Research on Student Learning

Student ideas about the shape of the earth are closely related to their ideas about gravity and the direction of "down". [1] Students cannot accept that gravity is center-directed if they do not know the earth is spherical. Nor can they believe in a spherical earth without some knowledge of gravity to account for why people on the "bottom" do not fall off. Students are likely to say many things that sound right even though their ideas may be very far off base. For example, they may say that the earth is spherical, but believe that people live on a flat place on top or inside of it -- or believe that the round earth is "up there" like other planets, while people live down here. [2] Research suggests teaching the concepts of spherical earth, space, and gravity in close connection to each other. [3] Some research indicates that students can understand basic concepts of the shape of the earth and gravity by 5th grade if the students' ideas are directly discussed and corrected in the classroom. [4]

Elementary-school students typically do not understand gravity as a force. They see the phenomenon of a falling body as "natural" with no need for further explanation or they ascribe to it an internal effort of the object that is falling. [5] If students do view weight as a force, they usually think it is the air that exerts this force. [6] Misconceptions about the causes of gravity persist after traditional high-school physics instruction [7] Misconceptions about the causes of gravity can be overcome by specially designed instruction. [8]

Students of all ages may hold misconceptions about the magnitude of the earth's gravitational force. Even after a physics course, many high-school students believe that gravity increases with height above the earth's surface [9] Many high-school students are not sure whether the force of gravity would be greater on a lead ball than on a wooden ball of the same size. [10] High-school students also have difficulty in conceptualizing gravitational forces as interactions. In particular, they have difficulty in understanding that the magnitudes of the gravitational forces that two objects of different mass exert on each other are equal. These difficulties persist even after specially designed instruction. [11]

References

[1] Nussbaum, J. (1985). The earth as a cosmic body. In Driver, R. (Ed.), *Children's ideas in science* (pp. 170-192).

Vosniadou, S. (1991). Designing curricula for conceptual restructuring; lessons from the study of knowledge acquisition in astronomy. *Journal of Curriculum Studies*, 23, 219-237.

[2] Sneider, C., Pulos, S. (1983). Children's cosmographies: Understanding the earth's shape and gravity. *Science Education*, 67, 205-221.

Vosniadou, S. (1991). Designing curricula for conceptual restructuring; lessons from the study of knowledge acquisition in astronomy. *Journal of Curriculum Studies*, 23, 219-237.

[3] Vosniadou, S. (1991). Designing curricula for conceptual restructuring; lessons from the study of knowledge acquisition in astronomy. *Journal of Curriculum Studies*, 23, 219-237.

[4] Nussbaum, J. (1985). The earth as a cosmic body. In Driver, R. (Ed.), *Children's ideas in science* (pp. 170-192).

[5] Ogborn, J. (1985). Understanding students' understandings: An example from dynamics. *European Journal of Science Education*, 7, 141-150.

[6] Ruggiero, S., Cartelli, A., Dupre, F., Vicentini-Missoni, M. (1985). Weight, gravity and air pressure: Mental representations by Italian middle-school students. *European Journal of Science*

Education, 7, 181-194.

[7] Brown, D., Clement, J. (1992). Classroom teaching experiments in mechanics. In Duit, R. (Ed.), *Research in physics learning: Theoretical issues and empirical studies* (pp. 380-397).

[8] Brown, D., Clement, J. (1992). Classroom teaching experiments in mechanics. In Duit, R. (Ed.), *Research in physics learning: Theoretical issues and empirical studies* (pp. 380-397).

Minstrell, J., Stimpson, V., Hunt, E. (1992). Instructional design and tools to assist teachers in addressing students' understanding and reasoning. *Instructional design and tools to assist teachers in addressing students' understanding and reasoning.*.

[9] Gunstone, R., White, R. (1981). Understanding of gravity. *Science Education*, 65, 291-299.

[10] Brown, D., Clement, J. (1992). Classroom teaching experiments in mechanics. In Duit, R. (Ed.), *Research in physics learning: Theoretical issues and empirical studies* (pp. 380-397).

[11] Brown, D., Clement, J. (1992). Classroom teaching experiments in mechanics. In Duit, R. (Ed.), *Research in physics learning: Theoretical issues and empirical studies* (pp. 380-397).