Title	Children's ideas in science: some strategies for teacher intervention
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Source	*Teaching and Learning, 16(1),72-80*
Published by	Institute of Education (Singapore)

Children's Ideas in Science: Some Strategies for Teacher Intervention

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Introduction

Teachers often teach science as if our children are empty vessels and know nothing about new ideas to be taught. In fact, research has shown that children often come to class with their own ideas or beliefs about why and how things behave as they do. Their ideas can surprise and amuse us because these ideas may sound reasonable and make sense and yet are scientifically inaccurate. These unscientific ideas are usually difficult to change through classroom instruction (Driver, Guesne & Tiberghien, 1985). These ideas are often called "children science", "alternative conceptions", "alternative frameworks" or "misconceptions". For examples, many children do not consider grass, carrots, cabbages, seeds and trees as plants as biologists do. They see the larger bubbles in the boiling water as heat, air, oxygen and/or hydrogen, etc. They believe that light travels farther at night than during the day (Osborne & Freyberg, 1985). Some research findings of children's alternative frameworks can be found in the publications of Driver and Erickson (1983), Osborne and Freyberg (1985), White and Gunstone (1992), and Bell (1993a).

Children have a wide range of conceptions which are considered undesirable by the teachers as these conceptions will hinder their learning. As a teacher, it is important to use some techniques to identify students' beliefs which they bring to the classroom before starting to teach something new to them. We need to constantly unteach their misconceptions or alternative frameworks for effective learning to occur. This article reports on some techniques which can be used to find out what children think or what alternative frameworks they have. An intervention method as a follow-

up strategy for improving or changing their alternative (or unscientific) conceptions is also discussed.

Finding Out What Children Are Thinking

From the review of literature, a few methods of finding out what children are thinking have been reported. These include the interview-about-instances (Bell, Osborne & Tasker, 1985); survey (Philips, 1991); concept mapping (Al-Kunifed & Wandersee, 1990); children's questions (Bidduiph & Osborne, 1984) and brainstorming (Bell, 1993b).

Interview-About-Instances

This is an interview method used to explore the concept which a child associates with a particular process, for example, photosynthesis. Each child is shown a series of drawings depicting various objects or episodes; or a demonstration of a phenomenon through the use of experimental set ups. S/he will rhen be asked some closed or open-ended questions related to the phenomenon. A sample of such interview questions is shown below as a guideline to how an interview can be conducted.

Example:

1. Introduction
   'I would like to talk to you about your meaning of the word animal. First I'll show you some drawings and then we will have a chat about them.'

2. Key question for each picture or card
   'In your meaning of the word animal would you think'of this as animal?'

3. Follow up question
   'Why did you say that?'
   'Can you explain to me why you think that?'
   'Can you tell me more about that?

4. A final question
   'Thank you for telling about your meaning of the word animal. Just to finish I wonder if you could describe to me in your own words what an animal is to you.'

(Osborne & Freyberg, 1985, Appendix D2, page 177)

Survey

The survey is another method which uses multiple-choice questions to find out the views of all students in the class in a relatively short span of time. It has the disadvantage that the teacher does not know why a student chose the answer s/he did, although s/he could probably make a good guess. The responses chosen by the whole class and the scientists' answers can be discussed and compared to help students develop their concepts. A survey question testing children's concept on burning candles is shown below as an example.

Example

When a candle is alight, does it need air?

(a) No, not really.
(b) Yes, to help the flame, but nothing happens to the air, except that it gets a bit hot.
(c) Yes, and some of the air gets changed into something else.

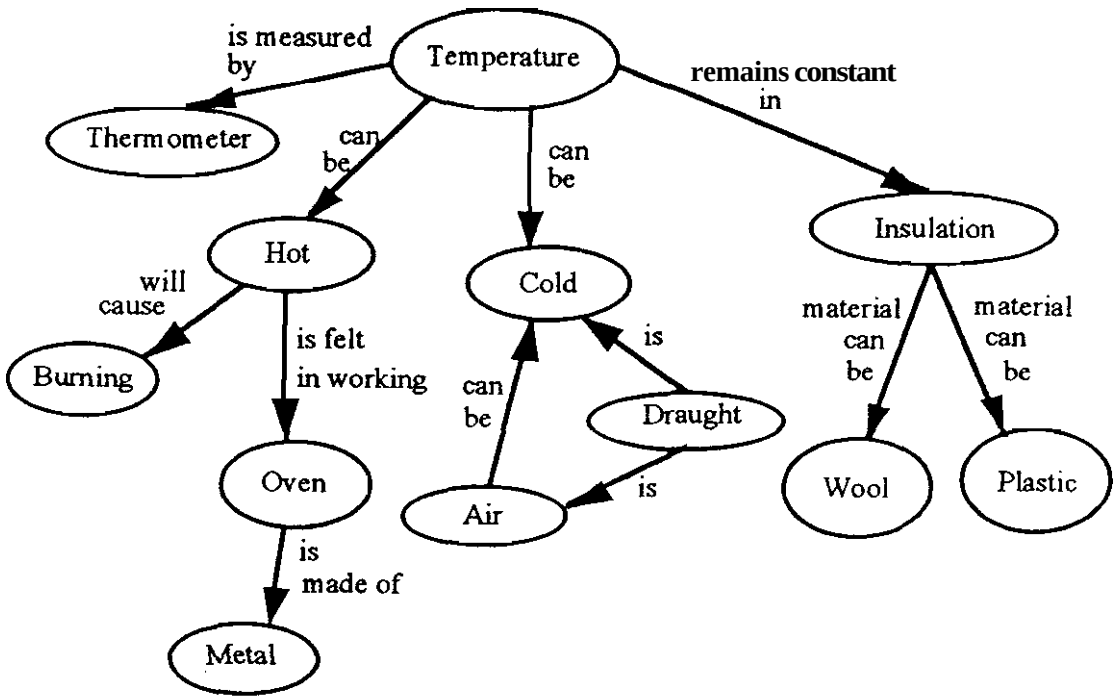
Concept Mapping

A concept map is a network diagram which demonstrates the conceptual structure of a topic in two dimensions. Concepts are hierarchically linked with the most general and inclusive concepts at the top, and proceed downward through less general concepts, and finally to more specific concepts and examples. The concepts are further linked with words that indicate relationships between them. These linking words are called propositions. A concept map is now shown to illustrate these points.

Example

Key words:

Hot, Cold, Temperature, Thermometer, Air, Oven, Draught, Burning, Metal, Wool, Plastic, Insulation



The teacher can cut out the rectangles or other shapes with the key concepts in a teaching unit. In constructing a concept map, students can move the pieces of paper around on a larger sheet of paper to show the relationships between the words. Once the network structure of the concept map is decided they can fix the pieces of paper to the larger sheet and then draw arrows and write phrases to illustrate the links. Concept maps are useful for finding out the ideas the students bring to a lesson and for discussion between students on a particular topic. Concept maps can also be constructed by students before and after a teaching unit as an evaluation tool to find out whether learning has occurred.

Students' Questions

Seeking the questions that students want to know the answers to is another way of finding out what students are thinking. Their questions indicate what they are thinking about, their interests, their

concerns, their confusion and their past experiences. The teacher can then teach accordingly taking into account their thinking, interests and concerns. The questions also serve as a basis for the teacher to organize the students' self-directed investigations or problem-solving activities.

Before asking students for their questions, the students need to do a series of "starter" activities to get them thinking and wondering. The activity works best if the students do not come to it unprepared. For a particular topic, prepare 5-10 small activities that are useful as starter activities. For example, for the topic of "change", you might prepare activities that illustrate the change of matter: a burning candle, rusting of steel wool, heating of sugar and rice, drying of clothes, melting of ice, adding 'ENO' (fruit salt) in water, etc. These can be arranged around the room and the students asked to operate the equipment at each station. Once the activities have been done, questions can be sought from the class. Students can write their own questions on separate pieces of paper and display them on a class poster. Or the questions can be contributed orally to a class discussion and recorded on a poster or overhead projector transparency.

Brainstorming

Brainstorming is often used at the beginning of a unit of work to elicit the existing ideas, feelings, interests and concerns of the students before any teaching begins. In this method, the teacher asks the students to give ideas and things they think are related to a topic, for example, pollution. The teacher records the suggestions on the board or overhead projector transparency in exactly the same words as the students have used. No attempt is made to rephrase or develop the ideas at this stage. They may wish to ask questions for clarification, for example, "Do you mean coffee is water?"

This technique is also useful to get the students thinking about a particular topic and to make links between what they already know and the new ideas to be introduced in the rest of the lesson. Teachers can try out this technique on these topics: living things, pollution, electricity, change, energy, etc.

A Teaching Strategy for Conceptual Change

A process of conceptual change involves the realigning, reorganising or replacing existing concepts to accommodate new ideas. Smith, Blakeslee and Anderson (1993) found that teachers showed little attempt to use conceptual change teaching strategies in the classrooms although the use of conceptual change teaching strategies increases the students' success in learning. A strategy consisting of three stages namely, Prediction, Observation and Explanation (POE), is useful for conceptual change.

Prediction

A teacher can start the lesson with activities to develop interest and set the scene. The students are asked to predict what will happen or explain what has happened. The methods mentioned above can be used to elicit children's ideas for this prediction exercise. A confidence scale, allowing students to express how sure they are of their answers, can be used to identify how strongly they hold their alternative conceptions. The following example showing an activity with questions illustrates how a prediction exercise can be conducted.

Example

I filled a cup and jug with water heated to the same temperature

(a) What would I find if I returned one hour later?
  (1) The water in the jug was hotter.
  (2) The water in the cup was hotter.
  (3) The water was the same temperature in both containers.

(b) How sure are you of your answer?

Just a guess	Not too sure	Pretty sure	I'm sure I'm right

(c) Explain your answer

Teachers can give students ample opportunities to discuss their answers to the questions; allowing them to work in cooperative groups with each group producing a record of their discussion on the overhead transparencies or in the form of a poster to share with the class. They are encouraged to have a diversity of view points. This provides teachers with firsthand information about their students' ideas and enables the teachers to see precisely how these ideas differ from their own. It also allows students to clarify their own thoughts by having to put these thoughts into words. Conceptual change is likely to happen if their beliefs have been made explicit. Teachers should listen respectfully to the ideas the students express and to their explanations of why these ideas make sense to them, and encourage other students to do so as well.

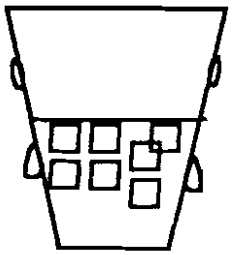
Observation

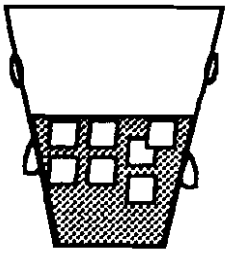
In the second stage of the conceptual change strategy, either the teacher demonstrates or lets the students do the experiment described in the prediction exercise. Sometimes, discrepant events (Chin, 1992) can also be introduced to create conflicts in students' minds. The following example is shown to illustrate the use of discrepant event in the conceptual change activity. This direct observation of an actual phenomenon or a discrepant event allows students to test their alternatives they propose. Brainstorming session can be conducted to allow students to explain the results. Students begin to see the discrepancies between their own explanations and the results they observe firsthand. Through this conflict, they grow dissatisfied with their imperfect theories. The teacher leads the discussion toward recognizing ideas that consistently explain the results obtained. The teacher should avoid making judgment on who is right or wrong but focus on how students support their thinking (Minstrell & Smith, 1983).

Example:

How does condensation happen?

(1) Iced water (2) Dyed water with ice





(a) What do you observe on the outside of glass (1) and glass (2), respectively?

(b) Based on your observation, where do the water drops on the outside of the glasses come from?

Explanations

When the students appear ready to modify or replace their alternative conceptions with more scientific ones, the teacher can include the scientific explanations or theories into the discussion. Students must make sense of the new ideas for themselves, knowing that the scientific conceptions can become believable, more than just the teacher's answer.

Conclusion

If we want childre'n to learn effectively with understanding, we need to deal directly with their ideas. This method demands greater flexibility from teachers. Each class of students possesses a unique range of conceptions, and teachers should make a constant effort to elicit it and respond accordingly by using familiar, everyday and discrepant events to devise experiences pitched at the students' conceptual levels.

References

Al-Kunifed, A., & Wandersee, J.H. (1990). One hundred references related to concept mapping. *Journal of Research in Science Teaching,* 27 (1.0): 1069-1075.

Biddulph, F., & Osborne, R. (1984). (Eds.) *Making Sense of Our World.* Centre for Science and Mathematics Education Research, University of Waikato, Hamilton.

Bell, B. (1993a). *Children's Science, Constructivisrn, and Learning in Science.* Geelong, Australia, Deakin University Press.

Bell, B. (1993b). *Taking into Account Students' Thinking.* Centre for Science and Mathematics Education Research, University of Waikato, Hamilton.

Bell, B., Osborne R., & Tasker, R. (1985). Finding out what children think. In R. Osborne, & P. Freyberg (1985). *Learning in Science.* Auckland: Heinneman, pp 151-165.

Chin, C. (1992). The use of discrepant events in teaching and learning science. *Teaching & Learning,* 13(1): 51-57.

Driver, R., & Erickson, G. (1983). Theories-in-action: some theoretical and empirical issues in the study of students' conceptual frameworks in science. *Studies in Science Education,* 10: 37-60.

Driver, R., Guesne, E., & Tiberghien, A. (Eds.). (1985). *Children's Ideas in Science.* Philadelphia: Open University Press.

Minstrell, J., & Smith, C. (1983). Alternative conceptions and a strategy for change. *Science and Children,* 21 (3): 31-33.

Osborne, R., & Freyberg, P. (1985). *Learning in Science: The Irnplications of Children's Science.* Auckland: Heinneman.

Philips, C. (1991). Slaying the Exam Fear Dragon: A recipe for building confidence and skills. *The Australian Science Teachers' Journal,* 37 *(4):* 61-62.

Smith, E.L., Blakeslee, T.D., & Anderson, C.W. (1993). Teaching strategies associated with conceptual change learning in science. *Journal of Research in Science Teaching, 30* (2): 111-126.

White, R., & Gunstone, R. (1992). *Probing Understanding.* London: The Falmer Press.