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Types of Deviation in Genetics Knowledge Presented in Textbooks Relative to the Reference Literature

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Abstract

The present study seeks to examine how basic knowledge presented in textbooks for the teaching of genetics in secondary schools approximates or deviates from academic knowledge of the subject. Among transposed scientific knowledge of greatest importance in education is knowledge of genetics. Therefore, knowledge taught in schools is necessarily subject to two influences. The first is *laxity*, which is the tendency to alter scientific knowledge, when presenting it in textbook form, to make it accessible to learners. The other is *rigorism*, which is the opposite of laxity, i.e., the tendency to approximate knowledge taught to scientific knowledge, seeking to transmit it correctly, with a commitment to scientific principles. Different types of deviations were identified in textbooks from Brazil and the United States. To determine how knowledge presented in textbooks deviates from that presented in the reference bibliography, concepts were classified according to type of deviation, using the following categories: *equivalent term* , *metaphor*, *conceptual deviation*; *deviation in the description of the process*, *generalisation of occurrence*, *content not updated*. The present study finds that the deviations cannot be classified as conceptual errors and are not necessarily related to the concepts themselves. Deviations were mostly categorised as *generalisations of occurrence*. The highest frequency of this type of deviation was independent of the concept examined or of the country of origin of the group of textbooks analysed.

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Keywords: genetics education, textbooks; didactic transpositon

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1. Introduction

The present study seeks to examine how basic knowledge presented in textbooks for the teaching of genetics in secondary schools approximates or deviates from academic knowledge of the subject. Different types of deviations were identified in textbooks from Brazil and the United States.

The study is justified by the importance of teaching scientific knowledge and the role of textbooks in the educational process.

Despite its complexity, a key characteristic of scientific knowledge is its reliability, which arises from the role of consensus in the scientific process (Ziman, 1985). Although scientific knowledge is not considered superior to other types of knowledge, it is the school's role to develop in children a worldview compatible with the knowledge generated by science (Cobern, 1996). However, for such knowledge to become comprehensible to students, it must undergo a didactic transposition (Chevallard, 1991) through the medium of textbooks (Forquin, 1992). Among transposed scientific knowledge of greatest importance in education is knowledge of genetics. Therefore, knowledge taught in schools is necessarily subject to two influences. The first is *laxity*, which is the tendency to alter scientific knowledge, when presenting it in textbook form, to make it accessible to learners. The other is *rigorism*, which is the opposite of laxity, i.e., the tendency to approximate knowledge taught to scientific knowledge, seeking to transmit it correctly, with a commitment to scientific principles (Franzolin & Bizzo, 2009).

Textbooks are among the major determinants of the knowledge taught in schools (Ball & Feiman-Nemser, 1988; Brasil, 2003; Instituto Nacional de Evaluación y Calidad del Sistema Educativo, 2004; Lee, Eichinger, & Anderson et al., 1993; Solbes, 1987). Several significant studies of the content of textbooks (examples include Alves & Carvalho, 2007; Caravita et al., 2007; El Hani et al., 2007; Skujienė et al., 2007; among others) were recently published at the *International Meeting on Critical Analysis of School Science Textbook*, held in Tunisia in 2007.

Some of these studies (El Hani et al., 2007; Ferreira & Justi 2004; Gericke & Hagberg, 2007) follow an approach close to that adopted in the present study, analysing the conceptual content of genetics, as presented in written text. However, the present study differs from other studies in several respects.

The difference between the present study and that of Gericke and Hagberg (2007) is that the latter authors focus on the specific conceptual content of "gene", seeking to classify different approaches to the concept. The present study, by contrast, analyses different presentations of knowledge within broad topics, comparing versions presented in textbooks with those found in a reference bibliography.

El Hani et al. (2007) identify treatments of genetics and cell and molecular biology concepts in Brazilian biology textbooks that were excluded, for quality reasons, by the National Program of Textbooks for Secondary Education (Programa Nacional do Livro Didático para o Ensino Médio - PNLEM) from a list of books to be used in classroom instruction by Brazilian public school teachers . Their study presents data relevant to the present study but differs from ours with respect to sampling. In particular, they sample books that failed the PNLEM evaluation; additionally, the authors use data from a governmental evaluation. Another important difference is that, although both studies examine the accuracy of the knowledge available in textbooks, compared with academic knowledge, the study of El Hani et al. describes conceptual problems with the material analysed, while the present study analyses the approximation and deviation relationships between knowledge presented in textbooks and academic knowledge in the reference bibliography.

In turn, Ferreira and Justi (2004) analyse various aspects related to how Brazilian biology and chemistry textbooks treat the concept of DNA. With respect to conceptual accuracy, the authors find that in biology textbooks, some DNA models are at odds with scientific models. However, Ferreira and Justi do not provide further explanation of how the comparison between knowledge in textbooks and scientific knowledge was conducted. Therefore, it is unclear what reference was used to represent knowledge produced by science.

The present study not only differs from studies published by other authors; it presents new elements not addressed in earlier investigations by the research group that developed it. A previous study analysed some basic genetics concepts from other areas of biology, including "genetic material", "chromosome", "gene", "homologous chromosomes", "allele", "homozygosis", "heterozygosis", "phenotype", "genotype", and "dominant" and "recessive" (Franzolin, 2007). These are basic concepts present in primary and secondary education textbooks. The present study analyses in detail other genetics concepts not examined in the previous study. These concepts were selected not only for their presence in textbooks but also because they are the concepts most frequently mentioned