BIOLOGY CONCEPTS IN THE BASIC EDUCATION AND IN THE ACADEMY: AN ANALYSIS METHODOLOGY

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▼ Abstract

This paper has analyzed Primary school Science textbooks and Secondary school Biology textbooks, verifying the distance between them and the scientific knowledge. To differ the types of distances found a toll was created to enable the classification in two categories, both resulting from the didactic transposition. One is the vertical distance, which comes from the transposition of the science knowledge to each education level and is necessary to allow students of different ages to learn. The other type of distance is horizontal, which is characterized as being not essential to the students' learning in their education level. The horizontal distances found in different education levels were compared. This research found a frequency of 0,27 horizontal distances in the concepts of primary Science textbooks, which is significantly higher than the frequency found in secondary Biology textbooks, which was 0,17%.

Key Words school Science and Biology textbooks, didactic transposition

1. INTRODUCTION

Textbooks have a big influence on what is taught at school. This occurs in Brazil and in other countries (Ball, Feiman-Nemser, 1988; Instituto Nacional De Evaluación Y Calidad Del Sistema Educativo, 2004; Carvalho, Silva, Clément, 2005; Brazil, 2003). Since they are important materials, they are the object of study of many researches worldwide. Usually, when researches analyze contents in textbooks, they talk about the distance between the contents and the scientific knowledge (Martínez-Gracia, Gil-Quílez, 2003; Carvalho, Silva, Clément, 2005; Ferreira, Justi; 2004, Mohr, 2000; among others)

This present paper goes yonder these analyses. We did not only identify in the textbooks knowledge that is not accepted by Science, we also attempted to consider the need for the school knowledge to get distant from the scientific knowledge. It is not the aim of this article to criticize the mentioned researches results. What we intend is to describe a distinguished methodology to analyze the distance between the school knowledge and the academic knowledge.

The school knowledge in the scientific disciplines is built from the social knowledge, such as the scientific knowledge that has specific features that justify its importance and

the necessity to teach it. In terms of the scientific knowledge, Ziman (1985) says what certifies the confidence in the scientific theories and facts is the consensus between the scientists. In order to be accepted, this knowledge firstly needs to go through lots of criticism, which can engender the repetition of the experiments that originated it or the logic comparison between its results and the other investigation results.

The school can provide approaches to the knowledge that the scientists consider valid. To do so, it is necessary to consider not only the characteristics of the knowledge but also the characteristics of the students, as well as their reasoning and their previous knowledge. According to Chevallard (1991), "didactic transposition" is turning a learning object into a teaching object. It exists due the fact that the operation of the school knowledge is different from the academic knowledge. The school knowledge could suffer changes that turn it into a learning object. These changes are necessary for this learning element to be taught.

Based on these presuppositions, this paper presents a methodology developed to analyze Science textbooks and Biology textbooks, checking the distance they keep from the reference knowledge. The aim here was not to use an evaluation of the books in a traditional style, considering concepts such as "right" or "wrong". Conversely, the aim was to estimate, through an epistemological analysis, how close or far the concepts are from the reference knowledge. The main concern of this paper lies on detailing thoroughly the developed and used analysis tool. Search results indicating some examples of distances found will be mentioned as well.

Several recent studies related to textbooks have been specifically concerned with the analysis of their contents. Significant examples of these researches (Alves; Carvalho, 2007; El Hani et al., 2007a; El Hani et al., 2007b; Castéra et al., 2007; among others were published in the *International Meeting on Critical Analysis of School Science Textbook*, held in Tunisia in 2007. Since the content from textbooks is also in the scope of this paper, it is considered part of a matter of great relevance to academic research.

2. METHODOLOGY

Thus, this methodology was developed to analyze contents of Biology, Chemistry and Physical textbooks (Bizzo, Del Carlo, Franzolin, Narciso Jr., 2007; Del Carlo, 2007; Franzolin, 2007). However, this paper focus in the description of the analysis of the Biology contents in textbooks for people from 15 to 17 years old (Primary school) and contents of the same area in the Science textbooks for people from 7 to 14 years old (Secondary school).

2.1 Textbooks selection

The selection criterion was that half of the books for each level of education (three textbooks) should be part of the lists of recommended books by the Brazilian evaluation programs: National Program of Textbooks in the Primary School (PNLD) from 2004 and 2005 or the National Program of Textbooks in the Secondary School (PNLEM) from 2007; the other half would be constituted of books that were not in these lists. So we evaluated six collections of Brazilian Science textbooks for Primary school and six simple volumes of Brazilian Biology textbooks for Secondary school.

2.2 Contents selection

Two categories were determined: in the first one there were contents that, in the evaluation carried out by PNLD, presented troublesome questions that deserve to be analyzed in this research, such as possible distance from the reference knowledge. The problems were spotted by analyzing documents with the results of the research elaborated by the specialists that took part in the evaluation carried out by the PNLD. Once during this selection the PNLEN evaluation had not happened, the documents involved in this evaluation were not used. The documents of PNLD already cover a range of contents that is enough for this present analysis. It brought up problems found in textbooks related to the areas of Botany, Ecology, Histology, Microbiology, Zoology and Vegetal Physiology. In the second category, there were central contents to Biology teaching: photosynthesis, cellular respiration and basic genetic concepts.

2.3 Bibliography of reference selection

In this research, the reference knowledge is considered the one that is the object of study of the teacher who is still at school, which means this object is part of the basic bibliography adopted in the Bachelor's Degree in Biological Sciences course at the University of São Paulo in 2005 and 2006. This bibliography has been also adopted as a reference both because its didactic transposition is closer to the scientific knowledge. However, its accuracy will not be discussed. Despite believing that this bibliography is likely to have controversy or errors, it is not part of the scope of this research to investigate them. Therefore, being approved by the Council of Graduation of a respected university that prepares future graduates in Biology, we believed that this bibliography presents a certain quality that deserves some credibility.

2.4. Analysis Tool

This research is an epistemological study. Therefore, the judgments involved in the analysis and its results are related to the view of those who investigate, and are inserted in a private knowledge ambit.

The distance was classified into two categories, both resulting from the didactic transposition. One is the vertical distance, which is caused by the transposition of the scientific knowledge for each level of education, being necessary to facilitate the learning process for students of different ages. In the axis represented in Figure 1 by the straight line v the knowledge that has a greater rigorism compared to the reference is inserted. The knowledge that is located inside this cone (exemplified by points in Figure 1) is also there due to its rigorism or accuracy, with respect to the reference, but their rigor varies depending on the academic age component.

The other type of distance would be the horizontal one. This refers to the distance in relation to the axis determined by the rigorism and, thus, it generates knowledge that is outside the cone that involves it. This distance can be characterized as an artifice used by those who teach intending to make the learning process easier, but it is not related to the academic age component. This contrast is a result of the laxity, that is to say, the flexibility of knowledge taught in relation to the rigor concerning the reference. However, it is important to clarify that the knowledge from this distance can-

not be reduced to conceptual errors. Although this distance can be in this category, it can be the knowledge of different natures. Therefore, a knowledge that has horizontal distance from the reference may be, for example, an everday knowledge, a knowledge created by those who teach and used it only as a didactic strategy, or even a knowledge characterized as an incorrect one, which is different from the conceptual error, because it does not stop the student from building a correct concept.

As it can be seen in Figure 1, the base of the cone has a larger diameter resulting from the greater need for didactic transpositions in the initial grades of education, aiming at making the knowledge appropriate to the student's ability to understand at his age. The cone narrows as the level of education gets higher because there is less need for didactic transpositions. Thus, a particular knowledge transposed didactically may be inserted into the cone during Primary school, characterizing itself as a vertical distance (exemplified in Figure 1 by point c_1). However, this same knowledge can be characterized as a horizontal distance, when it is no longer needed in Secondary school (exemplified now in figure 1 by point c2).

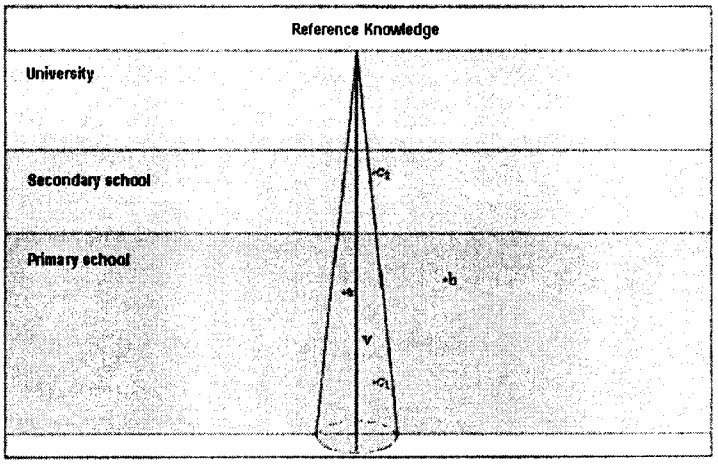

Figure 1 Representation of possible types of distancing found between the knowledge taught in the different levels of education and those presented by the reference. The axis v refers to the academic age component on which the vertical distances that have a greater rigor in relation to the reference are located. The cone that involves it shelters the other knowledge, which is vertically distanced from the reference at the different levels of education. Three distinct knowledge bands where represented: one corresponding to the knowledge taught in Primary school, another one corresponding to the knowledge taught in Secondary school and, finally, one corresponding to the knowledge taught at university. Each prominent point represents knowledge among many other subjects taught. The points a and c1 refer to knowledge taught in Primary school that is vertically distant from the reference and therefore is located inside the cone. The point b refers to knowledge also taught in Primary school which is horizontally distant from the reference and therefore is located outside of the cone. However, due to higher rigor in Secondary school, the same knowledge, represented now by point c2, is horizontally distant to the reference.

5. RESULTS

The results showed that the distance between the knowledge contained in textbooks and that ones of reference arising from the didactic transposition can be considered of two different natures. We present here some examples.

The vertical distance was those one needed to allow the student's learning. Among the vertical distance identified in the analyzed books, it was observed that there are authors who state, for instance, the pollination in angiosperms would be the transportation of pollen grains from a flower to another, while the reference states that this phenomenon is the pollen transfer from an anther to a stigma. So, the reference, explains that the pollination happens with the pollen grain transportation among specific flower parts. Nevertheless, some books concerned about adapting the content to the level they are related to, end up using vertical distance when mentioning that the photosynthesis is responsible for the production of nutrients in the plants.

On the other hand, the horizontal distance is not necessary to be adapted to the students' age, which means they are not necessarily related to concept errors or factors that make the learning process more difficult. Some of the books analyzed, for example, used terms such as "case", "shell" or "armor" to refer to the arthropods exoskeleton. These everyday terms would not have to be used for the students of certain education levels to understand the unique features of such animals. The authors could have used the term "external skeleton", which is closer to the original term "exoskeleton" and it would be easily understood. Yet, the fact that the authors decided to use terms such as "case", "shell" and "armor" may come from the concern of approaching the subject to be taught to the everyday life knowledge. In this case, the intention is not to adapt the knowledge to the students' age but to the studens' previous knowledge. Despite being a horizontal distance, it does not present epistemological obstacles to the students' learning, specially in Primary School where it is necessary to adapt the school contents to the cognitive and cultural level of the students. Its use does not prevent the students from understanding what an exoskeleton is later on.

However, a lot of horizontal distance found may make the learning process more difficult. An example, among the great number identified in the results, is the horizontal distance found in the anaerobic respiration and the fermentation. While the reference knowledge considers them different, certain textbooks see them as the same process. The reference clarifies that the anaerobic respiration is done by specific bacteria and that the electron-pair acceptor is different from the ones used in the fermentation process. Treating the two processes equally creates a serious epistemological obstacle to the comprehension of their differences.

This survey found a frequency of 0.27 of horizontal distance in the concepts of the Primary School Science textbooks, significantly higher than the one found in the Secondary School Biology textbooks, which was 0.17.

6. FINAL CONSIDERATIONS

A hypothesis to justify these results would be that the Second School books present a lower frequency of horizontal distance, because their authors use the knowledge evaluated in vestibular examinations as reference. The concern of the Second School

books with vestibular examinations was evidenced by the large number of questions of these exams that appear in the exercises. The same does not occur in the Primary School books.

The literature also identified knowledge similar to the one found by this research (Mohr, 2000), or belonging to the same content (El Hani, et al. 2007th). This knowlege could be considered an example of horizontal distance because it is far from the scientific knowledge. The didactic transposition or the adequacy of knowledge to the development of the student is addressed by some researches regarding its lack (Ferreira, 2004; Castéra, et al. 2007; El Hani et al., 2007b). They do not the mention examples that could be considered vertical distance. Therefore, the tool elaborated can be useful to new approaches in the analysis of textbooks contents. New analysis can not only identify in the textbooks knowledge that is not accepted by Science, but they can also to consider the need for the school knowledge to get distant from the scientific knowledge.

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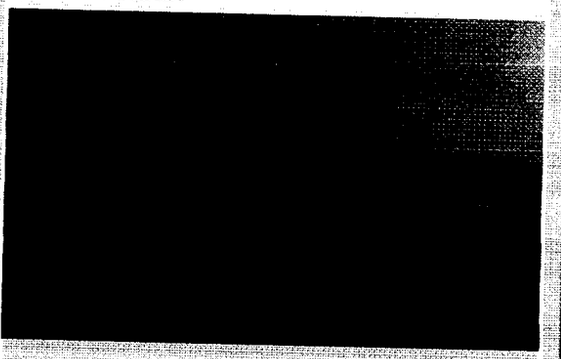

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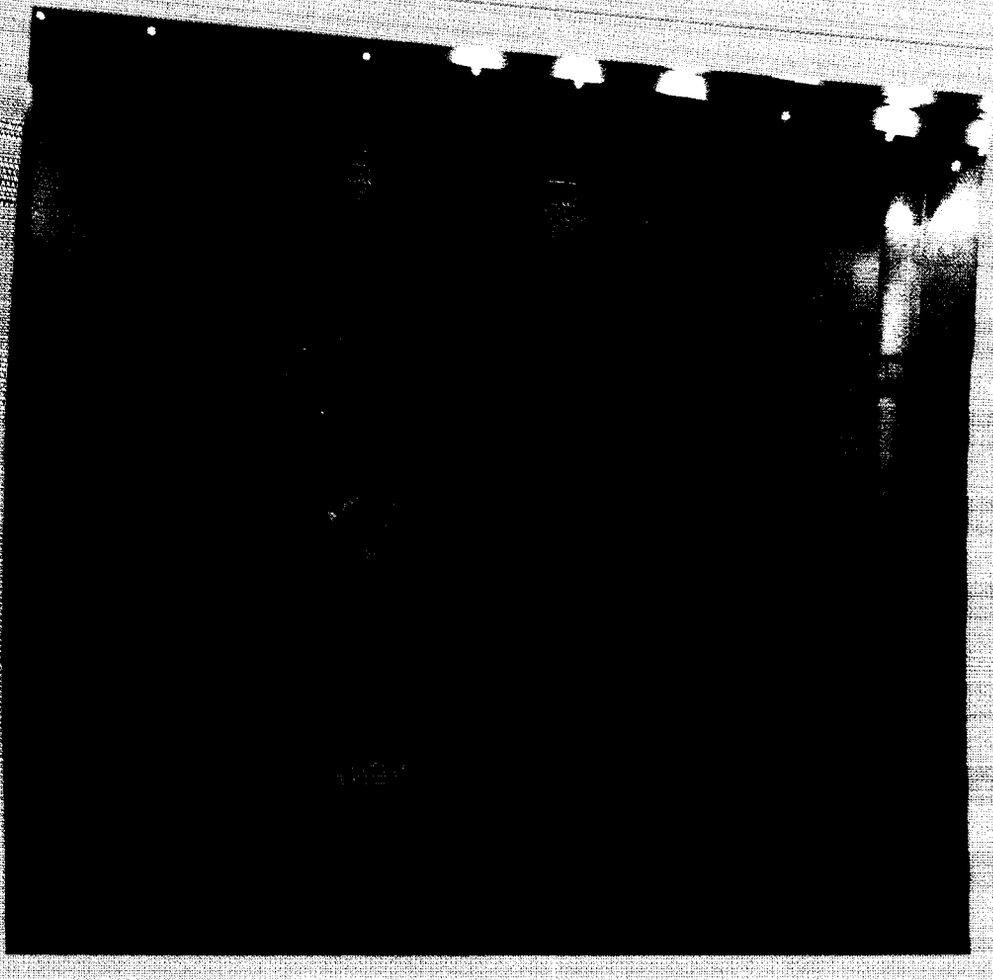

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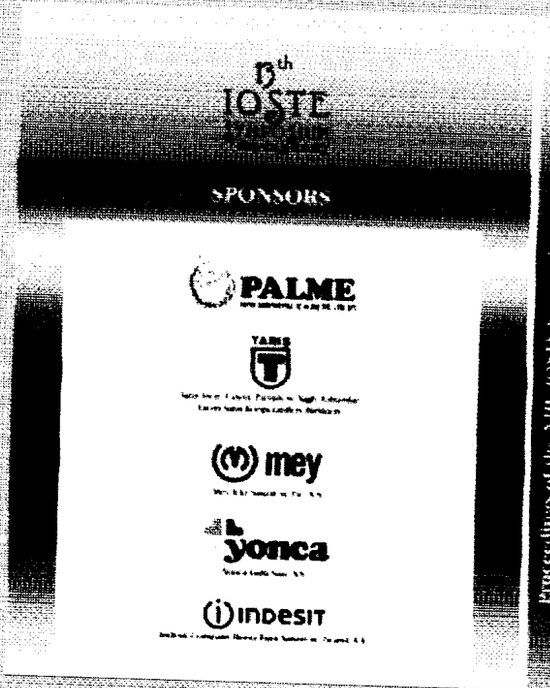

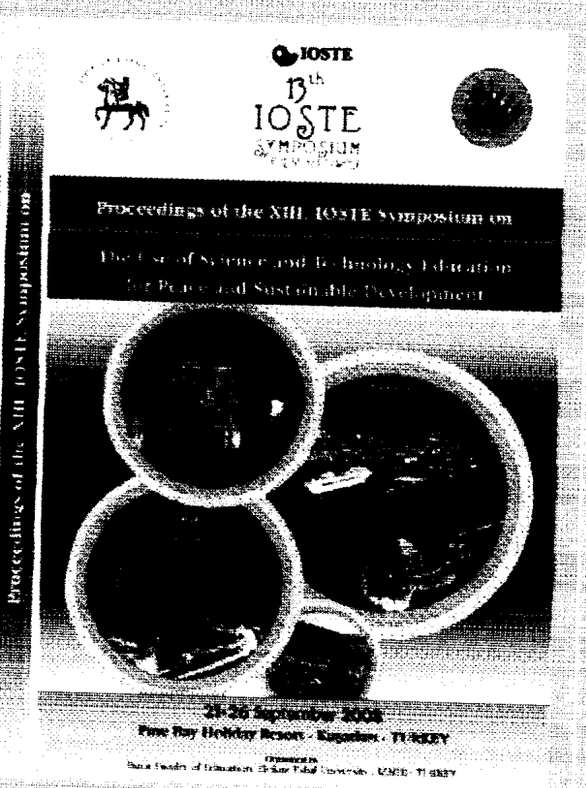

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