# Chapter 10
# Analyzing Discursive Interactions in Science Classrooms to Characterize Teaching Strategies Adopted by Teachers in Lessons on Environmental Themes

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**Abstract** The chapter analyzes discursive interactions in science classrooms to characterize teaching strategies adopted by teachers when addressing environmental issues. We studied classes taught at three different public elementary and secondary schools in Escada, a town located in Pernambuco, Brazil. We analyzed six episodes extracted from 6 of 28 video-recorded lessons involving three science teachers and sixth and seventh grade students. Our analysis took into account discursive dynamics proposed by Mortimer and Scott. We also considered teaching strategy interventions whereby teachers exposed students to situations, phenomena, and scientific concepts to promote science learning and to engage students in decision-making processes. Our results show that the analysis of discursive interactions characterized various teaching strategies in classrooms and revealed different aspects of science teaching and learning that promote scientific literacy. For instance, interactive/dialogic communicative approaches seemed to encourage students to actively participate in classroom discussions and engage in meaning making in regards to scientific concepts and attitudes. Moreover, the content of classroom interactions involving different perspectives seemed to support learning beyond conceptual dimensions and motivate students to make decisions when faced with relevant socioscientific issues.

**Keywords** Teaching strategies · environmental issues · science education · classroom discourse

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## 10.1 Introduction

Environmental problems arising in the contemporary world have prompted science educators and researchers to consider that the educational process should focus more on environmental issues. A new rationale could lead to an emancipation of culture and humanization that may allow for the emergence of innovative forms of living around the world. Through this perspective, environmental education could affect individual ways of life and should be conducted to promote attitudes and skills such as awareness, knowledge, and capacity as defined by Medina (2003) for evaluation and critical action in different contexts.

Science and environmental education share several aims when teachers bring together environmental issues, scientific concepts, and models on the natural world. In science education, it is important to teach students to serve as active citizens, to fulfill certain roles, and to share responsibilities when faced with scientific and technological issues related to the environment and society (Cachapuz, Praia, & Jorge, 2002). According to Carvalho (2006), for environmental proposals, scientific knowledge of nature and of its technological applications constitutes an object of critical understanding as a form of cultural knowledge required to understand socio-environmental relationships. In this chapter, we bring together convergent perspectives on science and environmental education to identify teaching strategies and discursive dynamics in science classrooms that can facilitate scientific literacy.

## 10.2 Literature Review

Roberts (2007) considers that scientific literacy is related to curriculum goals, and it could characterize what school science should be all about and what school should emphasize about science. He lists the aims and purposes of science education, which generate conceptions of scientific literacy: (a) vision I: science education with an inward focus – products (laws and theories) and processes (hypothesizing and experimenting) and (b) vision II: science education involving situations wherein science plays a role, such as decision-making on socioscientific issues. For vision I, "goals for school science should be based on the knowledge and skill sets that enable students to approach and think about situations as a professional scientist would." For vision II, "goals for school science should be based on the knowledge and skill sets that enable students to approach and think about situations as a citizen well informed about science world" (Roberts, 2007, p. 9). From the latter perspective, science education must involve more than information and concepts, as science teaching is designed to address the formation of values and attitudes. The second perspective has informed most science curricula around the world, including the national curriculum used in Brazil. One goal of the Brazilian curriculum is to develop abilities that help students view nature as a complex system whereby individuals in society act as agents who live in relation to the environment and to

other living beings, sharing responsibilities to make the world a better place (Brasil, 1998, 2006).

We argue that scientific literacy can complement perspectives on environmental and science education (e.g., related to the vision II, proposed by Roberts (2007)). In this case, the process of conceptualization involves fundamental relationships between individuals and society and social, cultural, economic, and political issues related to scientific knowledge. In this sense, environmental and science education can lead individuals to become more aware and to help transform their social conditions for the preservation and conservation of the environment. Norris and Phillips (2003) argued for distinctions to be made between fundamental and derived senses of literacy to show that conceptions of scientific literacy tend to neglect the fundamental sense of literacy associated with skills related to reading and writing scientific texts. Nevertheless, it is important to expand this concept toward a more holistic view of literacy that is related to knowledgeability, learning, and education. In this way, science education can promote scientific literacy when students engage in reading, writing, discussing, understanding, applying, and making decisions on scientific, environmental, and social issues.

With regards to teaching approaches in environmental issues, according to Cascino (2005), a naturalistic view of the environment often emerges in school contexts dedicated to environmental education. Pedagogical approaches tend to frame the environment as something to be understood based on laws of biology, chemistry, and physics while raising questions on the impact of human actions on nature (Carvalho, 2006). The naturalist view of the environment refers to the perception of nature as a biological phenomenon, where systemic interactions follow autonomously and independently of the social world, underpinning an understanding of a natural world in opposition to the social world (Carvalho, 2006). Carvalho (2006) states that a predominantly naturalistic view favors a limited understanding of the environment based strictly on physical and biological features despite interactions between the natural world and human culture. For us, it seems that the naturalistic view of the environment facilitates vision I approaches to science education as proposed by Roberts (2007).

In counterpoint to the naturalistic view, socio-environmental views are guided by a complex and interdisciplinary rationale that involves thinking of the environment not as untouched nature, but as a field of interactions among culture, society, and physical/biological dimensions of life processes, whereby all elements of such relationships mutually change dynamics (Carvalho, 2006). According to this perspective, humankind interacts with the environment as one participant of a social, natural, and cultural system of relations in which one component changes all others. In a similar way, we can view nature as a product of relationships of appropriation and transformation that humans form among themselves, which are mediated by work and development based on historical conditions (Tamaio, 2002). Socio-environmental views of the environment seem to favor vision II approaches to science education.

Grace and Ratcliffe (2002) argued that approaches to environmental issues require teachers to teach values that underlie science, environment, and society.

They claim that this challenges teachers to make a pedagogical shift, and many science teachers may find it difficult to do so. However, they cannot evade their responsibility to explain issues that fundamentally affect human health and the environment. Pedagogical strategies could lead students to learn scientific and environmental issues by articulating different dimensions for learning: conceptual, procedural, and attitudinal dimensions. Conceptual and procedural dimensions are related to the emphasis in scientific contents and procedures, respectively; and attitudinal dimension is related to the development of actions and values associated to the studied themes (Pozo & Crespo, 2009). Teachers must determine what students already know to design activities that challenge students, to create opportunities for discussion, to offer formative feedback, and to openly discuss their values and controversial issues (Dillon, 2012).

According to Haydt (1999), teaching strategies stand out as modes of intervention that contribute to teaching and that can expose students to scientific concepts, situations, or phenomena, thus enabling them to think about concepts, procedures, attitudes, and values depending on teachers' choices. Masetto (1997) highlights that teaching strategies function as tools that teachers use in the classroom to guide students toward learning outcomes, and then it gets success if they are embedding instructional value. The adoption of appropriate strategies favors pedagogical outcomes such as student participation and interest, group integration and cohesion, student motivation, attention to individual differences, and the expansion of learning experiences. In relation to critical environmental education, Jacobi (2005) states that teaching strategies can focus on changing habits, attitudes, and social practices; skills development; evaluative capacity; and student participation. Through such a process, discursive interactions established between teachers and students in the classroom play an important role in helping teaching strategies promote science learning and scientific literacy.

In analyzing teaching strategies, we consider an analytical framework on discursive interactions in science classrooms proposed by Mortimer and Scott (2002, 2003), allowing us to examine social interactions that occur between teachers and students in science classrooms and teachers' means of promoting such interactions. The analytical framework is based on five interrelated aspects that focus on the teacher's role, which are grouped into three dimensions: teaching focus (teachers' purpose, the content of classroom interactions), teaching approach (communicative approaches, patterns of interaction), and actions (teachers' interventions). We only discuss communicative approaches, patterns of interaction, and teachers' interventions in this chapter.

The communicative approach focuses on ways in which teachers work with students to address different ideas that emerge during lessons. Mortimer and Scott (2003) have identified four classes of communicative approaches, which are defined by categorizing the talk between teachers and students on two dimensions. The first dimension represents a continuum between *dialogic* and *authoritative* discourse, and the second dimension involves *interactive* and *noninteractive* talk. In a *dialogic* communicative approach, attention is placed on more than one point of view, more than one "voice" is heard, and an exploration or "interanimation"

(Bakhtin, 1934/1981) of ideas occurs. In an *authoritative* communicative approach, attention is placed on only one point of view, only one voice is heard and there is no exploration of different ideas. An important feature of the distinction between dialogic and authoritative approaches is that a sequence of talk can be dialogic or authoritative independent of whether it is uttered individually or between people. Thus, under the second dimension, *interactive* talk allows for the participation of more than one person, and *noninteractive* talk is performed by only one person. These two dimensions can be combined to create four classes of communicative approaches: (1) interactive/dialogic: teacher and students explore ideas; formulate authentic questions; and offer, consider, and work with different points of view; (2) noninteractive/dialogic: teacher reconsiders, in her speech, various points of view, highlighting similarities and differences; (3) interactive/authoritative: teacher generally guides students through a sequence of questions and answers, with the aim of reaching a specific point of view, typically one that supports school science; (4) noninteractive/authoritative: teacher presents a specific point of view, normally one that supports school science.

Patterns of interaction specify how a teacher and his or her students take turns in the classroom talk. It is helpful to evaluate whether interactions promote student engagement in classroom discourse. The most common patterns of interaction are I-R-E triads (Initiation by the teacher, Response by the student, and Evaluation by the teacher), but other patterns are also present in classrooms. In these patterns, a teacher offers a response to a student to prompt a further elaboration of their point of view and to thereby sustain interaction. In this way, the student is encouraged to elaborate on and explicitly outline their ideas. In some interactions, a teacher may prompt students to discuss through short interventions that often repeat part of what a student has just said or otherwise offer feedback for a student to explain his or her perspective further. These interactions generate chains of nontriadic turns (e.g., I-R-P-R-P … or I-R-F-R-F …) where P denotes a discursive action that prompts a student to talk and where F denotes feedback. Here, feedback is different from evaluation because it favors interactions between teacher and students to keep going. Evaluation, on the contrary, stops the chain of communication.

The final feature of the analytical framework presented by Mortimer and Scott (2003) focuses on ways in which a teacher intervenes to develop a scientific story and to make it available to all students in a class. In this chapter, we use these forms of intervention to characterize didactic strategies used by teachers in their classrooms. From Mortimer and Scott (2003), we characterize six forms of teacher interventions in terms of teacher focus and actions that correspond to: (1) shaping ideas, whereby a teacher's action can introduce a new term or paraphrase a student's response; (2) selecting ideas, whereby a teacher can focus attention on a particular student's response or overlook a student's response; (3) marking key ideas, whereby a teacher can repeat an idea; (4) sharing ideas, whereby a teacher can share individual ideas with a class; (5) checking students' understanding, whereby a teacher can solicit clarification on a student's idea; (6) reviewing, whereby a teacher can review activities of a previous lesson or the progress of the scientific story.

From the structure presented above, our analysis of discursive classroom interactions enabled us to characterize ways in which teachers interact with students in constructing meaning. This characterization seems to be essential to understanding how teaching strategies used by science teachers can promote scientific literacy.

## 10.3 Methodology

We employed a qualitative approach to our methodological design. The investigation involved three teachers of Biology (T1, T2, and T3), in three classes of sixth (T1), seventh (T2), and sixth (T3) grades, each one attended by about 25 students, in three different public schools across Escada, a town located in Pernambuco, Brazil. The teachers have the following professional profiles (Table 10.1).

We selected for analysis lessons in which teachers discuss environmental themes in the classroom. Data were collected from the video-recorded lessons. Various tables were constructed to illustrate the timing, activities, actions, themes/contents, and comments for each lesson. These tables provided an overview of the lessons, situating the analyzed episodes within full lessons. Our definition of episode is an adaptation of event definition in the tradition of interactional ethnography. Thus, an episode is defined as a coherent set of actions and meanings produced by the participants in interaction, which has a clear beginning and end and which can be easily discerned from the preceding and subsequent episodes. The episodes represent moments during the lessons whereby environmental themes emerged through discursive classroom interactions. From the selected lessons, six episodes were extracted and transcribed for analysis – two episodes for each teacher – and they were organized by numbering turns of speech. We refer to teachers (T1, T2, and T3) and students (S1, S2, S3, …) using initials and numbers. In Table 10.2, we present all of the episodes analyzed for this chapter.

In the study, we considered segments of episodes, represented by a set of turns, that depict different teaching strategies used by the teachers and discursive aspects that characterize interactions promoted during a specific moment of a lesson.

**Table 10.1** Professional profiles of the teachers who participated in the study

| Teacher | Formation: undergraduate/specialization courses | Teaching experience | Number of analyzed lessons |
|---|---|---|---|
| T1 | Science Teachers of Biology/Environmental Science | Elementary and secondary school for 15 years | Two from 14 recorded lessons for grade 6 |
| T2 | Science Teachers of Biology/Biological Sciences | Secondary school for 13 years | Two from six recorded lessons for grade 7 |
| T3 | Science Teachers of Biology/Science and Biological Teaching and Adult Education | Secondary school for 10 years | Two from six recorded lessons for grade 6 |

**Table 10.2** Episodes analyzed

| Teacher | ID episode | Discussion topic |
|---|---|---|
| T1 | 1.1 | Soil degradation and agricultural practices |
| | 1.2 | Soil pollution and prevention measures |
| T2 | 2.1 | Human effects on ecosystems |
| | 2.2 | Prevention of human effects on ecosystems |
| T3 | 3.1 | School waste |
| | 3.2 | Environmental conservation actions |

Due to space limitations, we only present the transcription for episode 1.1 in this chapter. However, all of the episodes are examined in our discussion of the results.

## 10.4 Results

We organize our results by presenting the episodes analyzed for each teacher and by then summarizing our overall analysis of the study data.

### *10.4.1 Teacher T1*

In episode 1.1, T1 had the intention to introduce and develop scientific views by facilitating an understanding of soil degradation and pollution processes resulting from deforestation and burning. The teacher used, as teaching strategies, questioning, reading the textbook, and oral presentation (when teacher exposes contents to the students mainly by verbal language), as shown in the transcription for episode 1.1.

Episode 1.1 Discussion on soil degradation and agricultural practices[a]

| Turns | Pattern of interactions |
|---|---|
| 1. T1: How have human beings contributed to soil degradation? Can someone guess? Nobody knows ((The class is quiet; the teacher picks up a book)). Let's take a look at the textbook, let's go! (++++) ((Before the pause, the teacher asks the students to read the book excerpt)). | I – Initiation |
| 2. READING FROM THE TEXTBOOK: Currently, ineffective agricultural practices degrade and pollute thousands of tons of soil worldwide. | |
| 3. T1: Check this out briefly … right? Most soil degradation occurs when vegetation is removed. You see, there are agricultural practices. | I – Initiation |

(continued)

(continued)

| Turns | Pattern of interactions |
|---|---|
| Do you know what agricultural practices are? S1 says here ((points to student 1 and asks him to explain)). | |
| 4. S1: Agriculture | R – Response |
| 5. T1: Agriculture, isn't it? This involves the planting of foods that are essential to us, right? Soybeans, wheat, rice, etc. in many cases, right? This agricultural practice, right? It can harm and degrade the soil. What happened thousands of years ago? Were cities the same as they are today? No! Right? Long ago, going back in history, when Brazil was first discovered, I'm going to talk about Brazil, our country, when we arrived here in Brazil. When they (colonizers) arrived here, was Brazil the way it is today? | E – Positive evaluation<br>I – Initiation |
| 6. S: No | R – Response |
| 7. T1: Was the population as large as it is today? | I – Initiation |
| 8. S: No | R – Response |
| 9. T1: No, and consequently our soils and natural environments weren't as they are today, right? The population grew, development occurred and people started to need more places to live – buildings and houses, right? Progress occurred – development and industry, right? Also, the need for agriculture and cattle ranching … what is cattle ranching? Can anybody tell me? Agriculture, (you) already know that involves plantation, but cattle ranching? (+++) Anyone remember? Have you never heard that word before? (++++) Okay, cattle ranching involves livestock on a farm. There can be cows, bulls, pigs, horses, etc., right? Often, vegetation is used as pastureland for these animals, and this can damage the soil. But back to what we were talking about before, check it out, what happened? There was a need … ((teacher points to someone near the door). There was a need for construction. Building became necessary to do … what? Someone must …. | E – Positive evaluation<br>I – Initiation |
| 10. S1: Plant trees | R – Response |
| 11. T1: What was needed to plant trees? | Repeating the question, meaning<br>E – Negative Evaluation |
| 12. S2: Cutting down trees | R – Response |
| 13. T1: Cutting down trees, is this clear? ((Teacher reinforces the student's response)). This raises the issue of deforestation, which is highlighted in your book and which also contributes to soil degradation. So is it deforestation? Is the meaning clear? What does this mean? What? | E – Positive evaluation<br>I – Initiation |
| 14. S3: Cutting down trees | R – Response |
| 15. T1: Cutting down trees. And, many times…. | E – Positive evaluation<br>I – Initiation |
| 16. S3: Destroying … | R – Response |

(continued)

(continued)

| Turns | Pattern of interactions |
|---|---|
| 17. T1: Somehow, it is destroyed. So why does this happen? You see I'm not against progress. We cannot be against progress, as it is necessary. But unfortunately, it brings, in some ways, destruction to nature, and consequently to the soil. You see, as I was saying, this is the purpose of deforestation. For people to actually build on and populate a place, it must be cleared. This was a necessity, but we ended up destroying the soil. In addition to deforestation ((writing the word on the chalkboard)), what is the other item we have here? ((Referring to the textbook)) deforestation, what else? Another item? ((Asks students look at the textbook)). | E – Positive evaluation<br>I – Initiation |
| 18. S4: Erosion | R – Response |
| 19. T1: Other point … erosion, this will come later (in the lesson). I am checking up there (the teacher points to a theme described in the textbook)). Deforestation we already see, but there is another point next to it. | F – Feedback |
| 20. S: Forest burning | R – Response |
| 21. T1: Exactly, forest burning. Actually, forest burning from deforestation, right? Why? Because people … ok. I am going to provide an example. Here in our town, what happens at a sugarcane plantation? What do people do (in soil) before cultivating sugarcane? | E – Positive evaluation<br>I – Initiation |
| 22. S: Burn | R – Response |
| 23. T1: Burn. Do you think this is necessary? In some ways it is, but does it harm or benefit the soil? | E – Positive evaluation<br>I – Initiation |
| 24. S: Harm | R – Response |
| 25. T1: It will cause harm because (burning) degrades more and more (soil), killing microorganisms. Soil supports many living things, right? Right? Many living things live in soil, and so burning forests kills these microorganisms and other animals, right? | E – Positive evaluation |
| 26. S1: And (it) pollutes the air. | I – Initiation |

[a]Conventions used in the transcription:
(+) – pauses;
( ) – insertions from authors;
(( )) – comments from authors;
…. – inconclusive speech or hesitation;
(…) – speech omission
CAPS LOCK – emphasis

In episode 1.1, the teacher focused the content of classroom interactions on a conceptual level by checking the students' comprehension of deforestation processes, agricultural practices, forest burning processes, etc. (turns 13–21), though not in the case of forest burning methods for cultivating sugarcane, for which a local case was highlighted (turn 21). This approach can be used to develop an understanding of the environment that is associated with the utilization of natural resources without considering an important dimension related to permanent interactions between the natural world and human culture.

The interactive–authoritative communicative approach was used in this episode. A focus on two enunciators – the teacher and textbook – contributed to an emphasis on the school science perspective in the discursive interactions. Student participation was restricted, as interactions permitted by the teacher only allowed students to speak briefly and to guess what she was thinking (see turns 9–12 and 17–21). In a general sense, students expressed ideas that reinforced what the teacher put forward in the discussion as supported by the textbook used. Patterns of interaction involved IRE triads (I-R-E (3-5); I-R-E (13-15), I-R-E (21-23) and I-R-E-I (23-26)) and one short chain (I-R-F-R-E (17-21)).

Several teacher's interventions were used to introduce agricultural practices as a cause of soil degradation. She asked the students to read an excerpt from the textbook featuring this idea (turn 2) and highlighted key points that support the view that soil degradation is a reflection of human actions. In the following turns (3–26), the teacher mainly focused on meanings related to scientific perspectives, highlighting key terms while repeating statements to the students (turns 5, 10, 13, 15, 21, 23, and 25), selecting meanings when responding to a student, and referring to another perspective expressed in the textbook before discussing the issue of "erosion" (turn 19). In this case, it seems clear that the textbook guided the teacher's discourse in the classroom.

It is important to highlight that the teacher drew attention to certain meanings (turns 11–17), leading students to think about negative effects of deforestation. She states that it is necessary to clear-cut areas so that humans can build homes, farms, offices, and so on. However, she does not facilitate dialogic interactions with the students when discussing opportunities for human beings to live in the natural world in a harmonious and respectful way. Despite the teacher's intention to pose questions on this particular theme, a naturalist view of the environment prevailed in the teacher's discourse.

### *10.4.2 Teacher T2*

During the two lessons, the teacher described human effects on ecosystems, and students gave oral presentations on different roles or ways in which human beings can preserve the environment using posters that they had created.

For episode 2.1, we observed that the teacher mainly adopted oral presentation as a teaching strategy. During the episode, T2 presented a brief review of prior lessons and asked students to read and present textbook excerpts to facilitate class discussions. In doing so, it seemed that teacher's intention was to introduce scientific ideas on ecosystem degradation and to then explore the students' views through their presentations on these ideas. The content of classroom interactions addressed a conceptual dimension when the teacher cited excerpts from the textbook and a procedural dimension when students engaged planned actions related to environmental issues.

In the final moments of episode 2.1, the teacher seemed to reinforce a negative view of the relationship between human beings and the natural world. It is important to highlight that views that explain the origins of Earth, supported by faith in a Creator who conceived all the things in Universe (creationist view), seem to reinforce a negative view of human effects on the environment: "… we review how Earth was constructed … appeared. How God, the creator, gave this planet to man, right? We commented on all of these things … how we received Earth from God, and how science states how it was formed … It was beautiful … natural … without human effects. So what happened? God created man to master all things … and so now, Earth has adapted to this situation" (T2 in episode 2.1). This comment suggests that the teacher found it difficult to present a rational and critical view of environmental issues.

The communicative approach employed was predominantly noninteractive/authoritative, as the teacher adopted mainly oral presentation as her teaching strategy. When students presented ideas based on textbook excerpts, an interactive/dialogic approach was used in the classroom, as the teacher interacted with students during their presentations. At least two points of view emerged through the discursive interactions: the scientific view, which is represented by ideas presented in the textbook used, and the student's ideas. For example, S2 stated: "And so, with the way that mankind is damaging nature, even human beings could become extinct. But, if man does not make certain products like chairs, beds, and wardrobes, how could we survive without a seat or bed? That's one thing I want to know … ((asking the teacher))." The teacher addressed this question by describing ways in which humankind can intelligently use natural resources without damaging the environment. Despite the occurrence of student participation, interactions between the teacher and students followed triadic patterns of interaction, with more than one response provided by the students and with the teacher listening to them before closing the discussion through an evaluation. The students often limited themselves to expressing their ideas, but they did not comment on the teacher's evaluation. In this sense, scientific views prevailed in the face of student questioning or misunderstanding, and the textbook played a predominant role in the lesson.

In episode 2.1, T2's interventions involved reviewing the development of scientific ideas and sharing and selecting meanings oriented toward a view of the environment as separate from human issues. This view holds institutions responsible for addressing environmental issues without consideration of the roles played by individuals in this context.

In regards to episode 2.2, we highlight a moment when the students' presentations were concluding and the teacher tried to organize conclusions of the discussion raised in the previous lesson. Some concluding ideas appeared to emerge through a poster presented by student S4: "As we can see, here we have the first figure ((points to the figure)) of wheat crops. Wheat is very important to our lives. However, this is very different from the first frame ((points to the other figure)). Here, he (the farmer) is only clearing the forest. If he had already planted wheat

with his wisdom, we can understand why he destroyed the forest and the trees of the forest to plant wheat. From his wisdom, he cleared trees and planted wheat (…).” It seems that the teacher argued that deforestation can be defensible if it involves growing crops, and she used this case as support for this claim. In the other hand, she highlighted the roles played by institutions and human beings in preserving the environment: “If we help human beings be conscious and aware of our negative effects on nature, we will have a better world.” T2’s position on the exploitation of natural resources by human beings is not clear. Opportunities and controversies involving human uses of natural resources were not addressed.

### *10.4.3 Teacher T3*

In the two lessons, T3 explored issues of school waste and environmental conservation. In episode 3.1, the teacher returned to the theme of school waste and asked questions to have students reflect on causes of other environmental problems (e.g., forest burning, deforestation, poverty, disease, violence, waste, consumerism) and on ways to address and overcome such problems.

The teacher T3 adopted questioning as a teaching strategy throughout the episode. She guided and engaged students in a classroom discussion, thus encouraging them to think about environmental issues and social compromises. The content of classroom interactions predominantly focused on the attitudinal dimension, helping students make decisions and perform critical actions supported by concise arguments.

The communicative approach used in episode 3.1 was interactive/dialogic, as throughout the episode, the teacher and students expressed ideas, and different points of view were taken into account through a discussion. In this sense, much of the time, extended chains prevailed as patterns of interaction as shown in the excerpt from episode 3.1 (turns 4–10):

Excerpt from episode 3.1: Illustrating extended chains

| Turns | Patterns of interaction |
|---|---|
| … | |
| 4. S1: We have to collaborate. | R – Response |
| 5. T3: We have to collaborate, but in what way? | P – Prompt |
| 6. S2: By not littering? | R – Response |
| 7. T3: But is just not littering collaborating? Could we do more? | P – Prompt |
| 8. S3: By not polluting the rivers and air. | R – Response |
| 9. T3: Yes – not polluting the air, not polluting the rivers, and not littering. We can do something to change this (situation), can’t we? | P – Prompt |
| 10. S: We can. | R – Response |
| … | |

When the teacher offered her students feedback, she encouraged them to reply to questions on their responsibilities related to the environment. The teacher's interventions suggest that she framed meanings while the students expressed their ideas, identified key ideas (turn 5), shared meanings (turn 9), and measured the students' comprehension by asking them to elaborate on their ideas (turn 7).

In episode 3.2, the teacher posed questions about dengue fever and about areas where there is a higher incidence of this disease. In doing so, she prompted her students to think about causes and consequences of this social, health, and environmental problem. The teacher prompted interactions between the students by questioning and measuring their level of understanding. Her students then presented their ideas on environmental issues affecting daily life. In this case, they discussed dengue fever and school waste. Finally, the teacher asked her students to reflect on their ideas.

## 10.5 Discussion

Results point out particular characteristics for each teacher involved in this work. For teacher T1, our analysis of episode 1.1 shows that the didactic strategy adopted by this teacher mainly involved oral presentation to textbook content. In this case, the didactic strategy did not appear to promote effective discussion on themes introduced during the lesson. These discursive features characterize T1: the teacher's intention was to focus heavily on the presentation of scientific views on the themes, the content of classroom interactions was limited to the conceptual dimension, communicative approaches were mainly interactive–authoritative, and patterns of interaction were predominantly triadic (IRE) with only one short chain. In episode 1.2, T1 sought to enable students to reflect on negative effects of forest burning on soils. She discussed ways to prevent such environmental consequences, guiding students using scientific perspectives. In the discussion, there was an emphasis on pollution as a principal result of human actions related to garbage disposal. Again, the teacher adopted predominantly oral presentation strategies while maintaining a conception of society–nature relationships that was essentially naturalist, and even when she described behaviors that can promote environmental preservation. Patterns of interaction were, again, IRE triads and the content of classroom interactions was predominantly conceptual.

During the two lessons, we verified that teaching strategies adopted by T1 did not enable students to develop a greater appreciation for different ideas throughout the construction of meanings. The predominantly authoritative communicative approach emphasized the school science views on environmental issues, disallowing the emergence of different perspectives. This appears to hinder the development of educational services for citizens and goals of environmental education. Triadic patterns of interaction prevailed during these lessons. The teacher initiated all interactions, students were afforded few opportunities for participation and the

**Table 10.3** Summary of the analysis of teacher T1: discursive aspects and teaching strategies

| Teaching strategy | Oral presentation | Reading | Questioning |
|---|---|---|---|
| Main discursive features | | | |
| Teacher's intention | Introducing and developing a scientific perspective<br>Promoting discussion<br>Guiding students on scientific ideas | Introducing and developing a scientific perspective<br>Promoting discussion | Introducing and developing a scientific perspective<br>Promoting discussion<br>Guiding students on scientific ideas |
| Content of classroom interactions | Conceptual | Conceptual | Conceptual |
| Communicative approach | Noninteractive/ authoritative<br>Interactive/ authoritative | Noninteractive/ authoritative | Interactive/ authoritative |
| Teacher's interventions | Selecting meanings<br>Marking key meanings<br>Sharing meanings<br>Shaping meanings | | Sharing meanings<br>Marking key meanings |
| Patterns of interaction | Episode 1.1<br>I-I-R-E (1-5); I-R-E (13-15); I-R-E (21-23) and I-R-E-I (23-26) – and one short chain – I-R-F-R-E (17-21)<br>Episode 1.2<br>I-R-F-R-F-R-E (1-9); I-R-E (9-11); I-R-E (11-13); I-R-E (13-15); I-R-E (15-17); I-R-E (17-19); I-R-E (19-21); I-R-E (21-23); I-R-E (23-25); I-R-R-E (25-28); I-R-E (28-30);<br>I-R-F-R-E (30-34); I-R-R-E (34-37); I-R-E (37-39); I-R-F-F-F-E (39-43). | | |

teacher's evaluation did not allow students to develop critical ideas. Table 10.3 shows a summary of the analysis on teacher T1.

In the two lessons, the teacher T2 used strategies that seemed to consider more than one point of view in discussions, as students were allowed to present their ideas. Effective student participation through oral presentations promoted an interactive/dialogic communicative approach. However, T2 did not promote a deep discussion on the themes, highlighting difficulties that can arise when developing values required to make critical decisions on environmental issues. This seemed to cause teacher T2 to focus the content of classroom interactions on conceptual dimensions and to limit interactions with students to triadic patterns. In this case, the interactive–dialogic communicative approach was limited, supporting weak interactions and superficial discussions. Table 10.4 presents a summary of the analysis on teacher T2.

In general, teacher T3 adopted teaching strategies that guided students through environmental education, questioning, study activity proposal, and supervision when she emphasized two dimensions in classroom interactions: conceptual and

**Table 10.4** Summary of the analysis on teacher T2: discursive aspects and teaching strategies

| Teaching strategies | Oral presentation | Oral presentation by students |
|---|---|---|
| Main discursive features | | |
| Teacher's intention | Introducing and developing scientific ideas<br>Supporting the student learning process | Exploring students' ideas |
| Content of classroom interactions | Conceptual | Conceptual<br>Procedural |
| Communicative approach | Noninteractive/authoritative<br>Noninteractive/dialogic | Interactive/dialogic |
| Teacher's interventions | Reviewing the progression of scientific ideas<br>Sharing meanings<br>Selecting meanings | Sharing meanings |
| Patterns of interaction | Episode 2.1<br>I-R-R-R-R-R-E (1-7); I-R-E (7-9); I-R-F-R-R-R-R-R-R-E (9-17);<br>Episode 2.2<br>I-R-E (1-3) | |

attitudinal. These teaching strategies promoted student participation and the discussion of different perspectives circulating through the classroom discussion. Such strategies also helped students make critical and sound decisions. Interactive/dialogic approaches were used in conjunction with interactive/authoritative communicative approaches during the analyzed episodes. Patterns of interaction predominantly included extended chains whereby feedback seemed to prompt students to think about the relevance of such themes and about their engagement in searching for solutions to environmental problems. Pedagogical positions related to socio-environmental views were adopted by teacher T3. Table 10.5 summarizes our analysis of episodes for teacher T3.

According to these results, the three teachers adopted different teaching strategies and discursive dynamics in their lessons. In addition, each teacher seemed to express a specific view on the environment. We summarize these results in Table 10.6.

Table 10.6 illustrates features related to teaching strategies and discursive dynamics in the analyzed lessons that facilitate or inhibit the development of scientific literacy in science and environmental education. In putting forward socioscientific and environmental issues in classroom discussions, the teachers did not necessarily help students develop skills and competencies associated with scientific literacy. In addition, it is not desirable for teachers' academic or scientific views prevail in discussions (see teacher T1). For scientific literacy in a fundamental sense (Norris & Phillips, 2003), it is not enough for students to read textbooks or make oral presentations, and it seems crucial to encourage critical debates touching on different points of view to achieve meaningful learning outcomes (see teacher T2). Finally, teach T3's socio-environmental views based

**Table 10.5** Summary of the analysis on teacher T3: discursive aspects and teaching strategies

| Teaching strategies | Questioning | Proposing and supervising study activities |
|---|---|---|
| Main discursive features | | |
| Teacher's intention | Helping students engage in study activities<br>Promoting discussions on environmental issues and social commitment<br>Developing arguments to help students make decisions | Motivating students to plan actions |
| Content of classroom interactions | Conceptual<br>Attitudinal | Conceptual<br>Attitudinal |
| Communicative approach | Interactive/dialogic<br>Interactive/authoritative | Interactive/dialogic<br>Interactive/authoritative |
| Teacher's interventions | Shaping ideas<br>Marking key meanings<br>Sharing meanings<br>Checking student understanding | Shaping ideas<br>Sharing meanings<br>Marking key meanings |
| Patterns of interaction | Episode 3.1<br>I-R-F-R-F-R-F-R-F-R-F-R-F-R-E (1-15); I-R-R-F-R´F-R-E (15-22); I-R-E (22-24); I-R-F-R-F-R-F-R-F-R-F-R-F-R-F-R-F-R-F-R-F-R-E (24-47).<br>Episode 3.2<br>I-R-F-R-F-R-F-R-E (1-7); I-R-E (7-9); I-R-F-R-E (9-13); I-R-E (13-15); I-R-E (15-17); I-R-E (17-19); I-R-F-R-E (19-23); I-R-E (23-25); I-R-F-R-F-R-E (25-31); I-R-E (31-33); I-R-E (33-35); I-R-F-R-F-R-E (35-41); I-R-E (41-43). | |

**Table 10.6** Teaching strategies and discursive dynamics found for the three teachers

| Teacher/environmental view | Didactic strategies | Content approach/patterns of interaction | Communicative approach |
|---|---|---|---|
| Teacher T1/naturalistic | Reading the textbook<br>Oral discussion | Conceptual/ triadic | Interactive–authoritative |
| Teacher T2/Creationist view; the environment is separated from human beings | Oral discussion<br>Oral presentations by students | Conceptual and Procedural/triadic | Noninteractive/ authoritative |
| Teacher T3/Socio-environmental | Questioning | Conceptual and Attitudinal/ extended chains | Interactive/ dialogic<br>Interactive/ authoritative |

on dialogic communicative approaches established from patterns of interaction in extended chains and based on questioning on conceptual and attitudinal dimensions of the content seemed to help students discuss environmental issues, fundamentally supporting scientific literacy.

Some teaching strategies (e.g., questioning) improved discursive interactions in science classrooms by creating opportunities for discussion and debate. Nevertheless, questioning does not guarantee that the students' points of view will be taken into account in classroom discourse. When questioning is based mainly on triadic patterns of interaction, as was the case for T1, communicative approaches employ a predominantly authoritative and interactive dimension and questioning serves mainly to measure and control meanings introduced in classroom discourse. By contrast, when questioning allows students to express their points of view, as was the case for T3, chains of interaction occur and communicative approaches are predominantly dialogic and interactive.

We highlight two relevant factors from the results of this investigation. First, the teachers' views on the environment – whether naturalistic, not well-defined, or socio-environmental – appear to guide teaching strategies in science classrooms, mainly regarding the content introduced and opportunities for students to express their ideas, as allowed by the teacher. There is not a necessary relationship between dialogic communicative approaches and socio-environmental views and between authoritative approaches and naturalistic views. As we have shown, T2 presented a not well-defined view but used a dialogic communicative approach. Nevertheless, the use of attitudinal content seems to improve opportunities for dialogic communication and brings about socio-environmental views in classroom discourse.

Second, interactive/dialogic communicative approach played a key role in engaging students in classroom discussions, and they appeared to favor the development of attitudinal dimensions for learning, although they did not guarantee such an outcome. In the same vein, we consider patterns of interaction in extended chains that promote dialogic interaction, which other works have examined (Aguiar, Mortimer, & Scott, 2009; Scott, Mortimer, & Aguiar, 2006).

## 10.6 Final Remarks

This work presents an analysis of didactical strategies and discursive dynamic adopted by teachers when they approach environmental issues in classroom, bringing together ways of integrating science and environmental education. In this sense, it seems necessary to engage students in dialogic and interactive discussions that offer them opportunities to learn, analyze, form positions, identify solutions, and make decisions in real life that are supported by scientific knowledge. According to this perspective, science curricula should not only be concerned with scientific content but also with values, cultural norms, ethics, policies, and social demands, guiding teachers and schools toward the development of scientific literacy in a fundamental sense.

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