The influence of scientific discourse on student´s understanding of biodiversity complexity

Rafael Gil de Castro, Marcelo Tadeu Motokane

University of São Paulo, São Paulo, Brazil

Abstract

Biodiversity is a main concept to biology understanding. The biodiversity includes three hierarchical levels, comprising from genes to ecosystem. Additionally, biodiversity has a major role to Science education, because it supports citizens to understand environmental questions from local until global levels. Our research group produces investigative didactic sequences (IDS) based on the references of Biological Sciences and Science Education (scientific literacy and the teaching by research). The activities of the IDS in this research had the intention of introduce students to the scientific ways of knowing the world, bringing them closer to the practices of scientific community. So this IDS present a scientific discourse marked throughout all its activities. Accordingly, the aim of this work is to understand which influence the scientific discourse of the investigative didactic sequence plays to the student's comprehension of the complex biodiversity concept. The didactic was applied to 31 students of the second year of high school. It totalized 16 classes of 50 minutes each. Data from this research are the written records of students along the activities proposed by the IDS. We use the concept of classification proposed by Bernstein to analyze the influence of scientific discourse on the student´s answers. In addition, we build another instrument to investigate the biodiversity complexity comprehension. Our data suggest that the predominant scientific discourse in IDS provided students to solve the problems proposed by using the scientific language rather than common sense. They extended their comprehension of biodiversity complexity by producing a higher number of associations of this concept with other concepts of biology (intradisciplinarity). Thus, this is one way of appropriating citizens with scientific knowledge so that they can act more critically, and then help to build a more sustainable society.

Keywords: biodiversity, discourse, scientific literacy

Corresponding author e-mail address: rafacastro07@usp.br ; mtmotokane@ffclrp.usp.br

Introduction

Biodiversity

The term biodiversity was coined in 1988 during the National Forum on BioDiversity in Washington. This forum was organized by the National Academy of Sciences and the Smithsonian Institution. The authors of the summaries about biodiversity include specialists from different scientific areas: economy, philosophy, law, biology and anthropology (MOTOKANE, 2005). Despite it has been characterized within the academy, biodiversity emerged initially from different social tensions caused by the crisis of the environmental resources. Gayford (2000) says that biodiversity loss was classified as "one of the major issues of our time".

It is clear that education plays an important role to the approach of this concept to all society and help to solve its reduction. In scientific education, biodiversity is a main concept to biology understanding. One of the most important authors to understand the complexity of this concept is Wilson, who published in 1997 a book entitled "Biodiversity II: understanding and protecting our biological resources". In the first chapter Wilson defines biodiversity as all existing variation in the different levels of life organization, from the genes of a local population to the species that comprises this community, or even the variation in all these communities. Thus, biodiversity includes three hierarchical levels, comprising from genes to ecosystem, in an integrated manner and with biological evolution as a structure main axis (LÉVÊQUE, 1999). Additionally, biodiversity has a major role to Science education, because it supports citizens to understand environmental questions from local until global levels.

Investigative didactic sequence

Our research group produces investigative didactic sequences (IDS), which promote contextualized and socio scientific issues. The IDS has moments of active participation of students and opportunities for students express their opinions. Our researches consider important the scientific literacy process and the development of arguments in biology classes. We developed the IDS based on the references of Biological Sciences (WILSON, 1997; LÉVÊQUE, 1999; GASTON, 2004), and for the references of Science Education we used the scientific literacy and the teaching by research (DRIVER, 1988; BYBEE, 1995; NSES, 2000). The activities of the IDS had the intention of introduce students to the scientific ways of knowing the world, bringing them closer to the practices of scientific community. There were moments in which students performed data collection, used logical reasoning and did explanations based on reliable evidence, arguing, among other important practices of doing science. So our IDS present a scientific discourse marked throughout all its activities. This discourse fits in Bernstein´s (1999) definition of vertical discourse, which presents a coherent, explicit and systematically form organized in scientific principles. The horizontal discourse, introduce a form of knowledge that is usually classified as everyday or "common sense". In formal education, the distinction between horizontal and vertical discourses presents the differences between local and official knowledge, and such discourses are evaluated according to their ideological position (MORAIS & NEVES, 2007). Accordingly, the aim of this work is to understand which influence the scientific discourse of the investigative didactic sequence plays to the student's comprehension of the complexity of biodiversity concept.

Methodology

Investigative didactic sequence (IDS)

The IDS starts with a real problem situation (JIMÉNEZ & PUIG, 2010) related to the construction of a hydroelectric plant in northern Brazil. The situation is based on the conflict of interest between two documents associated with the environmental impacts: the environmental impact reports (EIR) and the report of the experts. The last one was written by researchers who want to question some measures presented in the EIR. Accordingly, we scheduled three activities in which students must use scientific knowledge to develop them: an activity related to biodiversity at the level of species; one for the genetic level and one for the ecosystem level. At the end of the IDS, we presented geographical data of the location of the hydroelectric plant, and data of some populations of fish and other animal species that inhabit the region. With these data, the students wrote a report showing the losses in terms of biodiversity that this place would suffer from the construction of the hydroelectric plant.

Research subjects

The IDS was applied to 31 students of the second year of high school from a public school in the state of São Paulo (Brazil). It totalized 16 classes of 50 minutes each, during the months of February to May 2015. The six teachers who applied the IDS are undergraduates in a course of biological sciences, and ministered classes under the supervision of Biology teacher from school. The mediation of these teachers promoted with these students worked in groups during the development of the activities of the didactic sequence.

Data collections

Data from this research are the written records of students along the activities proposed by the IDS. We use the concept of classification proposed by Bernstein (1990) to analyze the influence of scientific discourse on the student´s answers. With this concept we create an analytical tool (TABLE 1) to discern the boundaries between scientific

discourse (vertical discourse) and non-scientific discourse (horizontal discourse). This instrument enabled us to analyze the student´s answers regarding the problems posed biodiversity of species, genetic and ecosystem. The strong classification (C^+) indicates that the students understand the difference between discourses and use the scientific discourse in their answers. The weak classification (C^-) indicates that students don´t understand the difference between the discourses and don´t use scientific discourse in their answers.

Table 1 – Analysis tool for discourses

C^+	C^-
The student uses predominantly scientific discourse (terms, concepts and/or epistemic practices of science) to solve the problem	**Scientific discourse is diffused among other speeches throughout the student´s response.**

In addition, we build another instrument to investigate the biodiversity complexity comprehension (FIGURE 1). The data of this part were the students' written records at two different moments of IDS application: the interview of pre-conceptions about the biodiversity concept applied during the first class; and the report that the students produced in the last class. Based on the records of the students, we identified what were the levels of complexity of the biodiversity concept that each student had at the beginning and in the end of the didactic sequence. Therefore, the higher the level of biodiversity complexity as more hierarchical levels the subject present when establishing more connections between levels, when relating with other knowledge within biology or another area and the higher the level of abstraction used.

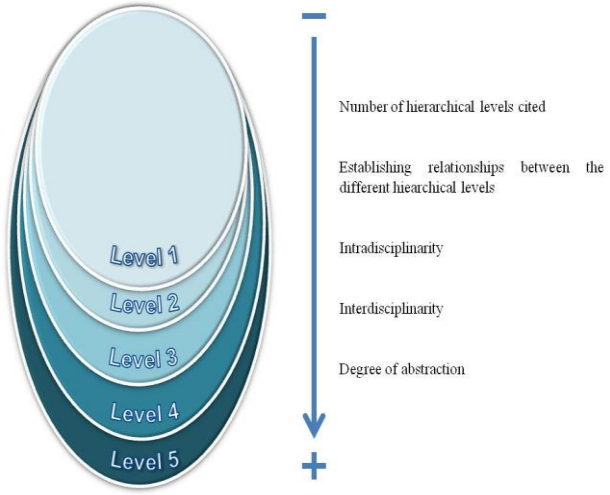

Figure 1: Scheme of gradation between five levels of complexity of the concept of biodiversity.

Findings and conclusions

Students mostly used scientific discourse to solve the problems proposed by the IDS. Exercises involving biodiversity at the level of species and genetic were those with the highest percentages of strong classification, with 93% and 69%, respectively. The percentage of 48% for the activity related to ecosystem biodiversity is mainly related to student´s efforts to use their own words (horizontal discourse) and appropriating the difficult vocabulary that this activity had. These data can be seen in figure 2.

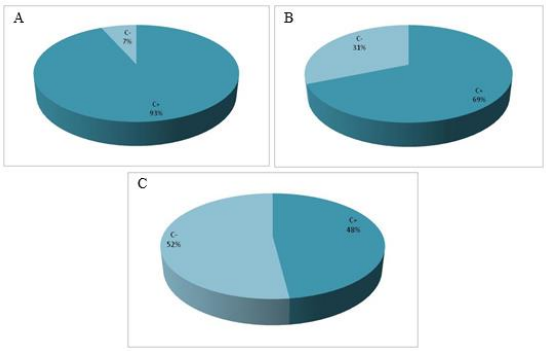

Figure 2 – The classification of student´s answers along the activities of IDS as the boundaries between the discourses. (A) corresponds to the activity involving biodiversity at the level of species; (B) to the genetic level, and (C) to the ecosystem level.

The classification of students among complexity levels had changed. Initially, the students were mainly classified between level one and two. However, the analysis of students' final reports demonstrated more complex levels of the concept (FIGURE 3), especially level three.

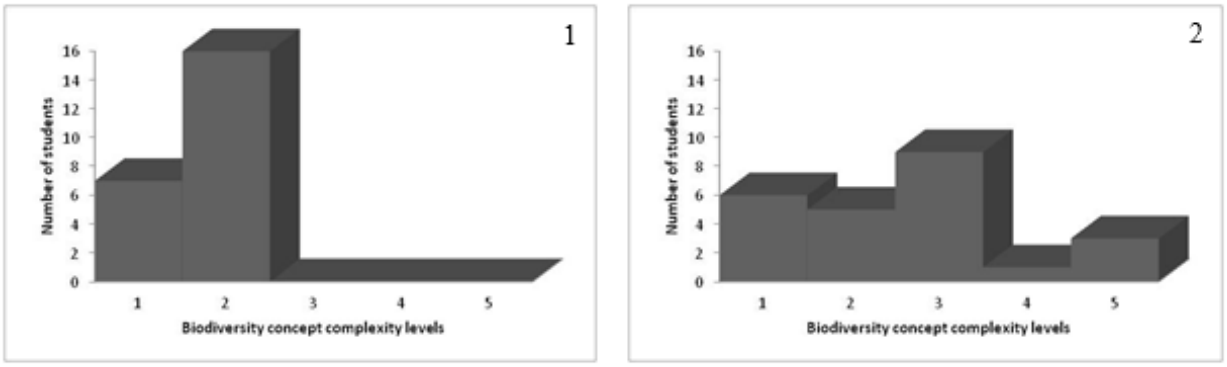

Figure 3 – Complexity levels of biodiversity present in the student´s answers to the interview of preconceptions (1)

Our data suggest that the predominant scientific discourse in IDS provided students to solve the problems proposed by using the scientific language rather than common sense. The performance of the students in solving problems of the IDS by using scientific discourse is related to the structure of the IDS. The IDS was built from the perspective of scientific literacy and teaching by research, and all the material (activities, choice of concepts, investigative nature) is within the epistemological perspective of science. Moreover, the IDS have a discussion of social-scientific problem that involves a reflection on the issue of Belo Monte in scientific ways of thinking. So, the IDS created a "scientific environment" were students be able to build the concept of biodiversity.

Observing the percentages of category C+, which is the choice of scientific discourse on the responses of students, there is the presence of this category in 93% and 69% of cases in the two main problems to be solved in IDS and 48% in the problem proposed by the third activity. The percentage of scientific discourse was lower in activities which the students need to use a high degree of abstraction. This caused a greater effort for students to explain the context in their own words and thus present a speech more similar to common sense.

The predominant scientific discourse present in SDI leaves some clues that ultimately promote aid to students at the time they need to use the appropriate concepts to respond the problem. This should be highlighted, because it isn´t common students use scientific knowledge to think this kind of problems, like a construction of a hydroelectric power plant.

Therefore, the speech of the IDS and the speech of teachers created a controlled learning environment, which encouraged students to use the scientific discourse, biological concepts and make conscious choices for different situations. Therefore, it allowed then to extend their comprehension of biodiversity complexity by producing a higher number of associations of this concept with other concepts of biology (intra-disciplinarity).

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