

## The Designed World > Energy Resources

### Research on Student Learning

Students may identify the transfer of energy to the environment with pollution or waste materials being thrown to the environment. [1] Students are not likely to be aware of the heating of the environment which accounts for the energy dissipated. [2] Students who have developed an awareness of heat transfer to the environment as a component of most energy transformations may assume that such a transfer results in energy "being lost." They do not think that energy has become spread out and is not as useful as energy which is "concentrated" in one place. [3]

Middle-school students do not always explain the process of heating and cooling in terms of heat transfer. [4] Some students think that "cold" is being transferred from a colder to a warmer object, others that both "heat" and "cold" are transferred at the same time. Middle- and high-school students often do not explain heat conduction phenomena as interactions. [5] For example, students sometimes think that, depending on its properties, an object which is at the same temperature with its surroundings can cool down spontaneously. Even after instruction, students don't always give up their naive notion that some substances (for example, flour, sugar, or air) cannot heat up. [6] Even after instruction, students don't always give up their naive notion that metals get hot quickly because "they attract heat," "suck heat in," or "hold heat well." [7] Middle-school students believe different materials in the same surroundings have different temperatures because they feel different (for example, metal feels colder than wood). As a result, they may not recognize the universal tendency to temperature equalization. [8] Helping most students develop scientific ideas in this domain appears to be possible only with long-term interventions that focus on connecting scientific ideas about rate of heat transfer, insulation/conduction, and thermal equilibrium with each other and with ideas students hold based on everyday experiences. [9]

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