Students' Explanations: A Review of How Students Understand the Theory of Evolution

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The abundance of varying life forms, and their abilities to survive in equally varied circumstances, becomes meaningful in the light of the theory of evolution. Naturally then, one of the often-used ways to diagnose students' understanding of the theory of evolution is to elicit and analyse their explanations of relevant phenomena. Around early nineteen eighties, science educationists interested in "children's science" called a similar approach as "interview-about-events" (e.g. 8)

In the conference that aims to review research in various branches and roots of science education, it would be appropriate to review research on the students' explanations of phenomena in the domain of theory of evolution. The review will be organised around the major principles –variation and natural selection (random or "blind" heritable variations, differential reproductive success in specific environments and consequent changes in population structure/speciation etc.) – of the theory of evolution (5); and what the students tell us about their understanding of these principles (1-4, 6, 7, 9-13, 15-19). This review thus intends to put the scientific explanations vis-à-vis students' explanations, and to present our interpretation of students' understanding of the phenomena. The observations are grounded in the current literature but more empirical and theoretical explorations are necessary for a clearer picture.

Students "see" the *variation* as a result of altered environmental condition. Thus, for most of the students, variation does not *precede* environmental change but *follows* it. Here, environment or "nature" is playing *instructive* rather than *selective* role. The cruciality of already-available-variations contributing to the survival in a now-different environment is generally not recognised by the students. In other words, they do not understand that evolution of the species is a "variational evolution" (12). Evolution, for them, is a consequence of the intrinsic drive of organisms to survive in the face of challenging environments; it is for them a "developmental or transformational evolution" – transformation of un- or less "adapted" organisms or "species" into the "adapted" ones. In a sense then, they perceive the "need" to adapt as a *cause* of evolution; adaptation, for majority of the students, is not the *effect* of natural selection over many generations. So, for many students, organisms or species-as-a-unit are adapting. Their pre-scientific explanations do not involve the concept of "changing populations" of individuals, each one having "unique constellation of characteristics (many of these common among the conspecific individuals)" (14). Students most probably fail to correctly disentangle various levels of biological organisation that vary continuously in the process of evolution: molecular/cellular (the source of variation), organismic (individuals that vary and, if successful, reproduce), populational (can change over many generations due to differential survival), and (rest of the varying) environmental level. Each of these levels has its own dimension of time, ranging from generation time to geological time. It is difficult to understand and appreciate – for students as well as for many of us – that, the evolution is, in Lewontin's words, the conversion of the variation among individuals within an interbreeding group into variation between groups in space and time (12).

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