ORIGINAL ARTICLE

Impact of the Context of Socioscientific Issues on Discourse Patterns Used in Science Classes

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***Abstract**: This study is a qualitative study conducted to examine the effect of socioscientific issues (SSI) on discourse patterns used in the classroom. The research was conducted with four elementary science teachers working in a public school. The research was designed as case studies of these four teachers and data resources were video recordings of these teachers' routine and SSI based lessons. The data was analyzed through discourse analysis. The discourse patterns used by teachers were examined in terms of adjacent the utterance, triadic, and chain discourse patterns. The results indicated that the discourse patterns used by the teachers in their routine lessons changed dramatically in the context of SSI and the chain discourse pattern came to the fore in the courses processed in the context of the SSI.*

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Introduction

THE concept of discourse is used in various fields, and underlying the word "discourse" is the idea that language is structured according to the patterns people's utterances follow when they take part in different domains of social life (Phillips & Jorgensen, 2002). In the context of education, classroom discourse, which is dialogic, represents the interaction of a variety of ideas, including students' ideas (Mortimer & Scott, 2003; Nystrand, 1997). It also refers to the language that teachers and students use to communicate with each other in the classroom. The pattern of discourse represents how language interacts in the classroom (Kaya et al., 2016).

Interaction in the classroom is fundamental to students' processes of meaning-making. As Vygotsky's sociocultural learning theory puts it, all learning originates in social situations, where ideas are rehearsed between people, mainly through talk (Mortimer & Scott, 2003). Through talk and interaction, people can make sense of what is being communicated, and the words used in social exchanges provide the tools needed for individual thinking. Hence, meaning-making is a dialogical process in which different ideas are brought together (Bakhtin, 1981). Besides being an essential component of learning (Gonzalez, 2008), enhanced classroom discourse helps to create a classroom community that is inclusive and supportive of all its members.

Simon (1997) indicated that by improving classroom discourse teachers can enrich the classical and authoritarian learning environments they widely use and transform them into interactive learning environments. Therefore, teachers are expected to differentiate the discourse patterns they use to improve dialogue in the classroom to make it easier for students to learn. Literature acknowledges that three distinct discourse patterns are used in classrooms. The contiguous rhetoric pattern is the discourse model consisting of the Initiation-Response stages (Schegloff, 1978). In this discourse pattern, evaluation and feedback are not present. The triadic discourse pattern usually involves explicit teacher evaluation of students' contributions (Scott et al., 2006) and is frequently conducted in an Initiation-Response-Evaluation (IRE) pattern (Mortimer & Scott, 2003). If the answers given by the students do not comply with the classical scientific knowledge, they are immediately given the correct answer or ignored by the teacher (Mortimer, 2005). A chain discourse pattern is a pattern of discourse consisting of Initiation-Response-Feedback-Response-Feedback (I-R-F-R-F) stages (Scott et al., 2006). In this pattern of discourse, instead of evaluating, the teacher gives feedback to prolong the dialogue by reflecting on the responses from the students (e.g., How? Why? Can you open this up a little bit more?). Thus, the students deepen their answers and can compare their old knowledge with their new knowledge (Scott & Ametller, 2007). Furthermore, an indispensa-

ble feature of the chain discourse pattern is that students are active participants in classroom discussions (Bosser & Lindahl, 2021; Nystrand, 1997). Chain discourse dialogues can remain open without teacher evaluation (I-R-F-R-F), while others end with a final assessment by the teacher (I-R-F-R-F-R-E). Rhetoric can create more complex and longer chain dialogues with students responding to each other's answers (Scott et al., 2006).

Arguably, the success of teaching depends on the teacher's ability to improve classroom interaction. Therefore, the discourse pattern used by the teacher in the classroom becomes important. However, studies on the discourses teachers use in their lessons indicate that teachers generally use authoritarian discourses (the adjacency pair or triadic discourse pattern) in classroom environments (Molinari & Mameli, 2010), which limit learning and interaction. On the other hand, researchers reported that in learning environments where discourse patterns are diversified towards more dialogic and communicative approaches, meaningful learning becomes possible (Buty & Mortimer, 2008; Myhill, 2006; Poimenidou & Christidou, 2010; Scott et al. 2006), students are encouraged to come up with new ideas (Scott et al. 2006), and students model the discourse language of teachers (Dawes, 2004).

Interactive learning environments are no doubt required for effective science education. The use of socioscientific issues (SSI) as a context in science lessons has significant potential in this sense. SSI are socially controversial issues related to science (Kolstø, 2001; Sadler & Zeidler, 2004). Ratcliffe and Grace (2003) define SSI as issues that are important to society, have a scientific basis, come up often in the media, involve politically and socially important issues regionally, nationally, or internationally, question ethical values, require an understanding of probability and risk, and do not have a single right answer. Examples include genetically modified organisms, global warming, cloning and nuclear power plants, which are closely related to society in our changing world and cause controversy that directly affects people's lives (Sadler, 2011).

Considering the objectives of the scientific literacy movement, SSI have emerged as an important context in science teaching and found their place in the curricula of many countries (Dawson, 2001). Today, institutions and organisations around the world advocate the inclusion of SSI as a teaching and learning context in science education (Ministry of National Education of Turkey [MONE] 2013; National Research Council, 1996; NGSS Lead States, 2013).

Research indicates that SSI-based teaching, in which SSI are used as contexts for teaching and learning, can promote the required knowledge and understanding for scientific literacy (Zeidler et al., 2009). SSI can be used as an effective context for learning science knowledge and skills in the classroom and serve as a basis for understanding science content (Klosterman & Sadler, 2010; Sadler et al. 2016; Wongsri & Nuangchalerm, 2010) and the

nature of scientific knowledge (Khishfe & Lederman, 2006). SSI-based instruction can also promote students' interests and motivation towards science (Dori et al., 2003) and their development of argumentation practices (Venville & Dawson, 2010) and moral reasoning (Lee et al., 2012).

SSI-based teaching differs from teaching science content in important ways. SSI is controversial because they are open-ended and unresolved. These topics also include uncertainties and relativities (Zeidler & Nichols, 2009). The characteristics of SSI provide the context for the emergence of multiple perspectives (Bosser & Lindahl, 2021). Teachers are not the primary source of knowledge and should be skilled in managing open-ended discussions in SSI teaching. Students in the classroom are expected to share and discuss their ideas. Thus, SSI-based teaching can offer opportunities for classroom discourse (Bosser & Lindhal, 2021).

Despite SSI's potential in developing classroom discourse, only a few studies focus specifically on how SSI contexts affect classroom discourse. Among these, Dawson and Venville (2010) explored teaching strategies that support students' discussion skills in decision-making through an SSI subject related to genetics. The results show that the teacher's facilitation of the process contributes to the resulting quality of argumentation and the students' consideration of different ideas. In another study, Puig and Jiménez-Aleixandre (2011) examined the teaching practices of a teacher in the context of an SSI involving Mendelian genetics. The researchers reported that the context and the efforts of the teacher had created a climate of confidence, which encouraged students to express and defend their opinions and ask one another to explain or support their claims. Chung et al. (2014) investigated the extent to which SSI instruction on gene modification technology contributed to enhancing students' communication skills in South Korea and concluded that SSI instruction could have a moderately large impact on students' ability to understand the key ideas of others and value others' perspectives and a marginally positive effect on developing active assertions. Bosser and Lindahl (2021) examined two science teachers' employment of a communicative approach during SSI-based teaching. The results indicated that teachers purposely use different communicative approaches to facilitate students' decision-making while promoting complexity in their reasoning.

These studies present valuable evidence about the potential of the context of SSI in classroom discourse. However, how SSI teaching affects and shapes the discourse in the classroom still needs to be explored and understood. To this end, the present study aims to examine the effect of SSI-based teaching on discourse patterns in the classroom.

Materials and Method

Table 1. Demographic Information of the Teachers Participated in the Study.

Teacher	Age	Gender	Educational Background	Years of Experience
Kayra	30	Female	Bachelor's Degree	9
Sevil	30	Female	Bachelor's Degree	9
Seda	33	Female	Bachelor's Degree	10
Figen	35	Female	Bachelor's Degree	4

This study was conducted within the scope of a larger national project in Turkey, which was conducted to expand the use of SSI in science classes. In Turkey, the revised science curricula in 2013 and 2018 put a special emphasis on the use of SSI as a context in science education to promote scientific literacy nationwide. Therefore, supporting teachers' professional development concerning using SSI effectively in their classrooms has become an important issue. In this national project, the aim of which was to support science teachers in the teaching of SSI and to ensure their professional development, the main objectives were (i) to develop an SSI learning/teaching framework following the revised science curricula, (ii) to design sample teaching modules that science teachers can use during SSI teaching, (iii) to support the professional development of science teachers regarding SSI teaching, and (iv) to make learning environments based on student-centred inquiry more widely available in elementary schools.

As a part of this nationwide project, this study focused on how discourse patterns were affected in classrooms where SSI was used as a context. Discourse patterns that teachers routinely used in their classrooms were compared with those they used in the SSI context. Here, the term "routine" is used to refer to teachers' daily lessons, in which they applied their typical strategies and which were not interfered with by an external context or technique.

A qualitative research approach was used in this research, and as the study aimed to examine classroom discourse patterns in depth in the natural environment, the case study design was applied.

Participants

This research was conducted in an urban public elementary school in Istanbul. The school had approximately 600 students and the average class size was 30 students. Four science teachers teaching in the school voluntarily participated in the study. **Table 1** presents the demographic characteristics of the participants.

One of these teachers, Kayra, completed her undergraduate education at a state university and had nine years of teaching experience. Kayra was

Table 2. Topics Taught by Teachers in Routine Lessons.

Teacher	Grade	Topic
Kayra	5th	Friction Force of Substances
Sevil	6th	The Circulatory System
Figen	7th	Pressure in Gases
Seda	8th	Covalent Bonds

Table 3. Socioscientific Issues Modules Used by Science Teachers.

Grade	Unit Name	Unit Name (Project)
5th	The Mystery of the Earth's Crust	Should Tourism be done in Fairy Chimneys, Cappadocia?
6th	Matter and Heat	Should Buildings be Mantled?
7th	Electrical Energy	Should Electricity be Generated from Nuclear Power Plants?
8th	Living Things and Energy Relations	Should Tourism be done around Lake Seyfe?

Table 4. Topics Used by Teachers in the Courses They Process in the Context of SSI.

Teacher	Grade	SSI Module	SSI1 Subject	SSI2 Subject	SSI3 Subject
Kayra	5th	Should Tourism Be Done in Fairy Chimneys, Cappadocia?	"Fairy Chimneys"	"Is our air polluted?"	"Should there be tourism in Fairy Chimneys or not?"
Sevil	6th	Should buildings be mantled?	"What degree does the Thermometer Read?"	"Fuels" and "Electricity Generation from Renewable Energy Sources"	"Should Buildings Be Mantled?"
Figen	7th	Should electricity be generated from nuclear plants?	"Electricity in our Lives"	"News, News, News"	"Should nuclear plants be built or not?"
Seda	8th	Should there be tourism around Lake Seyfe?	"Lake Seyfe" and "Food Chain"	"Therapeutic coding and Ms. Aylin", "How can we save Lake Seyfe?"	"Should or should not be farmed in Lake Seyfe?"

teaching science to the 5th graders. The second teacher who participated in the study was Sevil. She completed her undergraduate education at a state university and had nine years of teaching experience. Sevil was teaching science to the 6th graders at the time of the study. The third teacher was Figen, who completed her undergraduate education at a state university and had four years of teaching experience. Figen was teaching science to the 7th graders. The last teacher who participated in the study was Seda. She also

graduated from a state university and had ten years of teaching experience. She was teaching science to the 8th graders.

Research Process and Collection of Data

In the first stage of the study, four teachers were asked to choose a class from the classes they taught. Following their choice, the routine forty-minute science lessons (lessons without using SSI) of each participating teacher were observed and video-recorded in classes of their choice. The aim was to identify the patterns of discourse that teachers used in a routine lesson. At this stage, teachers were not told the exact purpose of the classroom observations (to follow discourse patterns) so that they would not deviate from the course routines they normally followed. Instead, they were informed that the aim was to define how the lessons were managed in general. **Table 2** shows the subjects the teachers taught in their routine lesson observations.

After routine lesson observations, teacher's guides and student notebooks were delivered to the teachers. These guides and notebooks contained materials that would inform and guide them in using the SSI as a learning context in their classrooms. These materials were prepared within the scope of one of the objectives of the national project: "Designing sample teaching modules those science teachers can use during SSI teaching". To this end, four teaching modules were developed for the 5th, 6th and 7th and 8th grades. The grades in which these units are located and the names of the SSI modules prepared to correspond to these units within the scope of the project are presented in **Table 3**.

Each SSI module consisted of a student notebook, a teacher's guide and evaluation papers. Student notebooks contained spaces for students to answer questions, take notes and write discussion results. The teacher's guide included instructions on how to process the sections and activities in the student books. The evaluation papers contained open-ended and closed-ended questions that should be applied to students twice in each unit.

Later in the study, three lessons that each teacher taught using these SSI modules were observed and video-recorded. These observations examined the discourse patterns in the lessons in the context of the SSI. The topics of the lessons the teachers taught using SSI modules are given in **Table 4**.

Data Analysis

Video-recorded lessons of participating teachers were used as data sources during the analysis. These videos consisted of a total of four lessons for each teacher, including routine lessons and those in the context of the SSI. A descriptive analysis approach was used for data analysis. Descriptive analysis is the interpretation of the data according to previously determined themes (Strauss & Corbin, 1990).

The process of data analysis of discourse patterns in the research started primarily by transferring video recordings to the computer environment. Later, each video was transcribed verbatim. Two researchers independently read the transcribed texts repeatedly. In the next stage, the discourse patterns that emerged in each lesson were coded independently by the two researchers. The unit of analysis was determined as episodes characterised by teacher-student dialogues initiated by the teacher. When coding the discourse patterns, the researchers coded each discourse they discovered as adjacent utterance (Initiation-Response, Schegloff, 1978), triadic (Question-Response-Evaluation, Lemke, 1990) or chain (Initiation-Response-Feedback-Response-Feedback, Mortimer & Scott, 2003). After the independent coding, the two researchers came together to compare their coding and the interrater agreement between them was calculated and found to be 98%. The researchers worked together on codes that had not yet been agreed on until all the codes were compromised. Then, frequency tables were created by counting the number of times in which different discourse patterns were used in each lesson video. These frequency numbers were compared to the total number of discourse patterns, and percentage tables were created. Afterwards, the number of times each discourse pattern was used for each teacher's lessons was calculated, and the total used discourse pattern ratios and the discourse patterns used by the teachers in their lessons were compared. To establish the credibility of our interpretations, the episode examples are presented in the results section to allow readers to assess them. The percentages and frequencies in the analysis graphs presented in the following section cover interactions involving teacher-student dialogues, not the entire course.

Results

In this section, discourse patterns that emerged in both routine lessons and those in the SSI context for each teacher are presented under separate headings. Lessons in the context of SSI are encoded as SSI1, SSI2, and SSI3 in graphs and tables.

Kayra

Kayra conducted routine and SSI lessons in a 5th-grade class. **Figure 1** presents the analysis of discourse patterns observed in Kayra's routine and SSI lessons.

As seen in **Figure 1**, Kayra used a triadic discourse pattern in the entire routine lesson (38 times). However, she switched to a chain discourse pattern in SSI2 and SSI3. In other words, the triadic discourse pattern was replaced by the chain discourse pattern as Kayra's lessons moved to the context of the SSI.

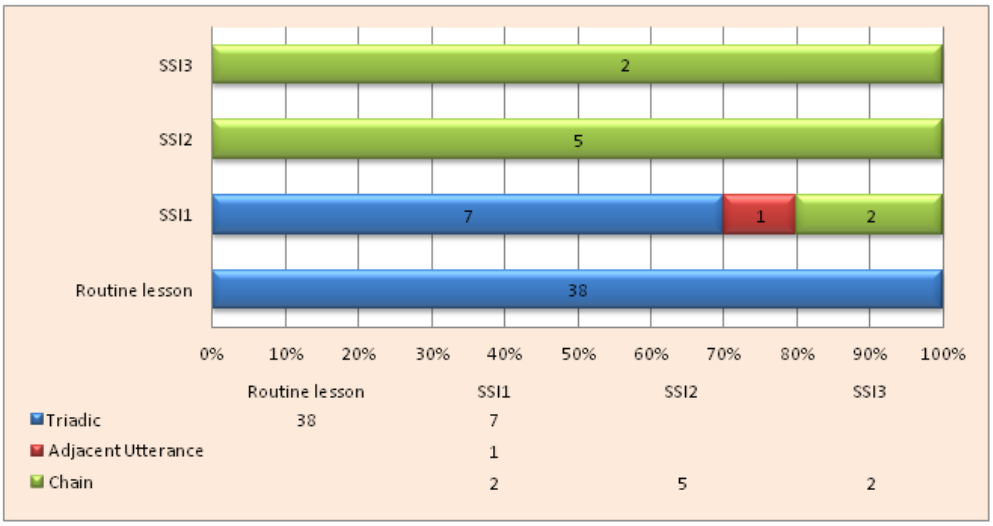


Figure 1. Discourse Patterns Observed in Kayra's Routine and SSI Courses.

Table 5. Triadic Discourse Pattern Sample Dialog Table of Kayra's Routine Lesson.

Line	Speaker		Discourse Indicators
1	Kayra	What about factors that reduce friction? Anyone who did not talk so far...	Initiation
2	Student	Planes have features reducing friction.	Response
3	Kayra	Yes, planes have some features reducing friction. Let's write this example down. The sharp nose of a plane reduces air friction… [Waits for students to write down]. Some of your friends gave examples earlier, there were other factors that affect the movements, let's remember them.	Evaluation/ Initiation

The subject of Kayra's routine lesson was "friction force" and she started the lesson by repeating the previously learned concepts to measure whether the students understood the subject. In this process, she used the triadic discourse pattern. **Table 5** contains a sample dialogue of the triadic discourse pattern that Kayra used in her lesson.

As seen in the dialogue presented in **Table 5**, Kayra started the dialogue with a question (**Table 5**), "What about factors that reduce friction? …" (Line 1). Here, the students gave examples that were debated in the previous lesson. When a student answered (Line 2), Kayra accepted the answer, stating "Yes, planes have some features reducing friction. Let's write this example down. The sharp nose of a plane reduces air friction" (Line 3). Such an evaluation finished the dialogue between the teacher and the student without

Table 6. An Example of the Chain Discourse Pattern Observed in Kayra's SSI2 Lesson.

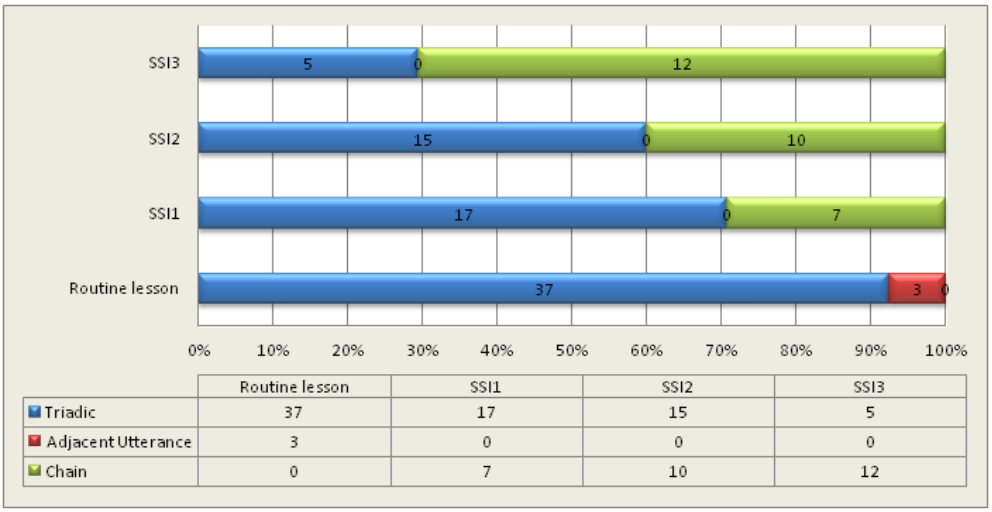
Line	Speaker		Discourse Indicators
1	Kayra	Let's get started on our ideas. Semih, what do you think can be done?	Initiation
2	S2	Well, we can prove it by taking a picture.	Response
3	Kayra	We can take pictures. Well, Semih said we can prove air pollution by taking a picture of it. Any other opinion?	Feedback
4	S3	By experimenting.	Response
5	Kayra	We make experiment. You are great, we measure them all, we experiment, we take pictures. Others?	Feedback
6	S4	I would look at urbanization, so I can link air pollution with increase in urban population.	Response
7	Kayra	Rumeysa says she would look at urbanization and the number of people in urbanized areas. She sees a connection with air pollution and urbanization rate. That is a good thought, too. Others?	Feedback
8	S5	I would look if there are trees.	Response
9	Kayra	Forestation! Furkan said he'd look at forests because trees help prevent air pollution. Isn't that right, Furkan?	Evaluation

allowing the student to explain. Then Kayra moved to another question and started another triadic discourse pattern in the form of IRE.

Kayra also used the triadic discourse pattern in SSI lessons (SSI1 lesson, see **Table 5**), especially in dialogues where she evaluated student answers to questions about the pictures in the student notebooks. She used the adjacent utterance discourse pattern once (SSI2 lesson, see **Table 5**) to get approval for her explanation about a picture in the student notebook. The chain discourse pattern, on the other hand, was frequently observed in Kayra's SSI lessons. The SSI context promoted brainstorming, where different ideas were presented during the discussion of questions without a true or single answer. **Table 6** presents an example of a chain discourse pattern observed in Kayra's SSI2 lesson.

In Kayra's SSI2 lesson, the topic was air pollution, and the interaction presented in **Table 6** was a section of the lesson where students provided their ideas about whether vehicles used in tourism (such as tourist buses) cause air pollution in Cappadocia. As seen in the table, Kayra started a chain discourse pattern by letting a student share his ideas about the discussion. After getting an answer from the student, she repeated the answer and gave feedback. As seen, she did not evaluate the answer and end the discourse; instead, she continued with the question 'Others?' (Lines 3, 5 and 7) that allowed the students to brainstorm. In Line 9, she evaluated the student's answer (Line 8) by adding her opinion and ending the dialogue.

Sevil



	Routine lesson	SSI1	SSI2	SSI3
Triadic	37	17	15	5
Adjacent Utterance	3	0	0	0
Chain	0	7	10	12

Figure 2. Discourse Patterns Observed in Sevil's Routine and SSI Lessons.

Table 7. An Example of the Triple Discourse Pattern Observed in Sevil's Routine Lesson.

Line	Speaker		Discourse Indicators
1	Sevil	Remember our skeleton and musculoskeletal system. Which organs were protected by our skeletal system?	Question
2	S1	Heart, lung.	Response
3	Sevil	Lung, heart. Isn't it?	Evaluation/Question
4	S2	Stomach	Response
5	S3	Large intestine.	Response
6	Sevil	No. Look, the rib cage is protecting our internal organs out front. It is the ribs part of our skeleton we call the rib cage. But the bones do not protect our organs in our abdomen; the muscles are protecting them.	Evaluation

Sevil conducted her lessons in the contexts of routine and SSI in a 6th-grade class. Chart 2 presents an analysis of discourse patterns observed in Sevil's routine and SSI lessons.

In her routine lesson, Sevil used the triadic discourse pattern (37 times). She used this pattern in situations where she wanted students to associate new learning with existing learning. In these dialogues, the questions she posed to the students had a single answer and she expected to hear that answer. **Table 7** provides a sample dialogue recorded in Sevil's routine lesson.

As seen in **Table 7**, Sevil initiated the dialogue by reminding students of the skeleton and musculoskeletal system, which they had covered in

the previous lesson, and asked for the name of organs that were protected by the skeletal system (Line 1). Sevil assessed the students' answer, "Heart, lung" (Line 2) with the sentence "Lung, heart. Isn't that right?" (Line 3), and at the same time, she asked a new question and waited for the approval of the students. Students gave other examples of the organs protected by the skeletal system with examples such as "Stomach" (Line 4) and "Large intestine" (Line 5). Since these answers were not the ones that Sevil had expected, she finished the dialogue with an evaluation (Line 6).

As shown in **Figure 2**, the chain discourse pattern had become dominant in Sevil's SSI lessons. While she never used the chain discourse pattern in her routine lesson, she used it seven times in SSI1, ten times in SSI2 and 12 times in SSI3. Although she continued to use the triadic discourse pattern in SSI courses, she did not use the adjacent utterance discourse pattern. The analysis showed that Sevil continued to use the triple discourse pattern in SSI lessons, especially in cases where she had wanted students to remember previous learning. On the other hand, she used a chain discourse pattern, as exemplified in **Table 8**, to reveal students' pre- or misconceptions and to allow students to explain their ideas on the issue.

Table 8 presents one of the dialogues between Sevil and a student in one of Sevil's SSI lessons. As seen, Sevil initiated the dialogue with a question about the thermal insulation of buildings and a student presented his ideas. Then, Sevil continued the dialogue by asking the student to explain the reason for his answer, providing feedback and asking for clarification. During the dialogue, Sevil provided feedback on the student's explanations (Lines 5 and 7) and finished the chain discourse pattern with an evaluation sentence indicating that she understood the student's answer.

Figen

Figen conducted both routine and SSI lessons in a 7th-grade class. **Figure 3** shows the discourse patterns observed in Figen's routine and SSI lessons.

As shown in **Figure 3**, while Figen used the chain discourse pattern only once in her routine lesson, it increased during lessons in the context of SSI (11 times in SSI1, nine times in SSI2 and 19 times in SSI3). While the triadic discourse pattern had the highest frequency of use in the routine lesson, its use decreased noticeably in the context of SSI. Figen usually used the triadic discourse pattern (88%) in her routine lesson to assess students' learning. **Table 9** contains a sample triadic discourse pattern observed in Figen's routine lesson.

Triadic discourse patterns contain initiation questions that have only one correct answer, which is known to the teacher, and have a testing quality. In the dialogue in **Table 9**, Figen asked, "…how do the solids move?" (Line 1), "... what do we need to measure the pressure of a solid?" (Line 3) and

Table 8. An Example of the Chain Discourse Pattern Recorded in Sevil's SSI2 Lesson.

Line	Speaker		Discourse Indicators
1	Sevil	So, yes, is there any another idea now, should we coat our building with thermal insulation materials?	Initiation
2	S1	I think we should not. Because all insulation materials have harmful effects for human health and, also negative effects for the environment. Some are flammable, some cause skin diseases. There are positive sides, of course, for example it lowers the gas bill, but I still don't prefer it.	Response
3	Sevil	Well, how do you know they're so harmful?	Feedback
4	S1	We talked about it earlier.	Response
5	Sevil	We talked about it. What did we say?	Feedback
6	S1	Well, we talked about the mantling stuff and all that harm they may cause.	Response
7	Sevil	We talked about their potential harms, but were they certain?	Feedback
8	S1	No, they were not.	Response
9	Sevil	But since there are risks, you still don't prefer it. Well.	Evaluation

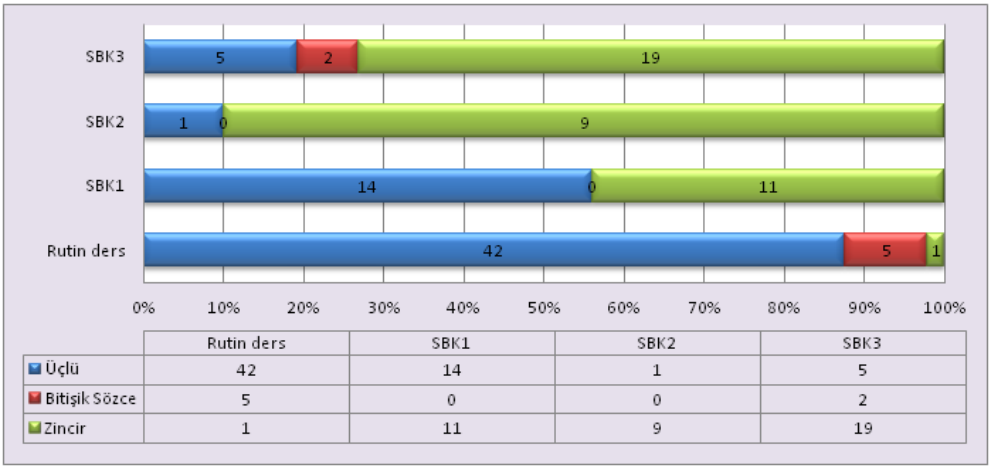


Figure 3. Discourse Patterns Observed in Figen's Routine and SSI Lessons.

waited for the known definitive answers from the students. In the dialogue, one student answered each question (Lines 2, 4 and 6). In addition, the teacher evaluated all the answers, and after receiving the expected answer, she continued the dialogue with a new question (Lines 3, 5 and 7).

In Figen's SSI lessons, she continued to use the triadic discourse pattern to remind her students of their previous learning. On the other hand, she used the chain discourse pattern in dialogues with no single correct answer, and answers varied from student to student. In these dialogues, she func-

Table 9. An Example of the Triple Discourse Pattern Recorded in Figen's Routine Lesson.

Line	Speaker		Discourse Indicators
1	Figen	Ok, how do the solids move?	Initiation
2	S1	They vibrate.	Response
3	Figen	Um, they just vibrate. So, what do we need to measure the pressure of a solid?	Evaluation/Initiation
4	S1	The area of application.	Response
5	Figen	The surface area, the area of contact. OK, the other one?	Evaluation/Initiation
6	S2	Weight.	Response
7	Figen	Weight or force. Well, how about liquids?	Evaluation/Initiation

Table 10. An example of the chain discourse pattern observed in Figen's SSI2 lesson

Line	Speaker		Discourse Indicators
1	Figen	Kaan, what do you think? Could this journalist be misleading the issue?	Initiation
2	S1	No.	Response
3	Figen	Why do you think that?	Feedback
4	S1	These are things that could happen.	Response
5	Figen	You're saying these are things that can happen. What if it's not happening?	Feedback
6	S2	Then he wouldn't have chosen to publish this story.	Response
7	Figen	Well, what else?	Feedback
8	S3	We don't know if it's possible, but the journalist doesn't have any evidence, and if he had proof, we might have thought he didn't deflect it.	Response
9	Figen	Ok, any other opinion?	Feedback
10	S1	It may occur or not; but we would have understood if he deflected.	Response
11	Figen	You're saying if he deflects, it'll be understood by society.	Feedback
12	S2	Everyone has their own truth, maybe he is not deflecting it.	Response
13	Figen	You say, he may not be deflecting the issue	Feedback
14	S3	He may be deflecting.	Response
15	S4	He may be misleading the society. That's why scientists should do research on the issue.	Response
16	Figen	So, my question is, why would those making such news wanted to mislead society?	Feedback
17	S1	Of course, they may be right, but it's already proven that nuclear plants are potentially harmful.	Response
18	S2	I think he reflects his own thoughts, it may inevitably be right or wrong.	Response
19	Figen	Your friend says that the journalist has his own thoughts, he has his own feelings, so those thoughts and feelings may have an effect on what he claims. I like to hear your thoughts about this?	Feedback
20	S1	Everyone has their own truths; but if you don't have any evidence to support these, spreading these might be wrong.	Response
21	Figen	Well, he says he didn't provide any evidenceabout his claims, we should not make claims about such serious matters without evidence or information.	Evaluation

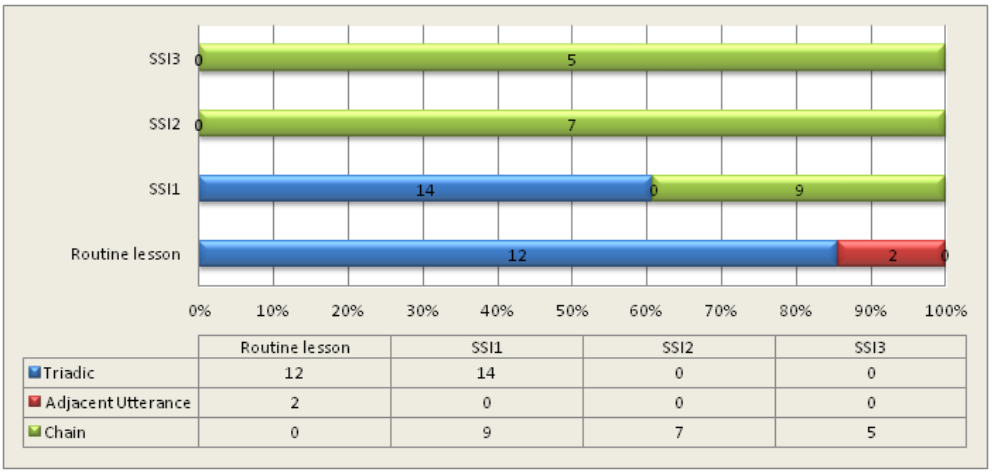


Figure 4. Discourse Patterns Observed in Seda's Routine and SSI Courses.

Table 11. An Example of A Triadic Discourse Pattern Recorded in Seda's Routine Lesson.

Line	Speaker		Discourse Indicators
1	Seda	Now let's look at electron configuration of hydrogen. How many electrons does it have?	Question
2	S1	One.	Response
3	Seda	There's only one. It does not have any other electrons. Now, hydrogen says that "I offer my only electron" And chlorine says, "If you share your only electron, I will share one of seven electrons in my last orbit with you."	Evaluation

tioned as a facilitator of the discourse in that she asked students to deepen their answers and rephrased their answers while providing feedback. **Table 10** presents a sample chain discourse pattern dialogue recorded in Figen's SSI2 lesson.

In the dialogue presented in **Table 10**, having presented a newspaper article about building new nuclear power plants, Figen initiated the discourse by asking about the reliability of claims presented in the article regarding nuclear power plants (Line 1). A student answered negatively (Line 2), and Figen asked the reason for the answer (Line 3), asking the student to expand his answer. In Line 9, Figen expanded the interaction by using the phrase "Any other opinion?" This is one of the chain discourse pattern words to get other students' answers. As seen in the table, Figen provided feedback and asked new questions to expand and continue the discourse (Lines 5, 11 and 19).

Seda

Seda conducted both routine and SSI lessons in an 8th-grade class. **Figure 4** shows the discourse patterns observed in Seda's routine and SSI lessons.

As seen in **Figure 4**, Seda used only the triadic and adjacent utterance discourse patterns in her routine lesson. While the chain discourse pattern was not used in her routine lesson, it became the dominant pattern in the SSI lessons (nine times in SSI1, seven times in SSI2 and five times in SSI3). **Table 11** provides an example of a triadic discourse pattern observed in Seda's routine lesson.

As seen in **Table 11**, Seda asked students, "Now let's look at the electron configuration of hydrogen. How many electrons does it have?" (Line 1). This question started the dialogue and a student answered: "One" (Line 2). When Seda heard the expected answer, she evaluated the answer and ended the triadic pattern.

She also used the adjacent utterance discourse pattern twice in her routine lesson, to check and recall previous learning. **Table 12** presents one of the adjacent utterance discourse patterns observed in Seda's routine lesson.

As presented in **Table 12**, Seda initiated the dialogue with a question on covalent bonds: "… lets' think about this. How many electrons in total will they share?" (Line 1). Having received the correct answers from the students (Lines 2 and 4), she posed new questions without any evaluation or feedback (Lines 3 and 6). Thus, the adjacent utterance discourse pattern occurs in the form of Initiation-Response-Initiation-Response in the dialogue.

Seda continued to use the triadic discourse pattern in the SSI1 lesson, where previous learning was reviewed and repeated. However, the chain discourse pattern was the dominant strategy in all SSI lessons, in which students presented and explained their perspectives on controversial topics. **Table 13** presents a chain discourse pattern observed in Seda's SS3I lesson.

As seen in **Table 13**, Seda started the dialogue with an initiation sentence: "Now, finally, I'm going to ask you this. So far, we've talked about organic farming. Now, what can be done for the people who live around Lake Seyfe if they cannot live on farming? Let's think about it. One of your friends said they should sell their farms" (Line 1). The student repeated his answer to the class (Line 2) and Seda requested more explanation (Line 3). This dialogue constitutes a pattern of chain discourse with no evaluation until Line 13. The dialogue continued with a new initiation question in Line 13 without evaluating the answers from the students (Line 11 and Line 12). Concerning the student's answer, "Miss, in organic farming, the environment does not get dirty" (Line 14), Seda provided feedback "You are saying the environment does not get polluted when it is organic. What about waste materials?" (Line 15) and then provided an evaluation (Line 17). The dialogue

Table 12. An Example of the Adjacent Utterance Discourse Pattern Recorded in Seda's Routine Lesson.

Line	Speaker		Discourse Indicators
1	Seda	Come on, lets' think about this. How many electrons in total will they share?	Initiation
2	S1	Two.	Response
3	Seda	How many electrons each atom going to share?	Initiation
4	S2	One.	Response
5	S1	Not one, two!	Response
6	Seda	The more the need, the more it will be put out there. How much is the need?	Initiation

Table 13. An Example of the Chain Discourse Pattern Recorded in Seda's SSI3 Lesson.

Order	Speaker		Discourse Indicators
1	Seda	Now, finally, I'm going to ask you this. So far, we've talked about organic farming. Now what can be done for the people who live around Lake Seyfe if they cannot live on farming? Let's think about it. One of your friends said they should sell their farms.	Initiation
2	S1	No, they may sell those lands to scientists. And with that money, they can buy fertile lands somewhere else.	Response
3	Seda	Well, is that your alternative solution?	Feedback
4	S1	Then they may do fishing. If they can't make a living with it, a lot of people have migrated from villages to cities, and they can do as well.	Response
5	S2	But life is very difficult in cities.	Response
6	S1	Well, everyone can manage it.	Response
7	Seda	But, Samet, think of it this way. How do they live in the city if they can only know farming?	Feedback
8	S1	They should think about the fish, too. If they are farmers, they should think of other creatures living in Lake Seyfe. They should do organic farming, then.	Response
9	S2	Then, we are not in favor of fishing.	Response
10	Seda	Why aren't you?	Feedback
11	S2	It damages the ecosystem.	Response
12	S3	Because those birds feed on fish.	Response
13	Seda	Omer, what do you think of the people in the villages there? For example, you think they should do organic farming. There may be some downsides to that. Like environmental pollution? What are your solutions for these?	Initiation
14	S2	Miss, in organic farming, the environment does not get dirty.	Response
15	Seda	You are saying the environment does not get polluted when it is organic. What about waste materials?	Feedback
16	S2	Recycling.	Response
17	Seda	Yes, recycling is important. But how can we promote recycling?	Evaluation/ Initiation
18	S1	By informing people.	Response
19	Seda	We have to inform them. How is that going to work?	Feedback
20	S1	There can be places to collect waste material, too, about recycling.	Response
21	Seda	Places to collect waste material. Well, then, these materials could sent to the relevant places.	Evaluation

Table 14. Frequencies and Ratios of Discourse Patterns Used by the Participant Teachers in Their Routine and SSI Lessons.

Teacher	Lesson Type	Frequency and Ratio of Discourse Patterns Used		
		Adjacent Utterance	Triadic	Chain
Kayra	Routine	0	36 (100%)	0
	SSI1	1 (10%)	7 (70%)	2 (20%)
	SSI2	0	0	6 (100%)
	SSI3	0	0	2 (100%)
Sevil	Routine	3 (8%)	37 (92%)	0
	SSI1	0	17 (71%)	7 (29%)
	SSI2	0	15 (60%)	10 (40%)
	SSI3	0	5 (29%)	12 (71%)
Figen	Routine	5 (10%)	42 (88%)	1 (2%)
	SSI1	0	14 (59%)	11 (41%)
	SSI2	0	1 (10%)	9 (90%)
	SSI3	2 (8%)	5 (19%)	19 (73%)
Seda	Routine	2 (14%)	12 (86%)	0
	SSI1	0	14 (61%)	9 (39%)
	SSI2	0	0	7 (100%)
	SSI3	0	0	5 (100%)

continued with a new chain discourse pattern that took the form of Initiation-Response-Feedback-Response-Evaluation (Lines 17, 18, 19, 20 and 21).

In **Table 14**, frequencies and ratios of discourse patterns used by the teachers in SSI lessons are presented in comparison with their routine lessons.

As outlined in **Table 14**, Kayra spent her entire routine lesson using the triadic discourse pattern for review and to assess whether the students had understood the subject. The chain discourse pattern was never used in this lesson. In her SSI lessons, however, the number of adjacent utterance discourse patterns and triple discourse patterns decreased while the use of chain discourse patterns became dominant, especially in SSI2 and SSI3 lessons. Although the number of uses of these chain discourse patterns may seem small (two and six times), these dialogues were lengthy and covered almost all the lesson time.

Table 14 shows that Sevil conducted her routine lesson using mostly the triadic (37 times) and adjacent utterance (three times) as a discourse pattern. Sevil did not use the adjacent utterance discourse pattern in her lessons in the context of the SSI, reduced the use of the triple discourse pattern (SSI1, SSI2, and SSI3, respectively; 17, 15, and five times), and increased the use of chain discourse pattern (SSI1, SSI2, and SSI3, respectively; seven, ten, and 12 times).

As seen in **Table 14**, Figen dominantly used the triple discourse pattern (42 times) in her routine lesson. She used the adjacent utterance five times, and the chain discourse pattern was used only once, which constituted only a small part of the lesson time. Figen continued to use each of the discourse patterns in SSI lessons. However, the chain discourse pattern became the most used strategy compared to the routine lesson.

Lastly, the triple discourse pattern was the major strategy (12 times) in Seda's routine lesson. However, the chain discourse pattern appeared for the first time and became the major strategy in the context of SSI.

Discussion and Conclusion

In this study, the change in discourse patterns used by science teachers in their routine and SSI lessons was examined. Routine lessons and lessons conducted in the context of SSI of four science teachers were analysed in terms of classroom discourse.

According to the results of the research, the participating teachers routinely used the triadic and adjacent utterance discourse patterns in their everyday lessons. Studies in this line of research confirm that teachers predominantly use the triadic discourse pattern in their classrooms (Kaya & Kilic, 2010; Lemke, 1990; Molinari & Mameli 2010; Nassaji & Wells, 2000). According to Lemke (1990), teachers often prefer the triadic discourse pattern as it provides advantages such as ensuring classroom management and establishing authority. In traditional classroom environments, the teacher transmits the knowledge, which the students are expected to remember later. Teachers often use methods of telling and showing in their lessons for this purpose. In this teaching model, knowledge is a collection of information independent of personal interpretation, while students are passive recipients who receive this information. The findings of this study indicated that teachers used the triadic and adjacent utterance discourse patterns in this traditional approach. They used these strategies to transmit new knowledge, to get students to remember and repeat previously learned knowledge, to measure whether students understood the subject and to combine new learning with previous knowledge in students' minds.

In many science classes, like those in participants' routine lessons in this study, the students have little room in classroom discourse. Many students do not speak at all, ideas arise but are not interpreted, and those that do not conform to the scientific perspective are ignored or corrected. Putman (2006) states that such teacher-centred authoritarian dialogues are preferred because it makes it easier to control class time and student behaviour. In such an environment, even though the teacher asks leading questions, the responses from the students tend to be limited to odd words here and there, interspersed in the teacher's delivery (Mortimer & Scott, 2003). Although

the teacher and students communicate in such interactions, the teacher's goal is to hear the correct information from the students. Often teachers even ignored wrong answers from students and only evaluated the correct answers. In addition, students' participation in the course decreases when the teacher responds to the student's answers (Nassaji & Wells, 2000). According to Alexander (2013), the consequences of this type of dialogic exchange, in which talk is essentially one-sided and cognitively unchallenging, are threefold: first, children may not learn as effectively as they should; second, children's potential to engage in dialogic interactions that challenge current perspectives or demonstrate their explanatory capacities may be inhibited or less developed; and third, teachers may be unaware of their students' understanding.

In classrooms where dialogical discourses are prioritised, however, the situation is the opposite. The teacher considers student ideas, enabling different ideas to be explored and combined (Scott et al., 2006). In addition, the teacher is not expected to give the student ready-made information, but to wait for the student to discover, encourage discussion of different ideas and guide them where necessary (Akpinar & Ergin, 2005). The results of this study show that the class atmosphere becomes dialogical with the use of SSI contexts. The participant teachers used the triadic and adjacent utterance discourse patterns in their SSI lessons, and the purpose was the same as that of routine lessons. However, their use of the adjacent utterance and triadic discourse patterns decreased dramatically in lessons in which SSI was used as a teaching and learning context compared to their routine lessons, while the use of the chain discourse pattern increased. Similarly, Bosser and Lindahl (2021) demonstrated that teachers could effectively utilize different communicative approaches in their classrooms to promote students' reasoning skills. It was evident that, as the SSI context allows students to present their ideas and perspectives, the chain discourse pattern emerged naturally in these lessons. In fact, in lessons taught in the context of SSI, the chain discourse pattern was sometimes the dominant approach and was used throughout the lesson.

In these lessons, the nature of classroom interaction changed. Significantly, the types and nature of questions were different compared with those of routine lessons. These questions were generally open-ended and controversial in that the answers varied by person, and the teacher provided continuous feedback. Indeed, it seemed that one of the important differences in SSI-based science teaching was the type of questions that the teacher used in dialogues. It was clear that SSI contexts allowed the teachers ask to thought-provoking questions that allowed students to express their thoughts and compare them with different ideas. Thought-provoking questions such as "Why do you think that? Why is this relevant? Can you explain that a little bit? What if it wasn't? So, what could happen in this situation?" are called

guidance questions (Brooks & Brooks, 1999). The analysis of the classroom discourse indicated that such reflective and thought-provoking questions were frequently used in lessons taught in the SSI context and naturally increased the number of chain discourse patterns.

In learning environments where scientific talk and argumentation are valued and prioritised, students find opportunities to communicate their thoughts freely and compare new ideas with their own (Jiménez-Aleixandre et al., 2000). In cases of no tension between existing and new views, learning progresses is easy for the individual. At other times, conflicts may emerge and will need to be resolved if new and existing ideas are to be integrated. Whatever the path, meaning-making is a fundamentally dialogic process in which different ideas are brought together and worked upon (Mortimer & Scott, 2003). The significance of SSI contexts for science learning appears here since SSI provides important possibilities for social exchange and classroom conversation.

The results of this study show that promoting SSI contexts in science classes is essential to increase the use of dialogical discourse. Sadler (2011) argues that in SSI teaching the teacher is the one who directs the discussion rather than being an authority in the learning environment. The use of dialogical discourse is manifested in the chain discourse patterns, in which dialogue is shaped based on student ideas. In addition, in this study, communication in such dialogues took place not only between teacher and student but also between students. Similarly, Chung et al. (2014) found that SSI instruction could help students to understand the key ideas of others and value their perspectives. Like Gillies's (2016) results, dialogues showed that students changed their minds as they listened to their pairs' opinions.

Indeed, teachers often encounter situations such as crowded classes, time limitations, and discipline problems, which, in turn, negatively affect teaching and learning (Dogan, 2021; Lehesvuori, 2013; Pimentel & McNeil, 2013). All these factors also restrict dialogic exchanges. However, the findings from this study revealed that the SSI context positively diversified the discourse patterns that appear in science courses. This situation suggests that the use of SSI as context will improve communication and interaction in science classes, thus being an important approach to achieving the goal of scientific literacy.

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