Research Matters - to the Science Teacher
No. 9604 December 23, 1996

Constructivism and the Learning Cycle

by William C. Robertson, 1340 Telemark Dr., Woodland Park, CO 80863

Introduction

It is difficult to spend much time in the field of education without encountering the term constructivism. Researchers don't always agree on the meaning of the term, and they certainly don't agree on the best way to implement a "constructivist philosophy" in the classroom. Not surprisingly, classroom teachers often end up a bit confused and without the tools to incorporate constructivism, whatever it is, in their classroom. Presented here is a script for a simulation and discussion intended to introduce, to an audience of classroom teachers, constructivism along with a practical method for incorporating it into instruction. This simulation currently serves as a opening for teacher in-service workshops conducted by the Wild Goose Company. You can read through the script to gain an understanding of constructivism and its applications, or view it as a tool to use in your own presentations.

The Simulation

What follows is a script you can follow if you want to do the opening simulation in this workshop with your faculty, your friends, your dog, or anyone who will listen.

1. Do a flashy demonstration. We suggest something dramatic, the science of which most of the audience is unlikely to understand. Our favorites include floating soap bubbles over a layer of dry ice in an aquarium and making a big fireball with lycopodium powder thrown through the flame of a propane torch.
2. Say: Okay, you walk into school on Monday and do this. The kids will be thinking, "This is going to be a good week!" But you might be thinking, "What now?" Which is a good question. If you have a bag of tricks that includes fun stuff like this, but have nowhere to go with it, you're in trouble. So... I'm going to help you answer "What now?"
3. Pass out copies of the drawings at the end of this script face down. 1/3 get hot dogs, 1/3 get poolside, and 1/3 get blank sheets. Explain that, on your signal, people are to turn the page over and study it. They are not to look at others' papers or discuss things with their neighbors. Give them a couple of minutes and then collect the drawings face down.
4. Hand out copies of the paragraph at the end of this script (all get the same one). Tell people to read and study the paragraph as soon as they get it. No discussion. Collect the paragraphs after a couple of minutes.

5. Ask the following questions and have the people answer out loud. Move through the questions rapidly enough that people don't have time to say things like "Well, my picture had a swimming pool and people. What did yours have?"
   - a. Does Bob own the frammets? (No)
   - b. Are langits attractive? (Yes)
   - c. If the sun were shining and you wanted to be cool, would a langit be a good thing to have?(yes)
   - d. Would you buy a frammet if Bob offered you one? (yes or no, depending on the picture. If no one says yes, address the question directly to the Hot Dog group. Listen for people in the blank sheet group to say something like "He doesn't own them, how can he sell one to me?" You can use that comment later, when pointing out that people with blank sheets used prior knowledge about buying and selling.)
   - e. If you were throwing a party for 10 people, about how many frammets would you have at the party? (Note wording, so statement can apply to both hot dogs and people. Answers will vary from none to 20 or 30. Take note of people with the poolside picture who go along with an answer of 20. they're going along with a prevailing answer even though it doesn't make sense in terms of their picture. How could you have 20 Frammets (people) at a party for 10 people?)
   - f. Would your answer change if the party were for 100 people? If so, how? (answer depends on picture)
   - g. About how expensive do you think a langit is? (answers vary from $29 to $5,000. Note people in the blank sheet group who give answers to this. Later they'll tell you they had no idea what a langit was, but if so how did they come up with a price? Point this out and they'll admit they did have something in mind, such as a fan or a refrigerator.)
6. Reveal that different people saw different pictures. Show everyone the pictures they didn't see.

The Discussion

1. Say the following to your group, soliciting input as you go:

   The simulation you just did was intended to demonstrate that people; students, teachers, everyone; interpret new information in terms of what they already know. We construct our knowledge in terms of prior knowledge. The fancy shmancy name for this idea is Constructivism. It's a buzz word that science education types use and is sure to impress administrators if you throw it out over the morning coffee.

   Twenty-five cent words aside, constructivism affects what goes on in the classroom every day, and you should be aware of how to deal with it. For example, suppose you want to teach your kids the concept of density. You figure there's no way to discuss the concept without defining it first, so you go to the board and write:

   density = mass/volume

And the kids are looking at this and thinking, "hmmmm ...... I went to Mass on Sunday...... my radio has a volume knob...... Density...... my brother calls me dense, so that means stupid....... okay, now....... stupid - church - radio. I don't get it. Never did understand this science stuff."

Because we tend to construct our knowledge, the students will try to make connections like this. In many cases, they make some strange connections. If the connections don't make any sense, there is a tendency to just throw the whole thing out the window. There's nothing wrong with this, it's human nature. The problem comes in when students see most of their education as a piling on of things that don't connect and don't make much sense. That's when you get kids memorizing everything rather than trying to understand it. Not a good thing.

2. Stop and give examples of how different groups interpreted the paragraph differently. Point out that even people with blank pages used other prior knowledge to interpret the paragraph. They usually have some mental picture of what langits and frammets are. Also give examples of how some people went along with answers that made little sense in terms of their picture. You'll get several nodding heads if you assume some of those giving inconsistent answers were thinking things such as "I guess I didn't read the paragraph well enough. I don't quite get it, so those other people must know what they're talking about." The same thing happens with kids trying to learn science or any other subject.
3. Say: Okay, what are we supposed to do about it? An oft-quoted phrase is "Find out what each student knows and teach him or her accordingly." Hey, that makes sense. No problem, right? Not exactly. Works great for the research lab but it's totally impractical for those in the real world of 20-30 kids who are finding new definitions for the term off-task.

   What you can do is provide a common base of experience for all the kids. Rather than walk into class and define density, give them hands-on experiences that will help them later understand the concept. For example, let them play with things that sink and float, let them explore objects that have the same mass and different volume or the same volume and different mass, and let them measure the masses and volumes of things. Once they have the experience, introduce the concept and help the kids tie the concept to their experiences.

   This technique is part of something known as **The Learning Cycle.** The Learning Cycle is a term coined by the developers of the Science Curriculum Improvement Study (SCIS) in the 1960s, but the general idea has been around longer than that and it goes by many different names and different versions have different numbers of stages. The version we use has three stages. First you **explore** an idea by doing hands-on activities, uncluttered by vocabulary and such. Second, you **explain** the concept, connecting it to the hands-on experiences the kids just did. Of course the kids don't understand the concept at this point, so they need to apply the concept in new, hands-on situations.

   EXPLORE > EXPLAIN > APPLY
4. In explaining the Learning Cycle, address the fact that most instruction, at all levels, omits the

explore phase. Most teachers start with explain and then let the kids confirm that what was explained is true.

5. After explaining the Learning Cycle, ask the audience to tell you how you just did the first two phases (explore and explain) of the Learning Cycle. The explore was the demo, the pictures and paragraph, and the questions. The explain was all the stuff about constructing knowledge and the Learning Cycle. The apply phase is seeing how this approach works with new activities. To emphasize the experiential nature of the explore phase, ask the audience the following questions:
   - Did you know why you were looking at the drawings? (no)
   - Did you know why you were reading the paragraph? (no)
   - Did you know why I was asking you all those questions? (no)
   - Do you now know why you did all that stuff? (Yes. We were being "set up" for the explain phase of things.)
   - Explain to the audience that if they have done a fantastic job of setting the kids up for the explanation, the kids will think the explanation is obvious, and offer statements like "Well, sure I see that. We just saw it happen." Just for the record, don't expect a statement like that all the time!
6. Return to the demo. Ask the audience to think about how to fit the demo into the Learning Cycle, i.e., what concept would you Explain if this demo was your Explore? Ask for a show of hands from those who think they can answer the question. Very few hands usually go up. Then ask for a show of hands from people who think they understand the science behind the demo. Should be a high correlation with those who raised their hands the first time. Lead the audience to the realization that it is very difficult to know how to fit an activity into your science program if you don't understand the science. Point out the two great myths of science teaching, that you don't need to understand it in order to teach it and that it's difficult to learn science.
7. Explain the science behind the demo. Then ask again how you might fit this into a Learning Cycle. Lots of people will be able to offer suggestions, proving your point that once you understand the science you can figure out how it fits in your curriculum.
8. In order to solidify the audience's understanding of the Learning Cycle, it's best at this point to follow up with a number of hands-on activities. If you can illustrate a full Learning Cycle, great. It works as well, though, to simply do an activity, make sure your audience understands the science involved, and then ask the audience to come up with different ways to fit the activity into the Learning Cycle. In other words, if this were an explore activity, what concepts could you explain from it. What activities might fit well in the apply phase?

Drawings to hand out to audience

[Drawings are on the next two pages. One is of Bob selling hot dogs (labeled as frammets) for a dollar. An umbrella (labeled a langit) is over his head. Second picture is of Bob sitting by a pool (labeled a langit) with a family of four off to the side (labeled the Frammets: George, Betty, Suzy, and Billy).]

1.

Paragraph for audience to read

A langit is a nice thing to have. It can keep Bob cool and it's attractive. A langit can also cool the frammets. One or two frammets are just about right for most people. It is difficult to find someone who can stomach more than three frammets at one time. Bob owns the langit, but he doesn't own the frammets.

1.

Research Matters - to the Science Teacher
is a publication of the National Association for Research in Science Teaching

---