Students' interpretations of changes in certain physical systems and the use of the energy model

N. Papadouris, Th. Kyratsi and C. P. Constantinou
Learning in Physics Group, University of Cyprus
{npapa, kyratsi, c.p.constantnou}@ucy.ac.cy

The study is embedded in the context of a research project that seeks to develop curriculum materials for the concept of *energy*. In the teaching approach that is taken in this project, *energy* is introduced as a model that accounts for changes in certain physical systems. The present study is directly targeted at the provision of background information pertaining to students' initial ideas and conceptual difficulties with respect to this approach.

Data was collected through a paper-and-pencil, open-ended questionnaire. The questionnaire consists of four tasks depicting changes in certain physical systems and students are asked to account for the changes and to clarify their causes. Participants are upper elementary students who fall into two groups depending on whether they were exposed to the *energy* unit included in the traditional school science curriculum or not.

Data analysis is focused on three issues. In the first instance, the analysis seeks to identify the various ways in which students account for the changes depicted in the systems. In an attempt to elicit students' spontaneous responses, participants were not informed that the test was in any way relevant to *energy*. Data analysis led to the identification of three categories of explanation. The first includes the responses that attribute the changes to a certain process that takes place within the system or to isolated objects of the system. The second category consists of the responses that associate the changes with *energy*, and the third comprises the responses that link the changes with a concept other than *energy* (force and electric current). Even though the energy-based responses are less frequent than the other two types of response, it is important to note that they account for at least 25% of the responses. In most cases, students who provide-energy based responses tend to draw on the idea of energy transfer. The remaining responses refer to energy as an abstract idea and fail to describe specific mechanisms that link the changes with energy. It is important to note that none of the responses drew on the idea of energy transformation.

The next issue addressed by the study includes the identification of the conceptual difficulties encountered by students when they draw on energy to account for the changes. In particular, data analysis provided evidence for students' failure to (a) differentiate between *energy* and *force* (b) identify appropriate energy sources in given physical systems or recognize that energy cannot be created, and (c) identify the immaterial nature of energy.

Finally, the last issue addressed by the study concerns the extent to which instruction about *energy*, as it is traditionally implemented in the Cyprus science curriculum, leads to different response patterns. Preliminary results from our data analysis suggest that traditional instruction does not seem to have any significant impact.