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How to Teach Evolution

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Abstract

Out of identified general didactic problems when teaching evolutionary theory, structured learning situations for pre-service teacher students were created together with performance assessment. The students' discussions showed almost no use of evolutionary concepts and well-structured learning situations failed as many students worked in an arbitrarily manner. The performance assessment showed anyhow good results as questions with open answers gave opportunity for constructive thinking. One conclusion is the strength in open questions, promoting the students' creation of reasonable explanations within a theoretical framework.

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Keywords: theory of evolution; learning outcome; learning design; performance assessment

1. Introduction

The theory of evolution has rarely been properly understood. Religious beliefs and mechanistic views where science should be used for accurate predictions leaves no room for a theory focused on dialectic processes between populations and species and their environment. This problem is also often reflected in teaching, dominated by examples of evolutionary processes instead of descriptions of the processes themselves, at the expense of deeper understanding if the theory.

Here we have tried find ways of teaching promoting a better understanding of the theory and the understanding of the evolutionary background of different observations in nature.

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1.1. Challenges from the school curriculum

According to the recent curriculum for primary education in Sweden, science education has to be linked to the students own experience targeting development of critical thinking and skills useable in daily life (Skolverket, 2011). Thus, the students are supposed to enhance their ability to review arguments and to use their understanding to argue in situations where scientific knowledge is of significant importance. Performance assessments according to the curriculum are used to evaluate the students' capacity to use knowledge not only in discussions and enquiries within a scientific framework but also in other situations. Thus, the students should be able use their achieved knowledge on the highest order of thinking as presented in Bloom's revised taxonomy (Anderson et al. 2001).

If this is applied on the Darwinist theory of evolution the students are supposed to be trained in evolutionary thinking, making it possible for them to draw evolutionary based conclusions and propose reasonable evolutionary based explanations behind different observations, rather than presenting pieces of evolutionary events. This shift of focus from facts to be remembered to the use of knowledge of evolutionary processes to construct explanations is an important change, challenging the teacher to act not as a mediator of facts from major evolutionary events but to create didactic situations promoting evolutionary thinking. The role of the teacher has changed from being a performer to a designer and director of learning situations (Mutvei & Mattsson, 2014).

This new situation is also a challenge for lecturers at teacher training programs. Now they have to design learning situations promoting practical skills of the students in the pre-service training to make them became teachers working according to the new curriculum. Just as the students at school, the students at the teacher training programs have to be trained in evolutionary thinking.

A quality report from the Swedish Schools Inspectorate (Skolinspektionen, 2012), concerning teaching in years 1–3 (age 6–9) shows that there is a focus on biology at the expense of chemistry and physics at school. But, this is not of advantage for biology as the teaching is focused on observations and learning of concepts instead of scientific methods and understanding of processes. We recognized similarities with higher education were students were drowned in detailed facts concealing major traits in evolutionary processes (Alters & Nelson 2002).

In addition, we had also discovered poor knowledge of the students of the main principles of evolutionary theory. Although many of them know and use words or concepts like random variation, natural selection, adaptation etc. they do not use them properly (Mutvei & Mattsson, 2014). Students often described evolutionary events as these were actions of individuals to reach goals and not as responses of populations to environmental influences. For example, *the poisonous snake becomes brightly colored in order to warn others*. This type of statements show poor understanding of concepts, groups (taxa), and processes. If teleological explanations are correct, evolutionary theory is superfluous. From the students' viewpoint there is a reason or explanation for everything and that is necessity and aim. Many of them are (erroneously) convinced that individual organisms have to actively react to environmental pressures and this is the driving force of evolution.

In order to give the students an adequate pre-service training to become good teachers of evolutionary theory we tried to design teaching situations similar to those they are supposed to design for their much younger students in the future. The key to this was the construction of performance assessments based on the core content and the knowledge requirements of the school curriculum and to let these outline the learning environment. (Jönsson, 2013).

1.2. Challenges from the theory

When introduced by Darwin, the theory of evolution had problems to be properly understood and accepted. Religious beliefs played an important role as the theory undermined the importance of an almighty creator but also scientist from most fields appeared skeptical. The non-mechanistic view with concepts like *random variation* and *natural selection* which rarely could be used for strict predictions of evolutionary events made the theory too different from other mechanistic views to make it appetizing for most scientists. At that time science should be used for accurate predictions. Theories of other scientific disciplines usually use pairs of concepts like *action* and *reaction* or *stimuli* and *response* as descriptions of more or less mechanical relations. In contrast to this the evolutionary theory, as most biology, describes dialectic processes. Further, the Darwinist theory focused on processes between higher entities like populations and species and their environment instead of the activities of the individual (Prigogine, 1997). Thus, at that time the theory of evolution had more similarities with some theories in