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Abstract: The plenary session began with a brief presentation by the two session leaders outlining two views of conceptual change or meaningful learning and the nature of the classroom environment that can facilitate such learning. Each presentation set out several assumptions about student conceptions, student learning, the teaching process, and change. The following two sections outline these assumptions.

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Implementing Conceptual Change in Classrooms

Plenary Session

Third International Seminar on Misconceptions and Educational Strategies in Science and Mathematics, Cornell University, Ithaca, NY, August 1 - 4, 1993

Session Leaders

George Posner

Cornell University, Ithaca, New York

Jeffrey Bloom

Acadia University, Wolfville, Nova Scotia

The plenary session began with a brief presentation by the two session leaders outlining two views of conceptual change or meaningful learning and the nature of the classroom environment that can facilitate such learning. Each presentation set out several assumptions about student conceptions, student learning, the teaching process, and change. The following two sections outline these assumptions.

"A Foundation for Framing the Implementation of Conceptual Change: A View Based on Classroom Ecology"

George Posner

1. Teachers and students enter classrooms with various conceptions of the subject matter, preconceptions about each topic in the subject matter, interpretations of the social rules for interacting with teachers and peers, and beliefs about the purposes for studying the subject matter, among others.
2. Teaching is a process of negotiation between teachers and students, as they struggle together over the meaning of tasks. Therefore, students and teachers both play an active role in shaping the enacted curriculum.
3. The process of negotiation is influenced by a set of frame factors that act as both resources for and constraints on teaching. These include the backgrounds and capabilities of the students and teachers, the equipment, materials, space and time available, the formal curriculum and its accountability system, and the school's political, organizational, and cultural characteristics.
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- formal curriculum and its accountability system, and the school's political, organizational, and cultural characteristics.
4. These factors make typical classrooms difficult environments in which to teach for meaning and real understanding. Meaning-oriented tasks requiring understanding and interpretation typically get transformed through a process of negotiation into more routine tasks emphasizing memorization and following rules in order to reduce the inherent risk and ambiguity of the tasks.
 - Meaning-oriented tasks requiring understanding and interpretation typically get transformed through a process of negotiation into more routine tasks emphasizing memorization and following rules in order to reduce the inherent risk and ambiguity of the tasks.
 5. Changing teaching practices requires a change in the conceptions and beliefs of both teachers and students, as well as changes in the factors that frame classroom teaching.

**"A Foundation for Framing the Implementation of Conceptual Change:
A View Based on Children's Cognition"**

Jeff Bloom

1. Children's understandings are much more complex than we have considered previously.
 - These understandings involve more than semantic, propositional knowledge (or formal knowledge).
 - In addition to formal knowledge, such personally meaningful understandings include emotions, values, aesthetics, beliefs, interpretive frameworks (such as, anthropocentrism), metaphors, imagery, personal experiences, and elaborative stories.
2. Such personally meaningful understandings are deeply embedded in children's sociocultural contexts.
3. Changing the nature and content of personally meaningful understandings is difficult and complicated.
 - When understandings involve emotions, values, beliefs, stories, personal experiences, and the intuitively sensible logic of interpretive frameworks, children have a highly personal stake in the value of their understandings.
4. Such personally meaningful understandings are not necessarily bad.
 - Although they may not be appropriate in a scientific context, they may be important and useful in other contexts.

- Because of their potential in other contexts, they can be a source of creative insight and problem solving in science, as well.
 - In addition, such personally meaningful understandings can have a significant contribution to our cultural richness.
5. Changing conceptions, in the context of what might be considered appropriate in the classroom, may be more a matter of constructing new understandings or perspectives.
- The danger of viewing conceptual change as replacement or restructuring is that such a view may tend to push us towards more mechanistic and positivistic classroom practices.
 - Deeper level change in belief or in allegiance to a particular perspective may not be an appropriate goal in the classroom.
 - Such a change in allegiance can be a long term process, well beyond the scope of the school year.
 - Such a change can be a highly personal decision at the roots of an individual's beliefs and particular sociocultural context.
 - Demanding such a change in allegiance may also be ethically questionable.
 - However, the classroom can plant the seeds for such long term change in allegiance.
6. Adding meaningful understandings and planting the seeds for further personal changes in allegiance requires that we respect children's personally meaningful and idiosyncratic understandings and that we respect the beliefs of a wide variety of sociocultural contexts.
- We do "lip service" to respecting students' alternative conceptions, but what we really want is change in allegiance to a scientific understanding.
 - Genuine respect requires seeing the potential value of personally meaningful understandings and their contextual appropriateness.

Classroom Environment

Both session leaders converged in their thinking on the nature of the classroom environment necessary for encouraging meaningful learning or conceptual change: the notion of the classroom as a community of scientists. The following briefly describes the points made by each session leader.

George Posner:

1. A classroom is more than a collection of individual students and a teacher. It is a community with a distinct set of values and norms for social interaction. It is a culture in which knowledge is socially

negotiated. Therefore, implementing conceptual change teaching may require a cultural change.

2. Research on conceptual change should begin to study classrooms in order to identify the characteristics and conditions in which conceptual change teaching can thrive.

Jeff Bloom:

1. In order for children to add a new understanding and acquire the skills and background for making personal decisions about changing allegiance to a particular understanding or knowledge claim, we need to create classroom communities that value the integrity of each individual's ideas and beliefs.
2. Such a community needs to promote inquiry into and evaluation of both personal and scientific understandings. Such evaluation of understandings and explanations needs to focus on determining the appropriateness of each understanding in various contexts.
3. The classroom community needs to be a community of researchers and/or scholars that reflects the diversity of sociocultural and personal understandings or perspectives.

Issues Raised During the Discussion

1. Dealing with students who get angry (or who are lost) when answers are not provided.
2. How to get students and teachers to feel comfortable with uncertainty.
3. Helping students recognize appropriate sources of authority.
4. Getting students to respect and desire evidence to support knowledge claims: "Convince me."
5. Students learning to reason through justification of ideas. Includes alternative forms of reasoning, such as pictorial reasoning and analogical reasoning.
6. Providing children with the tools for inquiry and the evaluation of ideas and explanations.
7. Providing the conceptual preparation, so that the classroom is a place where meaning can be negotiated.

8. How to deal with assessment, which is seen as an endpoint and which therefore drives instruction.
9. Expectations of students, teachers, and parents about schooling.
10. School culture and classroom culture as the objects of conceptual change.
11. Accountability issues.
12. How to validate students while telling students they are wrong.
13. Curriculum issues: Picking your battles wisely.
14. Curriculum restraints: Are they in teachers' minds?
15. The culture of schools as the major obstacle to (meaningful learning) educational reform.

Questions arising from this discussion:

1. What should we be aiming for in science education?
 - Negotiate a working definition of "change."
 - What are the goals of instruction?
2. What would a conceptual change classroom look like?
 - What are the characteristics of the classroom and school cultures that support conceptual change?
3. What is a defensible position for conceptual change teaching?

Session 2 Discussion

Why are we teaching kids science?

- to train scientists?
- for scientific literacy
 - to understand the nature of the epistemology
 - to understand the nature of the enterprise from a sociological perspective
 - to know something well, in which there is room to allow kids to explore an area of interest in depth
 - to develop abilities to question and evaluate, in order to help children function in society

The issues are much more complicated than we tend to think.

The goals are different for different levels from kindergarten to university.

Why do we organize topics the way we do?

A student's personal understanding of the world may involve the feeling that, "I understand what is going on. There are thinking processes that are unique to science. These processes need to be taught.

One such process involves the use of representations and models.

However, we have not been doing a good job of getting children to develop models. Model and representation use in the classroom has followed the pattern of transmission of other people's models. How can the process of using or developing models be used effectively?

Working definition of "change"

- Presupposition: It is not possible to remove children's understandings.
- We need to address the origins of children's conceptions.
- We need to help them work towards developing a more accurate understanding.
- Change involves conceptualizations that are "evolving." Such a notion of change involves processes that take a long time. Effective change involves the aesthetic experience of really understanding something.
- In order to help kids develop in depth understandings, we need to get away from doing "gee wiz" science.

Summary Discussion

- A consideration that "meaningful learning" rather than "conceptual change" may be a more appropriate term. Conceptual change is often used in a mechanistic way that views change as replacement (which could be through what is called restructuring). Meaningful learning may help to avoid this trap. The value and durability of children's personal conceptions can be acknowledged, while expecting students to construct meaningful understandings of more scientifically acceptable conceptions. Such a view does not necessarily expect students to change their beliefs or allegiances from one conception to another. This level of change may be highly personal and may require much more time, if such a change does occur.
- Further research:
 - on the dynamics of classrooms in order to identify the characteristics and conditions in which conceptual change teaching can thrive. Such characteristics and conditions can include teaching as negotiation, frame factors, classroom culture, the process of cultural change, etc.

- on the dynamics of various cognitive (personal and social) functions that affect meaningful learning and change.
- on the school, curriculum, social, and political constraints to implementing change in classroom culture.

Relevant Literature

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Session 1 and/or 2 Participants

(Please excuse any errors in spelling or omission. The names of some participants in Session 2 were not recorded.)

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