Teaching and Learning: The Journal of Natural Inquiry & Reflective Practice

Volume 2 | Issue 2 Article 3

9-1988

What Are We Learning From Children About Teaching And Learning?

Joseph Stepans

What Are We Learning From Children About Teaching and Learning

by
Joseph Stepans

As I was growing up in my native country in the Middle East, my brothers and I would get excited when my father came home from the store, holding a letter that had just arrived from abroad. A few of our relatives lived in Russia and some in America. My father would announce, "We got a letter today!" One of us would ask, "From whom?" Another would ask, "How long did it take to get here?" My father would respond after looking at the date. Someone else would ask, "How did it get here?" My father again would look at the envelope and say by water, air or land. The first time he responded, "By water," I took the envelope and looked at it. IT WAS DRY! I opened it, looked carefully at the writing--no indication of it having been in water!

"Upon reaching the river, I imagined, the letter was carried to the ocean where there were special winds at work."

Being the eldest of five brothers, though still young, I was usually responsible for mailing family letters. The closest mailbox was a little one that hung on the wall outside a bookstore. I had envisioned that behind the mailbox there was a big hole that led to the rivers under the ground that eventually led to the big oceans. As I dropped the letter, I would put my ear to the mailbox trying to hear the letter hitting the water. Sometimes I actually thought I heard it hit and I knew then that it was on its way. Upon reaching the river, I imagined, the letter was carried to the ocean where there were special winds at work. If the letter was to go to Russia, winds from a particular direction would carry the letter toward Russia. If the letter were to go to America, there were other winds that were responsible for carrying it to its destination. I imagined that my aunt or grandmother would be waiting on the other side of the ocean for the letter, day after day. Finally, she would see it floating on the water, carried to her by the waves. She would scream with joy and run into the water and retrieve her letter.

She would then stand in the line to dry her letter. A letter drier had opened a business and charged a certain amount of money for people to put their letters in a large cylinder with holes in it and dry them by turning a crank. This is how I explained to myself why the letters were not wet.

If my father told us the letter came by air, I had much more difficulty visualizing how the letters were able to survive winds from different directions and still reach their destination.

One day, when I was about 10 years old, I was approaching the bookstore with the little mailbox outside it, and saw a uniformed man carrying a large bag. He walked up to the mailbox, took out a set of keys, unlocked it, removed a stack of letters, and placed them in the bag. In a way I was disappointed that there was no hole behind the box but there was a big "Aha," at least partially explaining how mail went from one place to another.

Six years ago, when I joined the University faculty, I was in search of a direction for research. Reflecting back on my own childhood I decided that in order for me to be an effective teacher educator, I needed to spend time talking to students of all ages and listening to their views of the world and of how things work. I soon discovered that taking time to talk to learners and listening to them was absolutely delightful and educational.

In this paper, I would like to (1) share some sample conversations with learners, (2) report on a few studies done on children's conceptions of some common topics, (3) look at the change in students' understanding of concepts at different educational levels, (4) identify some sources or confusion or misunderstanding, and (5) discuss implications of these findings for the learning/teaching process.

I. Sample Conversations With Elementary School Children

A conversation with a seven year old child (C) on thunder and lightning:

I. What is thunder?

C. Thunder is when God becomes mad at all the angels.

I. What is lightning?

C. The noise that the angels make when they are crying after God has yelled at them, like mom does to me.

I. What is rain?

C. The tears of God and angels crying after they have made friends again.

A conversation with a seven year old child:

I. What is night?

C. When it gets dark and the stars and the moon come out.

I. Why is it dark at night?

C. Because you can't go to sleep in the day time.

I. Where does darkness come from?

C. Black paper.

I. What is day?

C. White paper and when the sky is clear it's blue paper.

I. What makes day change to night?

C. They change the paper?

A conversation with another seven year old child:

I. What is snow?

C. There are white mountains where white bears live and would cut out snowflakes and would spread them all over.

Sometimes these conversations reveal misconceptions underlying what looks like a solid grasp of a concept as in this conversation with an 11 year old:

I. What is rain?

C. It's water that falls out of a cloud when the clouds evaporate.

I. What do you mean clouds evaporate?

C. That means water goes up in the air and then it makes clouds and then, when it gets too heavy up there, then the water comes and they call it rain.

I. Does the water stay in the sky?

C. Yes, and then it comes down when it rains. It gets too heavy.

I. Why does it get too heavy?

C. 'Cause there's too much water up there.

I. Why does it rain?

C. 'Cause the water gets too heavy and then it comes down.

I. Why doesn't the whole thing come down?

C. Well, 'cause it comes down at little times like a salt shaker when you turn it upside down. It doesn't all come down at once 'cause there's little holes and it just comes out.

I. What are the little holes in the sky?

C. Ummm, holes in the clouds, letting the water out.

II. <u>Children's Conceptions of Some Common Science Topics</u>

The nature of life and what it means for something to be alive are ideas commonly encountered by children. Elementary science textbooks begin developing the concept of "living things" as early as kindergarten by giving examples and by comparing living and non-living things.

In one study, 30 fifth graders were randomly chosen from two different schools [1]. Each fifth grader was individually interviewed concerning 11 living and non-living objects. The living objects were a worm, a leaf, a tree, and a flower. The non-living things consisted of the sun, a candle, a bicycle, wind, a volcano, water and lightning. Each interview lasted 15-20 minutes and went something like this: "John, is the sun alive?" Following the child's response, the interviewer asked, "Why do you think so?" and additional follow-up questions were asked. After responding to all the items, the child was then asked: "What does it mean for something to be alive?"

Table I shows the number of students and percentages of fifth graders who said that the inanimate object was alive. In Table II some reasons given by these students as to why they thought the object was alive are included. Table III shows reasons given by students as to why they thought the object was not alive.

TABLE I.

Object	*Number of 5th Graders Who Said the Object Was Alive (N=30)*	*% of 5th Graders Who Said the Object Was Alive*
Sun	16	53
Candle	14	47
Water	19	62
Lightning	24	82
Wind	23	79
Volcano	22	76
Bicycle	11	36

TABLE II.

Is the sun alive?	*Is a candle alive?*	*Is a bicycle alive?*
Yes, because . . . - Itshines. - It pours heat. - It is moving. - It has energy which keeps us alive. - It got earth together to make life. - It keeps the solar system and universe alive.	Yes, because . . . - It has fire. - The flame is. - It burns. - It is moving. - When you light it you give life to it. - It is made of wax and wax was once a living thing.	Yes, because . . . - It moves and it turns. - When you ride it, it is. - You can pedal it. - Chains and gears work.

Is water alive?	*Is lightning alive?*	*Is wind alive?*	*Is a volcano alive?*
Yes, because . . . - It moves. - It flows. - Running water is. - It has insects, fish, bacteria and plants living in it. - Is made of living molecules. - Itdissovles. - It gets hot, evaporates, goes to the sky, gets big and then gets down.	Yes, because . . . - Itstrikes. - It moves. - It's full of electricity. - It gives out light and can show you things. - It's partly fire and fire is alive, because humans can't make it. - It can shock you. - It makes noise.	Yes, because . . . - It moves. - It blows. If it didn't it'll be dead. - It can grow. - It has molecules.	Yes, because . . . - Can explode. - Can erupt. - It erupts when it wants to. - We say it's "active."

TABLE III.

Is the sun alive?	*Is a candle alive?*	*Is a bicycle alive?*
No, because . . .	No, because . . .	No, because . . .
- Too hot for anybody to live on it. - Doesn't have heart. - Doesn't eat. - Doesn't move. - Doesn't do anything but glow. - Made of clouds of gases.	- Doesn't have heart. - Doesn't move. - All it does is burn. - You have to make it move through your strength. - You can blow it up. - Doesn't have brain. - Have to light it to make it alive. - Just sits there. - Wax is not alive. - Flame eats but not much.	- Can't move by itself. - It's made of metal, tube and rubber. - Can't talk. - It takes human power to move it. - It's dead until you get on it. - Doesn't eat. - Just sits there unless you decide to move it.

Is water alive?	*Is lightning alive?*	*Is wind alive?*	*Is a volcano alive?*
No, because . . .	No, because . . .	No, because . . .	No, because . . .
- Doesn't eat anything. - Doesn't grow. - Just sits or just runs. - You can do anything you want with it. - Can't get up and walk around by itself. - Doesn't need anything to grow.	- Comes around once in awhile. - Doesn't eat anything. - Doesn't grow. - It isn't around all the time, only when it wants to rain.	- It's just air that is floating. - Doesn't need food or water. - Doesn't have heart or anything. - Lord has to make it.	- It's made of dirt. - Doesn't move by itself. - It is just made of hot stuff.

None of these students had difficulty identifying a tree, a flower, a worm and a leaf as living things, and textbooks usually mention these things as examples of living things. The reasons that children gave for the living things to be alive, to a large extent, matched the criteria provided by most elementary science textbooks. However, the results indicate that the majority of these children were not capable of applying or transferring this information to a real situation.

III. Conceptual Change In Student's Understanding of Phenomena At Different Educational Levels

In other studies, students from varying educational levels--primary, intermediate, and junior high--were interviewed to determine how concepts change with development [2]. The phenomenon chosen for this research was the sinking and floating of objects in water. Items selected were those employed by Carpenter [3] at thc University of Nebraska and included: a small wooden cube, a large wooden block, a small metal cube, a looped wire, a large metal cylinder, a small metal cylinder, an aluminum sheet, a crumpled piece of aluminum, a ball of clay, a clay pot, a jar lid, and a jar lid with holes. This array of objects enabled us to evaluate how students related the fact of mass, weight, volume, surface tension, density, water pressure and buoyancy to sinking and floating.

Each interview began with: "If I place this object in this much water, will it float or will it sink? Why?" Follow-up questions were asked based on students' responses which were then categorized as (a) complete understanding, (b) partial understanding, or (c) no understanding.

Little difference was noted in understanding of sink/float concepts among students at the various levels. For example, a large number of older students said that when you crumple an aluminum sheet you make it heavier. However, students at the various levels used significantly different language to describe the concepts. Terms such as light, heavy, and weight used by the elementary students were replaced by density, surface tension, and buoyancy at the junior high level.

Unfortunately, the more sophisticated science vocabulary of the older students was not accompanied by increased understanding. It appeared older students were so concerned with trying to fit the correct scientific terms into their explanations that they lost sight of the phenomena at hand.

IV. What Are Some Possible Sources of Confusion/Misunderstanding

Students coming into a learning environment bring their own preconceptions of the world. These conceptions are not necessarily those of scientists that are accepted as "correct" by curriculum writer and teachers. Despite what teachers think about science concepts, many students maintain their early and erroneous concepts of the world for several years, even into adulthood.

Children develop preconceptions from the conceptual models they build for themselves, by reading children's stories, and from views presented to them by family members and adults they encounter in such places as day care centers and Sunday School classes.

In school the language found in textbooks and used by teachers may either contribute to creating misconceptions or are ineffective in removing naive conceptions. Examples below illustrate how written materials may bring about confusion in children.

A second grade science book starts a discussion on "where does the water go?" by showing a child sailing his boat in a puddle. The next picture shows that the following day when the child returns, the puddle is gone. The teacher's guide suggests to the teacher to ask the children: "Where did the water go?" The teacher is to tell the students that water evaporated and went into the air. Looking at the second picture, one sees cracks in the ground. When we have shown the two pictures to second graders and have asked them where they thought the water went, most of them responded, "Into the cracks, of course! Because there were no cracks in the first picture!"

The ambiguity between what the words say to children and/or suggest to teachers to tell the children and what the visual representations accompanying those words seem to indicate apparently creates a state of confusion in children.

A fourth grade level science textbook starts a discussion on "Machines and Work" by holding students responsible for how scientists define such terms as work, force, etc. The picture accompanying the definition shows a girl holding a large rock with the statement that, according to scientists, the girl is not doing any work. The discussion on machines begins with two pictures--one of a tilted board and the other of a bottle opener--as examples of simple machines. The page, in addition to machines, introduces other terms such as slope, inclined plane, ramp, and slanted surface. The objectives for the child consist mainly of naming these words. The following pages give staircases, screws, a wedge, a needle, a fork and a nail as examples of simple machines. This type of presentation introduces a new and difficult concept in physics and, at the same time, holds the learner responsible for a complex set of new vocabulary words. It completely ignores what the learner brings to the learning environment. The child's conception of a machine is probably something that has wheels and an engine and that makes noise. The presentation of an inclined plane, a bottle opener and a screw as machines may add to the learner's confusion. In introducing the terms in this way, the book holds the child responsible for concepts as defined by scientists rather than incorporating the new ideas into what the child already knows.

V. Implications for Learning and Teaching

Research tells us that to teach children we must talk to them and ask ourselves:

- Do we give the learner the opportunity to share his/her views in the learning process?

- Do we have the learner see that there are, in fact, other viewpoints on the same concept and the viewpoint of the book and the teacher is just another one?

- Are we in a hurry to correct a child's view and present, or impose on the child, the adult's or scientist's view of things?

We try to teach by lecturing--telling, rather than providing the learners with more effective opportunities to correct their naive conceptions. All too often we spend considerable time teaching, and children waste too much of their energy trying to learn, concepts in ways that are inefficient and inappropriate.

The student's inability to understand a concept and to apply information may stem from some of the following factors:

- the concept was introduced too early;
- the concept was not developed properly;
- no attention was given to what the child brought to the learning environment;
- the concept was introduced only verbally--no "hands-on" or other interaction with the ideas took place.

As educators we should take the time to talk to students, to find out how they view things, and to try to incorporate their way of looking at the world into the development of concepts. We should provide learners with some ownership in the development of the concept. We should give students the opportunity to see that it is perfectly acceptable to have different viewpoints on a given phenomenon or concept. If we believe that a major purpose of education is to remove misconceptions held by learners, wee need to (a) identify the naive conceptions held by learners, and (b) decide on proper time and effective methods to remove those naive conceptions.

Researchers in this area maintain that educators need to look at and start with the learner's view and conception of the topic at hand [4, 5, 6, 7, and 8]. Some of these authors recommend that in order to bring about significant accommodations in the learner, the following steps should be taken when introducing a new science concept:

- Provide the learners with a challenging situation--a situation which will bring to the surface students' preconceptions (a discrepant event, for example).
- Allow students to share their views on the situation with others in the learning environment.
- Present the "correct" view as just another view.
- Provide students with the opportunity to discuss the pros and cons of each view presented (including the "correct" view) and if appropriate, test the various views.
- Help students in their search for solutions and accommodations--do not continually provide "ready-made" knowledge.

Endnotes

[1] Stepans, J. I. (April 1985). Biology in elementary schools: Children's conceptions of life. The Biology Teachers, 47, 222-225.

[2] Stepans, J. I., Beiswenger, R. E., & Dyche, S. (September 1986). Misconceptions die hard. The Science Teacher, 53(6).

[3] Carpenter, E. G. (1981). Piagetian interviews of college students. In Fuller, E. G. (Ed.), Piagetian Programs in Higher Education. Lincoln: University of Nebraska.

[4] Cohen, M. (1981). How can sunlight hit the moon if we are in the dark?: Teachers' concepts of phases of the moon. Paper presented at the Seventh Annual Henry Lester Smith Conference of Educational Research, Bloomington, Indiana.

[5] Eaton, J. F., Anderson, C. W., & Smith, E. L. (1983). When students don't know they don't know. Science and Children, 20(7).

[6] Nussbaum, J., & Novick, S. (1981). Creating cognitive dissonance between students' preconceptions to encourage individual cognitive accommodation and a group] cooperative construction of a scientific model. Paper presented at the AERA Annual Convention, Los Angeles, California.

[7] Smith, E. L., & Anderson, C. W. (1981). Planning and teaching intermediate science: Progress report. NSF Grant, Michigan State University.

[8] Za'rour, G. I. (1975). Science misconceptions among certain groups of students in Lebanon. Journal of Research in Science Teaching, 12:4.