeleton to understand the muscular system. Last year, we used a flower model to understand the development of plants and their reproduction and growth. This year, we used a model for sense organs as well.	Response

Table 4. Continue

Turn	Speaker		Pattern's notions
7.	Teacher-5	Why do we use models? What will happen if they are not used?	Initiation
8.	Can	To teach.	Response
9.	Teacher-5	Then, what they do? Are they simplifying our work?	Initiation
10.	Levent	My teachers add visualisation.	Response

The discussion on scientific models began with the question 'Are models used in science?', which was subsequently answered by a student (turn 2). After this stage, the teacher changed the context with a new question (turn 3). The teacher used a new initiation pattern instead of obtaining feedback by changing pedagogical focus from one question to another. Another student responded to the second question (turn 4), and the teacher then narrowed the discussion to using scientific models in science lessons. The whole conversation proceeded in a *question–answer* discourse pattern. In this pattern, the teacher can change the topic (Liddicoat, 2007) constantly, and it was observed as a pattern of discourse used by teachers.

Communicative Approach

The communicative approaches used by teachers in the project—which forms an important part of classroom discourse analysis—are presented in Table 5. As shown in Table 5, *interactive–authoritative* is the most used approach, which is one of the four different communicative approaches, developed by Mortimer and Scott (2003). *Interactive–dialogic*, another discourse pattern, was the most preferred approach for two of the teachers. The *interactive–dialogic* pattern ranked second among the preferred communicative approaches for all—excluding two—teachers (Table 5).

Table 5. Percentages of Communicative Approaches and Patterns from Participants

Teachers (Snapshot recording time)	Communicative Approach (%)			
	Interactive–Authoritative	Non-Interactive–Authoritative	Non-interactive–Dialogic	Interactive–Dialogic
Teacher-1 (40 sec)	58	14	-	28
Teacher-2 (65 sec)	73	9	-	18
Teacher-3 (50 sec)	70	11	-	19
Teacher-4 (70 sec)	42	-	-	58
Teacher-5 (55 sec)	42	11	-	47
Teacher-6 (75 sec)	20	7		73
Teacher-7 (88 sec)	55	-	-	45
Teacher-8 (64 sec)	55	5	-	40

The *non-interactive-dialogic* approach was not used by participants during discussions of NOS. Moreover, teachers used a *non-interactive–dialogic* approach in some stage of the lessons as seen in Table 5.

Interactive–Authoritative Communicative Approach

During the dialogue, teachers were observed to use this pattern to find out information relevant to the aspects of NOS. The teacher's role in this process was as follows: ask a question, moderate the dialogue and nominate students to contribute. As shown in Table 6, an example of a snapshot recording provides evidence based on scientific knowledge.

Table 6. Sample Dialog of *Interactive–Authoritative* Communicative Approach

Turn	Speaker		Pattern's notions
1.	Teacher-5	What evidence did scientists have when they had theorised about the flatness of the earth? How did they prove their claims and have people accept them? They showed evidence to people, didn't they?	Initiation
2.	Students	Yes (Loud)	Response
3.	Teacher-5	What did they show?	Initiation
4.	Oğuzhan	Teacher, a man claimed that the earth was not flat but circular, and people said that he was insane and tried to kill him.	Response
5.	Teacher-5	Yes, they believed in the flatness of the world so much that if someone did not accept it, they would say that he/she was insane. But, there is also an environmental effect. You carried the discussion one step further; that is a different topic. Let's focus on evidence about our research.	Evaluation/ Initiation
6.	Merve	We first see the mast of a ship coming towards us, then the rest of the ship slowly becomes visible.	Response
7.	Teacher-5	Yes, you right and we will discuss this further. First, I want to discuss some evidence about the flatness of the earth.	Evaluation / Initiation
8.	Metin	Teacher, in the past, one man thought differently, but before him, everybody thought that the earth was flat.	Response
9.	Teacher-5	Well. I also want some evidence that would show this claim as well.	Feedback
10.	Metin	Teacher, when they were walking, the surface seemed flat everywhere.	Response
11.	Teacher-5	Anything else?	Feedback
12.	Mustafa	Teacher, there was a man named Magellan. He and his friends attempted to sail around the world. Magellan died, but his friends continued the journey and arrived back at the beginning point.	Response
13.	Teacher-5	Well, everyone said that the earth was flat, but Magellan's friends did not drop from the earth. This is an evidence that the earth is round.	Evaluation

The teacher started the teacher–student dialogue presented in Table 6; turn 1 shows that the teacher selected the content. The teacher wanted to start a discussion on how scientists seek evidence when conducting research; further, in turn 3, she asked a question to direct the pedagogical focus. However, the students continued to focus on the flatness of the earth as the subject, and she responded in that respect (turn 4). Next, the teacher evaluated the student's response and redirected the focus by saying, '… there was also an environmental effect. You carried the discussion one step further; that is a different topic. Let's focus on evidence'. This indicates that she wanted the student to focus on the content matter at hand. Another student, when given a turn by the teacher, provided a different answer: 'We first see the mast of a ship coming towards us, then the rest of the ship is slowly visible'. The teacher noticeably did not expect this answer; however, the response shows that the teacher is open to interaction but manages the discussion with an authoritative structure during this lesson by redirecting the focus of the discussion. In some parts of the dialogue, students provided answers that were unexpected. During the dialogue, the teacher regularly reformulated the questions to determine the

direction of the discussion (turns 5, 7, 9). The teacher managed the discussion to ensure that it followed a particular predetermined structure, as shown through the responses in turns 5 and 7.

Interactive and Dialogic Communicative Approach

This approach was not as dominate as authoritative approaches, but after completing the analysis, it was noted that this approach is used during some NOS teaching (Table 5). This approach differs from previous patterns of discussion, as the teacher responded to the students' contributions (Table 7).

Table 7. Sample Dialogue of *Interactive–Dialogic* Communicative Approach

Turn	Speaker		Pattern's notions
1.	Teacher-4	… Let's make interpretations relating to the food habits of the child in the first picture. What does his daily nutrition look like?	Initiation
2.	Seda	Mostly, he eats fatty foods.	Respond
3.	Teacher-4	He may be eating mostly fatty foods; we can interpret the picture in that sense.	Evaluation
4.	Emre	He consumes too many oily foods, which is bad for his health.	Respond
5.	Teacher-4	You said too many. Anything else?	Feedback
6.	Emre	He consumes a lot of unhealthy and fatty food.	Respond
7.	Teacher-4	Are there any different ideas?	Feedback
8.	Students	(No answers)	
9.	Teacher-4	You described what you saw in the picture. It was an observation, wasn't it? Now, I want you to make inferences on daily life. You don't have to write what you saw in the picture. Yes, Didem.	Initiation
10.	Didem	The child consumes fatty foods and fizzy drinks.	Respond
11.	Teacher-4	(Teacher completes students' contribution with him) … drinks. Well, is it an inference if I say that? Can I make an inference like that if I saw chips in his hands?	Initiation
12.	Teacher-4	This person likes junk food.	Respond
13.	Seda	A lot.	Respond
14.	Teacher-4	I don't know whether he likes it or not. I cannot make out whether he likes it or not, but he eats it.	Evaluation
15.	Seda	Well then, how is he eating?	Initiation
16.	Selim	Teacher, I think this child suffers from malnutrition.	Respond
17.	Teacher-4	We say he is malnourished in terms of what we see in the picture, true?	Evaluation

From the table above, the teacher selected content relevant to the laws of observation and inference in science and analyses the subject along with her students (turn 1). After asking a question, the teacher did not evaluate students' answers but provided the opportunity for another student to respond (turns 3, 5 and 7). Similarly, the teacher repeated students' responses, and then, the discussion was reformed (turns 11 and 13). Such repetition by the teacher is referred to as 'teacher echo' (Walsh, 2006). The teacher usually asked a question (turns 1 and 11) but did not conduct the evaluation directly in the discussion. Therefore, the evaluation of this conversation is that it is a NOS dialogue whereby the teacher does not use her authority. Moreover, one student contributes by asking a question (turn 15).

Non-interactive–authoritative Communicative Approach

This communicative approach was noted to be either not used or used less frequently than other modes by the participating teachers (Table 5). Teachers usually used this communicative approach at the beginning of a lesson or in an abstraction of the lesson. Notably, students' contributions are less or absent in this communicative approach. Teachers used rhetorical questions (Black, 1992) to interact, but the teacher was observed to provide his/her own answer and to construct the sequence of conversation. In Table 8, examples of *non-interactive–authoritative* approaches are shown.

Table 8. Sample Dialog of *Non-Interactive–Authoritative* Communicative Approach

Turn	Speaker		Pattern's notions
1.	Teacher-6	Do scientific studies influence social life? Can you give an example? Does it affect our life?	Initiation
2.	Esra	Scientists make some kind of experiment as a result of…	Response
3.	Teacher-6	…. He found scientific knowledge. What scientific knowledge is discovered? We know about the liquefaction of gases. Then, which technologies utilise it? What can be produced using this knowledge? Which technological products are produced? Flask… anything else? In LPG, in oxygen bottles, in organ transportation—such as a heart transplant—for transporting an organ from one location to another. Namely, it is scientific knowledge that is reflected in technological products. Can you give an example? Does scientific knowledge simplify our life? Anything else? What scientific knowledge makes our lives easier? This is why science and technology are connected to each other.	
4.	Student	(No answer)	
5.	Teacher-6	For instance, did it not simplify lives when Edison invented the light bulb? Anything else?	Initiation
6.	Students	(No answer)	
7.	Teacher-6	For instance, I saw a new mobile that has been recently developed. This phone is not affected by water; it does not break when dropped in water. The mobile phone was developed from scientific knowledge, wasn't it? … This information was used for mobile phone development, and it provides us with great ease, doesn't it? … Anything else?	Initiation
8.	Erdem	The cell was discovered in an incidental manner.	Response

In Table 8, the exemplification of this communicative approach commences with the teacher asking questions such as 'Do scientific studies influence social life? Can you give an example? Does it affect our life?' (turn 1). In turn 2, a student responded, but the teacher did not provide any feedback or evaluation (Walsh, 2011). The teacher used many rhetorical question such as 'What scientific knowledge is discovered? We know about the liquidation of gases. Then, which technologies use it? What can be produced using this knowledge? Which technological products are produced?' Thus, the teacher's pedagogical approach to transmitting knowledge to students is through extended teacher dialogue. The teacher continued to talk and provided answers to her own questions (turns 3 and 7).

Discussion, Results and Implications

This study aimed to determine discourse patterns and communicative approaches utilised for teaching NOS using an explicit–reflective approach. The analyses showed that the participant teachers used three different discourse patterns (triadic, chain and adjacency pair) as well as three different communicative approaches (*interactive–authoritative*, *interactive–dialogic* and *non-interactive–authoritative*) for teaching NOS using the explicit–reflective approach. This conclusion was derived from the data obtained from the classrooms of eight different teachers.

The triadic pattern was the most commonly used pattern among all teachers and also the most encountered pattern in the literature studies. According to most of the literature (Alexander, 2004; Lemke, 1990; Mehan, 1979; Mortimer & Scott, 2003), teachers used a triadic pattern for the majority of their lesson time as seen in this study. According to Lemke (1990), teachers do not wish to renounce the triadic pattern because it provides the opportunity to direct the subject and manage the classroom with authority. However, evaluating this pattern from an NOS perspective, it can hinder students' contribution in terms of reflective consideration or depth of inquiry. Teachers mostly ask standard questions in this pattern and do not encourage students to give reflective responses, which is important in terms of teaching NOS. Walsh (2006) pointed out that asking standard questions shapes student contributions in the sense of teacher's expectations.

In contrast to the triadic pattern, the chain discourse pattern provides students with the opportunity for more (engaging) discussion, reflective thinking and direction of the conversation. Using a chain pattern for NOS discussions supports students' thinking skills, communication skills, critical thinking ability (Mortimer and Scott, 2003) and science competency (Lemke, 1990). According to Ryder and Leach (2006), teachers should encourage student reflection by providing feedback (elaborative) to improve the quality of science teaching from a philosophical perspective. The analysis revealed that two of the participating teachers used this strategy. In addition, teachers who wanted less interaction used this pattern at the beginning of lessons and subsequently shifted to a triadic pattern. Seedhouse (2004) explains that changing of teachers' pedagogical focus influences teacher's talk and their interactional positions.

Adjacency pair is another kind of discourse pattern that was observed in the research findings. This pattern has not reported in discourse studies, but it has been found in conversation analysis research (e.g., Liddicoat, 2007; Schegloff, 1978). It consists of two different pairs, which are considered unsuitable for teaching NOS using an explicit–reflective approach, as this approach requires teacher–student discussion. Furthermore, it is also suggested that the initial discussion reshapes the reciprocal discussion (Kaya, 2011). An adjacency pair discourse pattern only consists of initiation and response (or *question–answer*), and NOS based on an explicit–reflective approach is supposed to lead to some agreement (evaluation) or contrast in discussions (Schwartz et al., 2004).

An important result was that dialogue was usually started by teachers. It was seen that dialogue started by students was either not permitted or interrupted by the teacher after a short time. This is an indicator of teachers' authoritativeness regarding the sequence of lesson organisation—especially when such incidents occur in the middle of a conversation or after a teacher's question. This demonstrates that the teacher is determined to complete the conversation or subject in the pre-planned manner. This result supports Ryder and Leach's (2006) claim in that teachers dominate the majority of the lesson time with their own questions and extended teacher dialogue. Further, Ryder and Leach (2006) determined that teachers spoke for around 60–69% of a 50–90 minute lesson. Another reason for extended teacher dialogue is that teachers may have identified some aspect of NOS to be focused on before the lesson.

Another result relevant to communicative approaches was the percentage of use of the *interactive–authoritative* approach. As seen in Table 5, during most of the interaction, the teacher attempted to provide answers. This result reveals similarities with the 'skills and system mode' developed by Walsh (2006, 2011) to explain classroom interaction. In this mode, teachers check students' knowledge and the transmission of knowledge by asking standard questions. On the other hand, according to Mortimer and Scott (2003), teachers' aim is to interact with students and ask questions to find out some answer that are already known by teacher.

Considering the results obtained from this study, the use of dialogic communicative approaches and chain patterns may improve the qualitative nature of an explicit–reflective approach. Using this study as a framework can improve teachers' awareness about NOS and help develop some discourse-related skills. In terms of classroom science discussion, appropriate discourse and communicative approaches should be included in in-service and pre-service teacher education programmes as suggested in accordance with this paper.

This study is important, as it introduces a new perspective on NOS-related studies and illustrates how teachers instruct on NOS-related topics and manage sequences of organisation of lessons. Further research based on discourse analysis will make a significant contribution to classroom interaction while teaching NOS topics in the classroom. Particularly, patterns of discourse that they will have acquire with new research can investigate in terms of classroom levels, subjects and different activities can provide details of perspective on both NOS and classroom interaction. The sample dialogue featured in this paper is available for use in the in-service and pre-service programmes. The obtained results highlight the need for further research in science education using sample dialogue, or other dialogue, to improve classroom interaction awareness.

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