Research on Student Learning

Even after some years of physics instruction, students do not distinguish well between heat and temperature when they explain thermal phenomena. [1] Their belief that temperature is the measure of heat is particularly resistant to change. Long-term teaching interventions are required for upper middle-school students to start differentiating between heat and temperature. [2]

Few middle- and high-school students understand the molecular basis of heat conduction even after instruction. [3] For example, students attribute to particles properties such as "hotness" and "coldness" or believe that heat is produced by particles rubbing against each other. [4]

During instruction, upper elementary-school students use ideas that give heat an active drive or intent to explain observations of convection currents. They also draw parallels between evaporation and the water cycle and convection, sometimes explicitly explaining the upwards motion of convection currents as evaporation. [5]

Students rarely think energy is measurable and quantifiable. [6] Students' alternative conceptualizations of energy influence their interpretations of textbook representations of energy. [7]

Middle- and high-school students tend to think that energy transformations involve only one form of energy at a time. [8] Although they develop some skill in identifying different forms of energy, in most cases their descriptions of energy-change focus only on forms which have perceivable effects. [9] The transformation of motion to heat seems to be difficult for students to accept, especially in cases with no temperature increase. [10] Finally, it may not be clear to students that some forms of energy, such as light, sound, and chemical energy, can be used to make things happen. [11]

The idea of energy conservation seems counterintuitive to middle- and high-school students who hold on to the everyday use of the term energy, but teaching heat dissipation ideas at the same time as energy conservation ideas may help alleviate this difficulty. [12] Even after instruction, however, students do not seem to appreciate that energy conservation is a useful way to explain phenomena. [13] A key difficulty students have in understanding conservation appears to derive from not considering the appropriate system and environment. [14] In addition, middle- and high-school students tend to use their conceptualizations of energy to interpret energy conservation ideas. [15] For example, some students interpret the idea that "energy is not created or destroyed" to mean that energy is stored up in the system and can even be released again in its original form. [16] Or, students may believe that no energy remains at the end of a process, but may say that "energy is not lost" because an effect was caused during the process (for example, a weight was lifted). [17] Although teaching approaches which accommodate students' difficulties about energy appear to be more successful than traditional science instruction, the main deficiencies outlined above remain despite these approaches. [18]

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