

MISCONCEPTIONS (“ALTERNATIVE CONCEPTIONS”) IN SCIENCE TEACHING

(H. Weller, EDW 472/SMS 491, Spring 2007)

A STUDENT’S ALTERNATIVE FRAMEWORK OF THINKING

- A student’s expression of an alternative conception is derived from the student’s “alternative framework” of thinking (his or her non-scientific thinking).
- If asked again, he or she may express a conception somewhat different.

WHAT RESEARCH TELLS US ABOUT ALTERNATIVE CONCEPTIONS: KNOWLEDGE CLAIMS FROM RESEARCH RESULTS

(In Chiappetta & Koballa Jr., 2006, p. 131; From Wandersee, Mintzes, & Novak, 1994)

- Learners come to formal science instruction with a diverse set of alternative conceptions about natural objects and events.
- The alternative conceptions that learners bring to formal science instruction cut across age, ability, gender, and cultural boundaries.
- Alternative conceptions are tenacious and resistant to extinction by conventional teaching strategies.
- Alternative conceptions often parallel explanations of natural phenomena offered by previous generations of scientists and philosophers.
- Alternative conceptions have their origins in diverse sets of personal experiences including direct observations and perceptions, peer culture and language, and in teachers’ explanations and instructional materials.
- Teachers often subscribe to the same alternative conceptions as their students.
- Learners’ prior knowledge interacts with knowledge presented in formal instruction, resulting in a diverse set of unintended learning outcomes.
- Instructional approaches that facilitate conceptual change can be effective classroom tools.

SOME TYPICAL ALTERNATIVE CONCEPTIONS IN SCIENCE

(from Weld, 2004, p. 117)

PHYSICS

Forces and Motion

- If no force is being applied, either objects are at rest or, if moving, they are slowing down.
- An object moves in the direction of the force applied to it.

Heat and Temperature

- Heat makes things rise.
- Heat and cold are material substances that can be transferred from one thing to another.

Light/Optics

- Light brightens objects so that they can be seen.
- Eyes play an active role in reaching out to intercept images.

Nature/States of Matter

- Gas molecules are not in constant motion.
- Heating and cooling play no role in particle motion.

Earth/Space Science

- The orbit of the earth is highly elliptical (related to change of seasons).
- The earth is flat.

CHEMISTRY

- Atoms vary in shape.
- Phosphorus atoms are yellow; water molecules are made of small drops (and other transferences of macroproperties to molecular level).

BIOLOGY

Animals and Plants

- Animals are alive, have legs, move, have hair or fur, live outside or in the woods.
- Plants are not alive.
- Plants must eat (get food from the soil).

Continuity

- Some traits come from the mother and others from the father
- Traits can change over time in response to the environment.

A RECOMMENDED INSTRUCTIONAL SEQUENCE FOR CHANGING STUDENTS' CONCEPTIONS

(In Chiappetta & Koballa Jr., 2006, p. 132; From Driver, 1988)

- Orientation: Begin the instruction with a focus on what is believed.
- Elicitation: Call on students to explain their ideas of the concept under study.
- Clarification: Probe students to clarify their ideas of the concept under study.
- Conflict: Create discrepant events that cause the learners to see that their conceptions are incorrect.
- Construction: Help students view their ideas differently and to provide more correct explanations.
- Evaluation: Assess students' understandings of the concepts under study.
- Application: Provide instances to apply what has been learned, especially to everyday life.
- Review: Ask each student to describe how his or her conceptions have changed from the beginning of the instructional sequence to the present.

REFERENCES

Chiappetta, E. L., & Koballa, Jr., T. R. (2006). Science Instruction in the Middle and Secondary Schools. Upper Saddle River, NJ: Pearson/Merrill Prentice Hall.

Driver, R. (1988). Theory into Practice II: A constructivist approach to curriculum development. In P. Fensham (Ed.), Development of Dilemmas in Science Education (p. 141). Philadelphia: Falmer Press.

Wandersee, J. H., Mintzes, J. J. (1994). Research on alternative conceptions in science. In D. L. Gabel (Ed.), Handbook of Research on Science Teaching. Upper Saddle River, NJ: Merrill/Prentice Hall.

Weld, J. (2004). The Game of Science Education. Boston: Pearson.