Research on Student Learning

Students of all ages (including college students and adults) have difficulty understanding what causes the seasons. Students may not be able to understand explanations of the seasons before they reasonably understand the relative size, motion, and distance of the sun and the earth. [1] Many students before and after instruction in earth science think that winter is colder than summer because the earth is further from the sun in winter. [2] This idea is often related to the belief that the earth orbits the sun in an elongated elliptical path. [3] Other students, especially after instruction, think that the distance between the northern hemisphere and the sun changes because the earth leans toward the sun in the summer and away from the sun in winter. [4] Students' ideas about how light travels and about the earth-sun relationship, including the shape of the earth's orbit, the period of the earth's revolution around the sun, and the period of the earth's rotation around its axis, may interfere with students' understanding of the seasons. [5] For example, some students believe that the side of the sun not facing the earth experiences winter, indicating a confusion between the daily rotation of the earth and its yearly revolution around the sun. [6]

Although upper elementary students may identify air as existing even in static situations and recognize that it takes space, recognizing that air has weight may be challenging even for high-school students. [7] Students of all ages (including college students) may believe that air exerts force or pressure only when it is moving and only downwards. [8] Only a few middle-school students use the idea of pressure differences between regions of the atmosphere to account for wind; instead they may account for winds in terms of visible moving objects or the movement of the earth. [9]

Before students understand that water is converted to an invisible form, they may initially believe that when water evaporates it ceases to exist, or that it changes location but remains a liquid, or that it is transformed into some other perceptible form (fog, steam, droplets, etc.). [10] With special instruction, some students in 5th grade may be able to identify the air as the final location of evaporating water [11] Students must accept air as a permanent substance before they can identify the air as the final location of evaporating water. [12] For many students, difficulty understanding the existence of water vapor in the atmosphere persists in middle school years. [13] Students can understand rainfall in terms of gravity once they attribute weight to little drops of water (typically in upper elementary grades), but the mechanism through which condensation occurs may not be understood until high school. [14]

Students of all ages may confuse the ozone layer with the greenhouse effect, and may have a tendency to imagine that all environmentally friendly actions help to solve all environmental problems (for example, that the use of unleaded petrol reduces the risk of global warming). [15] Students have difficulty linking relevant elements of knowledge when explaining the greenhouse effect and may confuse the natural greenhouse effect with the enhancement of that effect. [16]

References

[1] Sadler, P. (1987). Misconceptions in astronomy. In Novak, J. (Ed.), *Proceedings of the second international seminar misconceptions and educational strategies in science and mathematics*, 3, (pp. 422-425).

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] Atwood, R., Atwood, V. (1996). Preservice elementary teachers' conceptions of the causes of seasons. *Journal of Research in Science Teaching*, 5, 553-563.

Dove, J. (1998). Alternative conceptions about the weather. *School Science Review*, 79, 65-69.

Philips, W. (1991). Earth science misconceptions. *Science Teacher*, 58, 21-23.

Sadler, P. (1998). Psychometric models of students conceptions in science: reconciling qualitative studies and distractor-driven assessment instruments. *Journal of Research in Science Teaching*, 35, 265-296.

[3] Galili, I., Lavrik, V. (1998). Flux concept in learning about light: A critique of the present situation. *Science Education*, 82, 591-613.

Sadler, P. (1998). Psychometric models of students conceptions in

science: reconciling qualitative studies and distractor-driven assessment instruments. *Journal of Research in Science Teaching*, 35, 265-296.

[4] Galili, I., Lavrik, V. (1998). Flux concept in learning about light: A critique of the present situation. *Science Education*, 82, 591-613.

Sadler, P. (1998). Psychometric models of students conceptions in science: reconciling qualitative studies and distractor-driven assessment instruments. *Journal of Research in Science Teaching*, 35, 265-296.

[5] Galili, I., Lavrik, V. (1998). Flux concept in learning about light: A critique of the present situation. *Science Education*, 82, 591-613.

Salierno, C., Edelson, D. C., Sherin, B. (2005). The development of student conceptions of the earth-sun relationship in an inquiry-based curriculum. *Journal of Geoscience Education*, 53, 422-431.

[6] Salierno, C., Edelson, D. C., Sherin, B. (2005). The development of student conceptions of the earth-sun relationship in an inquiry-based curriculum. *Journal of Geoscience Education*, 53, 422-431.

[7] Sere, M. (1985). The gaseous state. In Driver, R. (Ed.), *Children's ideas in science* (pp. 105-123).

Driver, R., Squires, A., Rushworth, P., Wood-Robinson, V. (1994). *Making sense of secondary science: Research into children's ideas*.

Krnel, D., Watson, R., Glazar, S. (1998). Survey of research related to

the development of concept "matter". *International Journal of Science Education*, 20, 257-289.

[8] Driver, R., Squires, A., Rushworth, P., Wood-Robinson, V. (1994). *Making sense of secondary science: Research into children's ideas*.

Sere, M. (1985). The gaseous state. In Driver, R. (Ed.), *Children's ideas in science* (pp. 105-123).

Henriques, L. (2002). Children's ideas about weather: A review of the literature. *School Science and Mathematics*, 102, 202-215.

Nelson, B.D., Aron, R.H., Francek, M.A. (1992). Clarification of selected misconceptions in physical geography. *Journal of Geography*, 91, 76-80.

[9] Driver, R., Squires, A., Rushworth, P., Wood-Robinson, V. (1994). *Making sense of secondary science: Research into children's ideas*.

[10] Bar, V. (1989). Children's views about the water cycle. *Science Education*, 73, 481-500.

Russell, T., Harlen, W., Watt, D. (1989). Childrens' ideas about evaporation. *International Journal of Science Education*, 11, 566-576.

Russell, T., Watt, D. (1990). Evaporation and condensation. *SPACE Project Research Report*.

Krnel, D., Watson, R., Glazar, S. (1998). Survey of research related to the development of concept "matter". *International Journal of Science Education*, 20, 257-289.

[11] Russell, T., Watt, D. (1990). Evaporation and condensation. *SPACE Project Research Report*.

[12] Bar, V. (1989). Children's views about the water cycle. *Science Education*, 73, 481-500.

[13] Lee, O., Eichinger, D.C., Anderson, C.W., Berkheimer, G.D., Blakeslee, T.S. (1993). Changing middle school students' conceptions of matter and molecules. *Journal of Research in Science Teaching*, 30, 249-270.

Johnson, P. (1998). Children?s understanding of changes of state involving the gas state, Part 2: Evaporation and condensation below boiling point. *International Journal of Science Education*, 20, 695-709.

[14] Bar, V. (1989). Children's views about the water cycle. *Science Education*, 73, 481-500.

[15] Andersson, B., Wallin, A. (2000). Students' understanding of the greenhouse effect, the societal consequences of reducing CO2 emissions and the problem of ozone layer depletion. *Journal of Research in Science Teaching*, 37, 1096-1111.

Koulaidis, V., Christidou, V. (1999). Models of students' thinking concerning the greenhouse effect and teaching implications. *Science Education*, 83, 559-576.

Meadows, G., Wiesenmayer, R. (1999). Identifying and Addressing Students' Alternative Conceptions of the Causes of Global Warming: The Need for Cognitive Conflict. *Journal of*

Science Education and Technology, 8, 235-239.

Rye, J., Rubba, R., Wiesenmayer, R. (1997). An investigation of middle school students? alternative conceptions of global warming as formative evaluation of teacher-developed STS units. *International Journal of Science Education*, 19, 527-551.

[16] Andersson, B., Wallin, A. (2000). Students' understanding of the greenhouse effect, the societal consequences of reducing CO2 emissions and the problem of ozone layer depletion. *Journal of Research in Science Teaching*, 37, 1096-1111.