Research in Science Education, 1991, 21, 96 - 103

SOCIALLY CONSTRUCTED LEARNING IN EARLY CHILDHOOD SCIENCE EDUCATION

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ABSTRACT

This paper outlines the findings of a study in which the concept of electricity was introduced to young children in a child care centre. Three areas were examined: first, the perceived difficulties associated with the teaching of science to very young children (3-5 year olds); second, a discussion of the approach used to teach electricity to young children, and finally, the study and its findings. When the teaching of electricity (through a unit on torches) followed a socially constructed approach to learning, all of the children were able to connect up a simple electric circuit and talk about the electricity flowing around the circuit.

INTRODUCTION

A great deal of research has been directed towards children's conceptions of electricity (Tiberghien & Delacote, 1976; Shipstone, 1984, Duit, Jung & von Rhoneck, 1985). Many research projects have sought to find ways to teach this concept to children. However, this effort has been concentrated on upper primary and secondary aged pupils. Yet very young children frequently hear the words 'electricity', 'power' and 'energy'. Most of their constructed environment makes use of electricity. Little is known about how very young children conceptualize scientific phenomena, or how they make sense of electricity in their everyday life.

Shipstone's (1985) review of studies with older children indicates that there are five distinct models of children's representation of direct current (D.C.) circuits. They are, unipolar, clashing currents, attenuation, sharing and the scientific model of D.C. circuit representation. This research indicates that children do have a variety of alternative scientific views which are difficult to modify once formed (Osborne & Freyberg, 1985).

Children's alternative views are believed to be formed by two factors - everyday language that has a different scientific definition and everyday experiences which contradict scientific theories. An interesting example of everyday experiences is cited by Johsua & Dupin (1985; p. 135):

> ...when they consider current conservation in a serial circuit: how can a student explain that the (material) fluid conserves itself and, at the same time, the fluid (of energy) "exhausts" itself little by little? Especially when this last phenomena is so clearly visible (lighting the bulb and wearing of the battery)!

Gilbert, Osborne & Fensham (1982) suggest that many 'words in science are used in an alternative way to everyday language' (p. 625). Children frequently interpret scientific words in terms of their everyday meaning. Conversely words used in everyday discourse can facilitate alternative understandings. In the consumption model of electricity, it can be speculated that phrases such as 'It uses electricity', may give children a consumption model of electricity. Indeed, it can be argued that if teachers do not have knowledge of the particular models of alternative views often expressed by children (or indeed an understanding themselves about the phenomena under study), then they too can be using everyday language for specific scientific terms, thus explicitly encouraging alternative conceptions.

TOWARDS A THEORY OF SOCIALLY CONSTRUCTED LEARNING IN EARLY CHILDHOOD SCIENCE EDUCATION

Science learning in early childhood is better placed within a paradigm in which learning is viewed as being socially constructed. The soviet psychologist Lev Vygotsky argued that children are entrenched in social experiences, many of which they participate in or make use of, but which they do not always understand. These experiences are initially encountered on an interpsychological plane, that is, within the social mores of the particular group. These experiences cannot be understood at the intrapsychological plane (cognitive understanding) without being socially mediated from within the cultural group (Wertsch, 1985). This view of learning emphasizes the importance of the teacher in the education process. It makes explicit the role the teacher takes, and it identifies the teacher as leading conceptual thinking rather than following the children's lead.

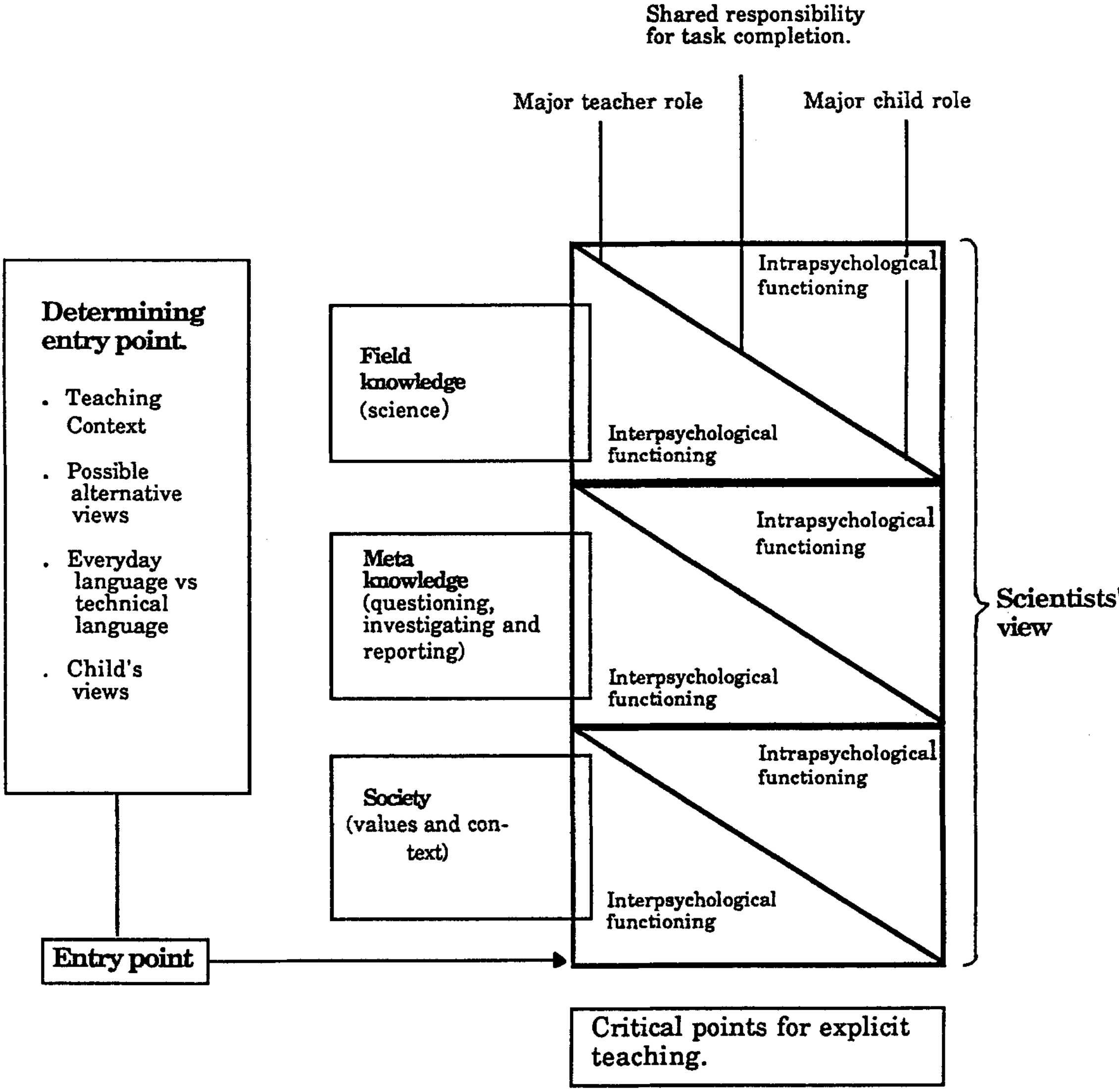
Vygotsky has argued that the adult allows the child to work well beyond her/his level (as defined by the child's independent efforts). This process of adult and child working together moves the child through to its zone of proximal development ('the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with a more capable peer', Wertsch, 1985; pp. 67-68).

In Fig. 1 a model of teaching science to early childhood children that incorporates a social construction of learning is presented. Here Bruner and Haste's (1987) scaffolding metaphor as depicted by Cazden (1988) forms the basic building block for science education. A number of levels of scaffolding are presented. They include Field knowledge, Meta knowledge and Society.

Field knowledge includes all the scientific and technological knowledge that has been specifically planned for in the unit of science. In traditional terms it is the 'content' knowledge. Meta knowledge includes all of the process skills and knowledge required for a participant to engage in during the teaching of the unit of science. Two aspects are important here: first the ability of participants to question; investigate and report; and second the ability to understand and take charge of specific genres.

Society includes the explicit realization on the part of the teacher that specific societal values are assumed in the selection of content for investigation. Here teachers can intervene and create learning contexts that address gender inclusiveness and encourage for example, the caring for the natural environment.

In each of the areas of Field knowledge, Meta knowledge and Society, it is not assumed that all areas will require the same levels of scaffolding. Indeed, it can be assumed that when children first encounter early childhood science education, more teacher modelling will be required with Meta knowledge, whilst Field knowledge may need a greater role to be given to the child.



<u>Fig. 1 A model of scaffolded early childhood science education.</u>

Determining the entry point.

It is the teacher's role to scaffold learning for the child so that the child is inducted into scientific understandings found and applied in society. The teacher must determine the entry point for the child by considering four factors: teaching context, possible alternative views, everyday language, and the child's views.

First, the teacher must identify a teaching context for the phenomena under study. It must reflect the child's home experiences in some way so that the child can immediately identify the phenomena under study and bring to it previous experiences. For example in the teaching of electricity, the use of circuits is outside most young children's experiences. However, using torches is not. Contextualizing the teaching experience ensures that the transfer of knowledge and skills is direct and relevant. This approach fits within the child's learning patterns as they occur outside the school environment.

Second, it is important to determine the child's view of the phenomena under study. This factor is well recognized in the interactive approach to teaching science, and most teaching texts for early childhood education (Weber, 1984). When the experiences are familiar, the child is more likely to be able to express her/his ideas. The importance of identifying the children's ideas is well recognized in the literature (Osborne & Freyberg, 1985).

Third, the teacher must identify the possible alternative views that older children seem to acquire about the phenomena under study. If the teacher is aware of the views that children inadvertently acquire, she/he can take steps to ensure against young children developing these ideas, by explicitly imparting information to children at key times during the course of the explorations. For example, in teaching a unit on electricity, once children have successfully identified how to connect up a circuit, the teacher can read to children how the electricity flows around the circuit (since this aspect is not visible). This would ensure that young children are not left to try and come up with a theory for themselves, in which alternative views could be acquired.

Finally, in preparing for the teaching of a specific scientific concept, the teacher needs to examine the possible variations between the technical language and the everyday language. If teachers are aware of problems associated with language, they can take steps to explicitly address possible confusion for children. For example, teachers can explicitly indicate that when a word is used by scientists it takes on a more specific definition. Here children are given the rules for the linguistic games found in speech and texts, and they are better able to cope with the difficulties of the language of science.

Another aspect associated with the use of scientific language, is the everyday language that encourages misconceptions. For example, asking children 'what things use electricity?' encourages a consumption model for thinking about electricity. Teachers who are aware of the alternative views that older children have, can ensure that they carefully structure the lessons to avoid the use of such terms, for example 'What things need electricity to make them work?'

During the teaching of a unit of science it is possible that critical points for explicit teaching may be needed. It is necessary to identify in advance sensitive learning periods in which to introduce factual information. Two different contexts may emerge: first, when scientific theories cannot be easily deduced by the children from their explorations; and second, when misinterpretations can be made easily by children. For example, electrical flow cannot be seen, and as a result information must be given explicitly to children at critical periods during their investigations.

Finally, the role of the teacher is crucial for the success of the approach. The teacher should at all times follow up children's explorations with further questions and factual information. The teacher links the lessons together, prompts the ideas children express, and ensures ideas are shared formally at group time. At all times teachers need to ensure that technical terms are used. Young children do not necessarily need a watered down curriculum. They are not only capable of using technical terms but need these terms to label their experiences so that they can think about them in the absence of concrete materials.

Social construction of learning theory provides a sound basis for teaching science to children as young as three years of age in a child care setting. The present study sought to try out this theoretical approach.

THE STUDY

A group of children (4 year olds; N=16) were involved in a study which incorporated scaffolding techniques discussed above during the teaching-learning process of a series of science based experiences. The experiences consisted of six group times and six free choice sessions over six days. All lessons were audio and video taped (18 hours). Discourse analysis was conducted on all dialogues collected. During free choice time, children could join in the science experiences (coming and going as they wished).

Investigations commenced with the establishment of shared understanding between the teacher and the children through the children manipulating torches and expressing what they knew about them. This was followed by the teacher and the children working together to understand how the torch worked, and later the construction of their own torch using batteries, bulbs and wires.

Within a framework which started with the children's questions, children were moved towards scientific understandings. The teacher modelled the investigation process (based on the children's questions), and over time, the children took on the investigation process themselves. The children connected up the circuit, initially in collaboration with the teacher, but after a period of time, less teacher assistance was given. The children could not only construct their own torch, but modify and extend the experience for themselves without difficulty. Simultaneously children were given direct instruction on how the electricity flowed around the circuit, first, through the reading of factual books, and second, by the teacher outlining electrical flow to individuals as they worked with the materials. The possibility of alternative views caused by confusion between technical terms and everyday terms was explicitly dealt with. In the following transcript, Sam attempts to understand the difference between the technical term of a 'flat' battery with that of the everyday usage of the word 'flat'.

T: Sam, come and tell us some of the things you know about torches? What do you know about how they work?

C: If you leave them on for a long time and you don't turn it off it will just waste.

T: Yes, do you all agree that if you leave the torch on for a long time the batteries will get wasted?
C: No I said forever!
T: Forever, what will happen if you leave it on forever?
C: It will waste.
T: And will it still work?
C2: No.
C3: Or you get new batteries.
C2: They will be flat.
C: (Sam) They won't be flat they'll just be sort of round.
They won't be like that (indicates with hands together).
T: No they won't change shape will they? They won't be flattened down. They'll still be round won't they?
C: They won't be flat like a piece of paper!
T: No they won't, so what do we mean when we say they're flat?
C: You mean they won't work.

At the end of the teaching unit each child was interviewed to determine her/his understandings and asked to connect up a circuit. All children talked about how the electricity continuously flowed around a simple electric circuit, and all children were able to connect up the circuit. In the following excerpt from a whole group discussion, it is clear that Elizabeth has understood current conservation, a sophisticated scientific phenomena, normally not fully understood by children and even some adults.

T: And goes where? It goes from the battery along the wire to?
C: The light bulb
T: The light bulb, and then where? Here's our picture of it all. It starts in the battery and goes along the wire to the light bulb and then where?
C: Battery
C: Back to the battery
C: (E) And it makes it better and puts it away again
T: What was that Elizabeth?
C: (E) It makes it good again and then puts it back and then throws it away again.
T: Yes the electricity goes round and round in a circuit

Towards the end of the teaching unit, the teacher prompted children at group time to express their understandings:

T: We're going to try and think of all the things that we know about batteries and torches and electricity. Do you think you can remember all those things you know?
C: Yes
C: How much is there?
T: I'm looking for people who can tell me what's inside a torch.
C: Batteries
C: Wires
C: Light bulb
C: A spring
T: I think that's all.
C: No that thing, the black one up the top

T: What could we call it? That's the part that attaches to the light bulb.
Now, what's inside a battery?
C: Electricity
T: When we pulled apart the battery what did we see inside it?
C: Black stuff
T: Yes the black paste
And what's this part called?
C: Carbon rod
T: And what's the funny name for this outside part of the battery. Zzz?
C: Zinc
T: That's right there's a zinc case.

The children freely recalled the names of items they had been investigating. With less familiar terms such as zinc, appropriate teacher prompting assisted with recall. Whilst group discussions do not reflect individual children's conceptual development, the views expressed above were representative of the views obtained from interview data with children on a one-to-one basis.

At the conclusion of the experiences with the torches (12 sessions over 6 days) and over two months later, the children were re-interviewed and once again asked to connect up a circuit. In addition, children were asked to draw their circuit. All children easily connected up the circuit and all children were able to explain that the electricity flowed around the circuit. Most children were able to draw their circuit.

The adult-child interaction evident throughout the unit on torches focused on extending the children's cognitive understanding of the materials they were manipulating. This was achieved by commencing explorations from within a socially meaningful context, namely torches, and moving to an abstract context and understanding (through the use of circuit materials). This movement in thinking was only possible through the carefully planned and implemented adult-child interaction.

Adult-child interaction throughout the unit featured many of the traditional interaction types such as questioning and procedural interaction. However, what was significant and different to most learning contexts was the greater emphasis placed on joint exploration and task completion and direct instruction (abstract-based) during explorations with the materials. Children were given information that moved them from the concrete to the abstract, first in a concrete context (as they worked with the materials) and later in an abstract context (during group time, when felt board props or circuit diagrams were used). These information sharing sessions were repeated many times, without loss of interest by the children. The success of this approach is evident in the cognitive attainment of the children as outlined above. Indeed what is now clear, is that children are most receptive to learning experiences which help them to understand everyday phenomena no matter how difficult the concepts are perceived to be by the adult world.

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ACKNOWLEDGMENTS.

I wish to thank the Director and staff of the Wiradjuri pre-school child care centre for their co-operation in the trial of this unit of science. Special thanks go to Karina Harris for trying out the ideas enclosed, and Alan Nicol for assisting with the data collection. Finally I'd like to express my appreciation to Brian Gray for the lengthy and in-depth discussion regarding the theoretical approach (particularly the model developed) and the findings of the research.

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