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Conceptualizing energy by practicing scientists, in the online media and by junior high school students

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Abstract - Shahar Abramovitch

There are two different populations of students who study science together in Junior High School (JHS)– those who may continue to study more advanced science and may become future scientists and engineers, and those who will learn very little more science and usually no more instruction focusing explicitly on energy. Thus, instruction of science in JHS should do the impossible and move between two parallel trajectories, one providing the basis for future STEM studies (future scientists) and the other the basic literacy for those who will not continue to study science and but should be wise consumers of science.

Energy is one of the fundamental concepts of science, in all disciplines. Due to its centrality, energy was identified by the Framework for K-12 Science Education (NRC, 2012) as a cross-cutting concept (CCC) that bridges the different disciplines and should be learned by all middle school students. Instruction on energy in MS should provide the foundational understanding of energy, whether students will go on to study more science or won't. Underlying the requirement to teach energy as a CCC is the implicit assumption that the different disciplinary perspectives of energy have something in common which should be the focus of instruction and which supports the way energy is used by all participants in the different disciplines.

The goal of this dissertation is to address the dilemma whether the conceptualization of energy as a CCC fits the needs of both future scientists and lay citizens. In order to answer these questions, I first interviewed top-level scientists and asked them to explain phenomena from different disciplines; each phenomenon can be explained in a variety of ways, one which is an energetic explanation. My results suggest that the top-level and experienced scientists I interviewed don't treat energy as a CCC.

Second, this study investigated whether the JHS energy curriculum, as advocated by many national standards, helps students construct the knowledge needed to be consumers of ongoing scientific research. To do so, I characterized the conceptions of energy that underlie the discourse in science articles in top-level online sites aimed at an educated audience composed of individuals who may not be actively engaged themselves in science or engineering. My results show that energy is rarely presented in these quality journals in way it is taught in class. That means that if a student will decide to read energy related news article in the media or if a teacher uses science news to encourage literacy assignments, they will find a wide gap between the curriculum and the way energy is presented in current media.

Third, since the Israeli science standards for JHS students highlights the goal of creating scientifically literate students, I asked if and how energy instruction in Israeli JHS helps students develop the conceptual understanding needed to make sense of energy-related issues from the articles mentioned before? To do so I gave 7^{th} and 9^{th} grade students edited articles followed by questions checking students' conceptions of energy. Results show most students use naïve conceptions when answering questions to an energy-related article. Relatively few draw upon the energy-related conceptions underlying JHS science education.

To conclude, results show that current instruction promotes neither the future scientists nor the lay citizens. Grasping energy as a CCC is a difficult task that requires, in my opinion, a more profound change in instruction. It should start by highlighting the differences between the different science disciplines in the curriculum and not avoiding them in order to create a truly interdisciplinary way of teaching energy serving both populations.