ARGUMENT AND EXPLANATION IN CLASSROOM DISCOURSE

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ABSTRACT: This work proposes to investigate the features of the discursive interactions among teachers during a teaching sequence about ecology. The results show a predominance of explanatory interactions and only one argumentative interaction. Although some turns present the structure of an argument according to Toulmin's model, most interactions lack contextual indicators of argumentative process such as dispute of ideas and engagement in persuasion. Thus, the focus on discursive interactions rather than argumentative products may help to clarify the distinction among practices of the classroom discourse.

KEYWORDS: Argument, explanation, discursive practices, science education.

INTRODUCTION

During the past two decades, the potential role of argument in formal science education has been a significant focus of research (Kuhn, 1991; Driver *et al.*, 2000; Erduran; Jiménez, 2008). However, the field lacks clarity about the concept of "argumentation" (Osborne; Patterson, 2011). The distinction among argumentation and other discursive practices is necessary to define the goals of classroom interactions properly.

Osborne and Patterson (2011) have identified confusion in the literature between the concept of argument and the concept of explanation. In an explanation, the purpose is to make sense of a phenomenon, increasing the understanding accounting for its genesis. The main feature of an explanation is that the phenomenon to be explained is not in doubt. Driving the need for explanation is the presupposition that the phenomenon occurred. In an argument, however, there is not so much a phenomenon to be explained but a claim to be justified. Arguments attempt to justify conclusions that are equivocal with a claim that is supported by the data, which act as the premises for the claim.

Some of the conflation of argument and explanation arises because arguments are essential to the process of justifying the validity of any explanation as there are often multiple explanations for any given phenomenon. However, there are two discursive entities: the explanation that attempts to account for the given phenomenon, and an argument that examines the question of whether the explanation is valid (Osborne; Patterson, 2011).

The explanatory discourse does not contain ideas in dispute since the explanations begin with statements presumed to be true (Vieira; Nascimento, 2009). Thus, the process of justifying the occurrence of a phenomenon through an explanation does not aim to convince or persuade the listeners but to make the unfamiliar, familiar or more readily comprehended. On the other hand, the argumentation arises from uncertain issues and the process to justify them must convince the audience about which claim is more coherent and plausible.

A clear definition of "inference" is also necessary for studies of classroom discourse. The practice of inferring is the act of deriving logical conclusions from premises known (body of evidences) and it is another important practice of science (Santa-Clara; Spinillo, 2006). The warrants of any argument are premises used to lead listeners to a particular claim (Osborne; Patterson, 2011), and many scientific explanations provide causal accounts of phenomena through inferences, for example, hypothetico-deductive accounts in the form of *modus ponens* ("*if* p, *then* q; p, *therefore* q") (Lawson, 2004). Thus, argument as both explanation and inference can be seen as discursive processes of justification, which can confuse scientists and teachers.

The most used methodological approach to analyze classroom discourse is Toulmin's (1958) model or Toulmin's Argument Pattern (TAP), which proposes a more prescriptive characterization of argumentation, determining the structure of an argument (Erduran *et al.*, 2008). However, analyses of TAP have been criticized because the focus is on the argumentative products (components of an argument) and not on the argumentation as a process. The model attempts to capture the elements that support one claim and not controversial claims in dispute, being a limited approach to distinguish argument from explanation and inference (Leitão, 2007).

More procedural and contextual indicators are important to avoid confusions when analyzing overlapping discursive practices in school context. For example, one way to distinguish the argumentative discourse would be identifying its persuasive nature. Studies of classroom discourse focused on teachers' practices and expansion of analytical approaches are still scarce in literature (Keys; Bryan, 2001). Thus, this work proposes to investigate the features of the discursive interactions among teachers during a teaching sequence about ecology.

METHODOLOGY

The participants are a group of 70 biology teachers from public high schools in the State of São Paulo, Brazil. To assess the discursive interactions, each teacher was videotaped and audio-recorded while solving a teaching sequence mediated by two members of the LINCE research group of University of São Paulo (USP) (referred to hereafter as educator I and educator II). The activity lasted 90 minutes and the audio-recordings were fully transcribed to capture all the teachers' oral contributions.

The teaching sequence relied on the 'predict-observe-explain' framework by Erduran (2006) and provides a context for exploring teacher engagement in scientific argumentation. This framework promotes the evaluation of alternative explanations about a particular phenomenon. For this study, we chose an ecological phenomenon - the structure of plant communities - and the participants had to discuss the effects of seed predation and competition between plants on tropical forests.

The analysis of the transcripts was undertaken in three stages. The first step was to divide the transcripts in episodes, which contextualized the participants' actions and offered a panoramic view over the flow of discursive interactions throughout the teaching sequence. An episode is a set of turns devoted to a single activity, topic or theme within the lesson.

The second step was to identify the discursive practices of the teachers, and for this we elaborated the following categories: *Classifying; Defining; Describing; Comparing; Concluding; Deducing; Justifying*. The first three categories were adopted from Silva (2008) analyzing the typical epistemic operations of school science, and the other ones were elaborated in interaction with the data. Argument and explanation were not included because they are wider discursive practices. For example, one explanation can involve the *description* of causal mechanisms that act as *justification* to *deduct* certain events or phenomena. Thus, the identification of arguments and explanations required a third analysis step.

This third step was to categorize the discursive interactions as argumentative or explanatory. The main indicator of argumentative discourse was the presence of at least two controversial *conclusions and their respective justifications*. When the goal of the discursive practices was to increase the understanding of an assertion (a single conclusion), rather than defend ideas in dispute (at least two controversial conclusions), the discursive interactions were categorized as explanatory. The explanatory episodes were categorized into different levels of complexity, as described in the next topic.

RESULTS

The teachers presented the following discourse moves throughout the teaching sequence (Table 1):

Table 1.
Categories of discursive interactions observed in this study.

Episodes	Predominant type of discursive interaction
Episode 2. Hypothesizing causes of the differences between two tropical forests	Explanatory interaction on level zero, *changing to* level one *at the end of the episode*
Episode 3. Focusing on the seed predation as causal account	Explanatory interaction on level two
Episode 4. Testing the hypothesis about predation	Explanatory interaction on level two
Episode 5. Focusing on the competition between two plant species	Explanatory interaction on level two
Episode 6. Testing the hypothesis about competition	Argumentative interaction

Explanatory interaction on level zero occurs when the teachers list causes (factors) of a phenomenon, but without indicating the generative relations or relations of causality between these elements. When the causal mechanisms are also described, offering well-established explanatory accounts of the phenomenon, the explanatory interaction acquires the level one of complexity. On levels zero and one, the discourse is dominated by *description* and there are no practices of *justifying* and *concluding*.

Example of explanatory interaction on level zero (episode 2):

Turn	Speaker	Quote	Discursive Practice
100	Educator II	So... how to explain the differences between the two forests?	
101	*Teachers*	Climate... soil... moisture	*Describing* (listing causes)
102	Educator I	But... what are the hypotheses?	
103	*Teachers*	Climate... soil	
104	*Teacher?*	Climate... soil... moisture	
105	*Teachers*	Soil	
106	Educator I	No... this is not hypothesis	

Example of interaction on level one (episode 2):

129	*Teacher 12*	If the red plants are more adapted to the soil type of the forest A (...)	*Deducing*
130	Educator I	Then... if they are more adapted... then...	
131	*Teacher 12*	There will be more red plants at the site A	*Deducing* (*describing* relations of causality)
132	Educator I	The site will have greater amount	

Beyond constructing causal accounts of a phenomenon, interaction level two aims to *justify* the choice of certain generative relations. Complex explanations are dependent on multiple generative relations. That is, the generative relations that form the explanations are themselves dependent on prior explanations, which are seen as being "primitive" with respect to the explanation itself. Thus, on level two, there are two explanatory moves: the first to explain the phenomenon (explanation itself) and the second to clarify why this explanation is valid (prior explanation).

Example of interaction on level two (episode 3):

> In this episode, teachers had to complete the following exercise (the intervals [1] and [2] should be completed with the verbs <u>increase</u> or <u>decrease</u>):
>
> "If the seed predation rate ____[1]____, the abundance of plant species will ____[2]____, because ____[3]____."

193	Educator I	If the seed predation rate...	
194	*Teachers*	Increases	*Deducing*
195	Educator I	If the seed predation rate increases... the abundance of plant species will...	
196	*Teachers*	Decrease	*Deducing* (*describing* relations of causality - first explanatory move)
197	Educator I	Decrease	
198	Educator II	Why?... Why is it an inverse relationship and not a direct one?	
199 - 267	[...]		
268	Teacher 2	Because the predator destroys the seed embryos... impeding the birth of new plants	Justifying (justifying the deduction - second explanatory move)
269	Educator II	Yeah... this is a justification	

Finally, argumentative interaction occurs when *justifications* are used to defend ideas in dispute (at least two controversial *conclusions*), rather than provide causal accounts of a phenomenon (a single conclusion), for example (episode 6 below). When asked about competitive dominance between the two plant species presented by the teaching sequence, the teachers developed two controversial conclusions because they used different data to support their claims (data of species under natural conditions in opposition to experimental conditions):

479	*Teacher 7*	There is no stronger competitor because at the site B the abundance of red plants and yellow plants are equal	*Justifying* to defend a *conclusion* (claim number one)
480 - 494	[...]		
495	*Teacher 16*	Red species is the strongest competitor because under experimental conditions... when the two species are planted close to one another... the yellow seedlings grow much less than red seedlings	*Justifying* to defend an opposite *conclusion* (claim number two)

When in the role of students during teacher training, the participants initially had the same attitudes that usually disapprove in their classes such as describing rather than explaining or explaining without justifying the choice for certain causal accounts, which required efforts of the educators to enhance the quality of the teachers' discourse.

Despite the increased complexity of the discursive interactions, teachers were engaged mainly in the construction of explanations and there was only one argumentative episode. Berland and Reiser (2011) suggested that an obstacle to argumentative discourse is the variety of instructional goals in science classrooms. For example, teachers and students can emphasize the goal of sensemaking over the goal of persuasion, engaging more in generating and understanding a single idea than evaluating and criticizing of counterideas.

CONCLUSIONS

If even teachers have difficulties to develop spontaneously certain discursive practices such as deducing, concluding, justifying, how can we expect students to do it? We should think about whether the teachers are prepared to change and control the discursive dynamics of their classrooms, requiring the appropriate use of scientific language. It is necessary to expand the research focused on teachers and incorporate the findings in teacher education programs, presenting instructional strategies that can support the inclusion of argumentation in science education.

In our study, the focus on discursive interactions rather than argumentative products (according to Toulmin's model) helped to clarify the distinction between explanatory and argumentative moves, being an important tool for researchers and teachers better plan and assess their work.

REFERENCES

Berland, L.K.; Reiser, B.J. (2011). Classroom Communities' Adaptations of the Practice of Scientific Argumentation. *Science Education*, 95, pp. 191-216.

Driver, R.; Newton, P.; Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, 84, pp. 287-312.

Erduran, S. (2006). Promoting ideas, evidence and argument in initial science teacher training. *School Science Review*, 87, pp. 45-50.

Erduran, S. (2008). Methodological foundations in the study of argumentation in science classrooms, in Erduran, S. & Jiménez, M.P.A. (eds.). *Argumentation in Science Education: Perspectives from Classroom-Based Research*. Dordrecht, Netherlands: Springer.

Erduran, S.; Jiménez, M.P.A. (2008). *Argumentation in science education: Perspectives from classroom-based research*. Dordrecht, Netherlands: Springer.

Keys, C.W.; Bryan, L.A. (2001). Co-constructing inquiry-based science with teachers: Essential research for lasting reform. *Journal of Research in Science Teaching*, 38, pp. 631–645.

Kuhn, D. (1991). *The skills of argument*. Cambridge, England: Cambridge University Press.

Lawson, A.E. (2004). T. rex, the crater of doom, and the nature of scientific discovery. *Science & Education*, 13, pp. 155-177.

Leitão, S. (2007). Processos de construção do conhecimento: a argumentação em foco. *Pro-Posições*, 18, pp. 75-92.

Osborne, J.F.; Patterson, A. (2011). Scientific Argument and Explanation: A Necessary Distinction? *Science Education*, 95, pp. 627-638.

Santa-Clara, A.; Spinillo, A.G. (2006). Pontos de Convergência entre o Inferir e o Argumentar. *Psicologia: Teoria e Pesquisa*, 22, pp. 87-94.

Silva, A.C.T. (2008). *Estratégias Enunciativas em Salas de Aula de Química: Contrastando professores de estilos diferentes*. Tese de Doutorado. Universidade Federal de Minas Gerais, Belo Horizonte.

Toulmin, S. (1958). *The uses of argument*. Cambridge, England: Cambridge University Press.

Vieira, R.D.; Nascimento, S.S. (2009). Uma proposta de critérios marcadores para identificação de situações argumentativas em salas de aula de ciências. *Caderno Brasileiro de Ensino de Física*, 26, pp. 81-102.