Conceptual change: from research to instructive practice
FOR A TIMELY DEALING WITH STUDENTS' "LAMARCKIAN» VIEWS

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Introduction

The Greek educational system appears even today, particularly conservative with the subject of teaching evolution. Evolution, as a complete unit is at the end of 9th grade biology textbook, and the majority of teachers do not teach it. But even though it is taught, teachers are not informed on the results of cognitive studies, and so they do not know that they need to take into account their students' ideas, and use them to plan their teaching. Evolution is not taught in the 12th grade either. In 12th grade the relevant chapter is removed from the subject matter of the course and so far, it has been exempted from the teaching of biology. All this, results in students graduating from a Greek school, while having been taught very little and thus being deprived of basic knowledge on evolution. Specifically they use the «Lamarckian» model, "the most pervasive among students" (Jensen and Finley 1995) to explain biological change.

Theoretical background

«Lamarckian» views are considered to be the explanations of biological change as effects of the environment, resulting in changes in individuals and inheritance of these acquired traits but also including ideas about changes in DNA due to environmental factors (Jimenez-Aleixandre1996). According to Bishop and Anderson (1990), students fail to make a distinction between the appearances of traits in a population and their survival over time. They think that there is a single process in which characteristics of the species gradually change and believe that the environment causes traits to change over time. Comprehensive didactic interventions are reported in bibliography, focused on "Lamarckian" views (Jensen and Finley 1995, Jimenez-Aleixandre 1992, 1996, Stern 2002 etc.), in genetics-evolution (Banet and Ayuso 2003), etc.

As far as the theory for conceptual change is concerned, a distinction is made according to Vosniadou et *al*. (2001) between the views of science learning presented by Posner et al. (1982), which focuses on the incompatibility between two distinct and equally well-organized explanatory systems, one of which will need to be abandoned in favor of the other and the "different in fundamental ways" based on the results of cognitive studies.

Vosniadou *et al*., (2001) suggest that conceptual change is a slow revision of an initial conceptual system through the gradual incorporation of elements of the currently accepted scientific explanations.

Aims

In the particular research, an effort is made, through instructive interventions, in order to pave the way for teaching evolution. It is focused on the challenge of conceptual change of the 9th grade students' "Lamarckian" conceptions. The research question was whether the consolidating concepts on genetics, can be useful for a timely dismantling of the students' Lamarckian" conceptions and can lead to the notion of natural selection. Our interventions were sought much earlier than teaching the unit of evolution, without the invocation of names or terms (adaptation, natural selection, Lamarck, Darwin etc.), left for another time of the instruction.

Methodology

a) Greek biology curricula and textbooks were explored, with criteria to localize points - in their structure and the way of analysis of concepts - in order to find out whether they face or contribute to the makeup of students' synthetic models.

b) Conduct of research in three phases:

1st: Investigating 9th grade students' synthetic models, through pre - tests which asked them to interpret instances of biological change. Almost 60% of students held Lamarckian views (the rest were tautological or uncodeable answers). Their views were similar to those in bibliography and concerned the way in which the environment is believed to exert its influence, including the need, use or disuse, and adaptation (Bishop and Anderson1990, Brumby, 1979, 1984, Clough and Wood - Robinson 1985, Hallden 1988 etc.).

2nd: There followed *short-term, exploratory* interventions, based on the pre-tests findings. The instructive interventions were focused basically on:

- The role of *variation* within a population, (a concept ignored by students) - The *random mutations*, as a source of variation. This is a very important key-point for conceptual change. In that phase, interventions tried to make students capable of comprehending that the environment does not dictate these mutations to DNA, required by the organisms … Moreover that individuals with suitable traits, will contribute more offspring to the next generation and … *thus populations change through the changing proportion of individuals.*

After the interventions, there followed a discussion on particular examples, among students in groups and with the whole class.

3rd: *Three weeks later*, questionnaires were handed out to students, which called on them to interpret other instances of biological change.

Three 9th grade classes (24-25 students each) of a public school participated in the research, in hours granted by teachers of the school.

Findings - Conclusions

a. Greek biology curricula and textbooks do not take into consideration students' synthetic models.

The references to the concept of Adaptation/s *in lower, than 9th grade, grades*, leaves space to alternative explanatory models to grow, at a time when the exact interpretation of Adaptation is not possible.

b. Conceptual change appears to have taken place in principle. After the interventions, 30% of students, abandoned "Lamarckian" views and interpreted the instances of the questionnaire, with the notion of natural selection. This shows that when *prerequisite concepts* are built in time, and with the teachers' conscience of their future utilization, *they* have the dynamics to constitute conceptual structures, which can replace students' explanatory models, like "Lamarckians". Moreover, it may not be necessary, to wait for "*a*" chapter of evolution, in order to introduce all the relevant concepts. We can begin introducing them, in various previous phases of teaching biology.

c. In our research, an equally well-organized explanatory system, *the "Lamarckian" in this case*, is abandoned in favor of the other. However during this process, students were helped to become aware of their existing beliefs and presuppositions, and to create larger theoretical constructions that have greater explanatory adequacy, as Vosniadou *et al*. (2001), have described.

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