Constructionism

Tools to build (and think) with

Since the landmark discoveries of the renowned Swiss psychologist Jean Piaget, we can no longer view children as empty vessels into which adults pour knowledge. Piaget has shown that children, from the moment they are born, actively construct knowledge out of their experience in the world. This article looks at a recent advance in educational theory - Constructionism - and suggests ways in which new learning materials and environments can be designed to support and nourish children's active construction of knowledge.

LEGO dacta

What is constructionism, and what does it have to do with Piaget?

Constructionism is a theory of education developed by Seymour Papert of M.I.T.[1]. It is based upon a theory of knowledge created by the Swiss psychologist Jean Piaget (1896-1980). Papert worked with Piaget in Geneva in the late 1950s and early 1960s.

A theory of knowledge is a set of ideas that tries to explain what knowledge is and how it develops in people's minds. For example, one such theory states that knowledge is innate. Another theory states that knowledge is a mere reflection of experience. Piaget's theory states that people actively construct knowledge - that is, they construct robust systems of belief - out of their experience in the world. For this reason he called his theory constructivism.

Piaget's aim was to understand how children construct knowledge. He devised many ingenious tasks and questions that revealed what sorts of knowledge structures children build at different ages. For example, he discovered that young children believe that water changes its amount when poured from a short, fat glass into a tall, skinny glass. Older children, who structure their knowledge in a different yet equally coherent way, say that the amount of water remains the same even though it looks like there's more.

Piaget did not see himself as an educator, but as an experimentalist. Seymour Papert, on the other hand, wanted to use what Piaget learned about children as a basis for rethinking education. He wanted to use Piaget's theory of knowledge to form a theory of education.

How yon think about education depends on how you think about knowledge. For example, if you think knowledge is innate, then education consists of drawing this knowledge out of children by asking them to perform tasks or to answer questions that require this knowledge. Alternatively, if you think knowledge is simply a reflection of outer experience, then education consists of furnishing children with the "right" experiences, showing them the "right" way to do things, and telling them the “right” answers. Conventional education **is** largely based on these types of theories.

But if you believe, as Piaget and Papert do, that knowledge is actively constructed by the child, then education consists of providing opportunities for children to engage in creative activities that fuel this constmctive process. As Papert has stated, “Better learning will not come from finding better ways for the teacher to instruct, but from giving the learner better opportunities to construct”. This view of education is what Papert calls *constructionism.*

The theory of constructionism states that learning happens especially well when children are engaged in constructing a meaningful product, such as a sand castle, a poem, a machine, a story, a computer program, or a song.

Thus constructionism involves two types of construction: when children construct things out in the world, they simultaneously construct knowledge inside their heads. This new knowledge then enables them to build even more sophisticated things out in the world, which yields still more knowledge, and so on, in a self-reinforcing cycle.

Creating better opportunities for learners to constmct has led Papert and his research team at M.I.T. to design various sorts of *construction materials* for children, as well as settings or *learning environments* within which such materials can best be used.

What are some examples of good construction materials for learning?

Most art materials make good construction materials. Paper, cardboard, clay, wood, metal, plastic, soap, and all kinds of “junk” that people might otherwise throw away, are great to build with. Papert first began thinking about constructionism in the late 1960s, after observing a group of students become deeply and actively engaged in creating soap sculptures in an art class over several weeks. He then began to wonder why mathematics classes were so unlike these art classes.

In most math classes, students are given a demonstration of a problem-solving technique or are shown the format of a mathematical proof. Then they are typically assigned problems (not of their own choosing) which they must solve, and they do this with varying amounts of success. Such a class is dominated by instruction, not construction.

In most art classes, on the other hand, students are involved in creating something personally meaningful. Though they may all be using the same medium (such as soap), they do not all work on “the same thing”. Elements of fantasy, imagination, and creativity contribute to the quality and uniqueness of the finished product, which bears the personal touch of its creator.

This is not to imply that instruction is always bad. Instruction is like a strong medicine. If it comes at the right time and at the right dosage, then it can indeed be helpful. But if it’s administered at the wrong time (against the learner’s will) or at the wrong dosage (too much or too little), then it can be a hindrance or even intellectually poisonous!

Papert’s contemplations on that soap-sculpture class led him on a many-year journey to design a more constructable mathematics. Long before he invented the word “constructionism”, the ideas existed in his mind as “soap-sculpture mathematics”. He knew he would have to work with media more sophisticated and powerful than simple art materials to create such a mathematics.

In the 1970s, Papert and his colleagues designed a computer programming language called Logo, which enables children to use mathematics as a building material for creating pictures, animations, music, games, and simulations (among other things) on the computer.

More recently, in the mid-1980s, members of his M.I.T. team developed LEGO TC Logo, which combined the computer language Logo with the familiar LEGO construction toy. LEGO TC Logo enables children to control the structures they build out of LEGO elements. Children program a computer to make their constructions move, or walk, or light up, or respond to various stimuli. The resulting "behaviors" of such machines can be arbitrarily complex.

With LEGO TC Logo, children are engaged in three types of construction:

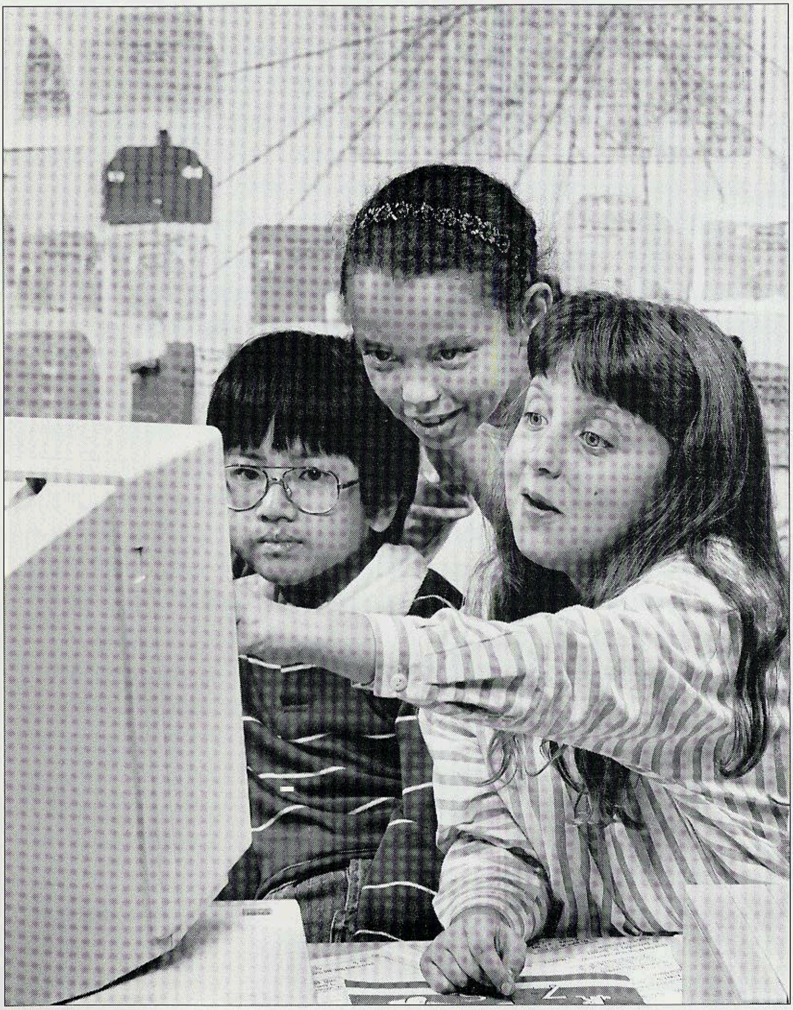
(1) they are building structures out of LEGO elements;
(2) they are creating programs on the computer; and
(3) they are constructing knowledge in their heads as a result of these activities.

Moreover, when using LEGO TC Logo, children learn much about science and design by being scientists and engineers, just as they learn about mathematics by being mathematicians when using Logo. This is something very different from simply learning about science or math.

What is meant by a good learning environment?

Good building materials certainly aid constructionist learning. But they are not the whole story. Equally important is the learning environment or social context within which construction of knowledge (i.e. learning) takes place. Good learning environments try to maximize three things: *choice*, *diversity*, and *congeniality*.

Again, the theory of constrnctionism holds that learning happens most powerfully when students are engaged in constructing personally meaningful products - products they truly care about. But one person cannot dictate what is to be personally meaningful for another person. This is where *choice* enters the picture. The greater choice a student has of what to construct or create, the greater the likelihood of personal engagement and investment in the task. And the more a student can *relate to* or *connect with* the task at hand, the greater the chances are that the new knowledge will connect with a student's pre-existing knowledge - this is what Piaget meant by the phrase "assimilation of knowledge". Moreover, these impor-



tant elements of personal connection and care will serve to make the learning experience deep, meaningful, and long lasting.

Diversity is important to a learning environment in at least two senses: diversity of skill and diversity of style. A rich learning environment includes people of various skill levels, ranging from novice to expert. Sometimes this means combining different age groups in one classroom space.

When students are all at the same level, they sometimes reach a plateau and are at a loss for ideas and directions in which to advance their work. In a more diverse setting, people with less experience can learn much from freely associating with others who display a level of skill slightly above their own. People with more experience refine their skill and knowledge through helping and explaining things to others. And the diversity of artifacts created fuels everyone's creative imaginations. Ideas are borrowed and embellished in an exciting, vibrant cross-fertilization of knowledge.

Diversity of style means that, when it comes to creation of meaningful products, there is no one right way to do it. For example, some people like to plan out carefully what they want to do in advance. When they have thought through their plan, they get to work, perhaps revising their plan a bit along the way. This is often a very efficient way of working, but it is not the only way. Other people prefer to work without a preformed plan and instead engage in a sort of "dialogue" with their construction. They do something, and then they stand back, look at what they have done, and decide what to do next. People who prefer the first way of working are sometimes called "planners" and people who prefer the second way, "tinkerers". Both styles are equally valid and must be accepted and respected. Many boys tend to be planners and many girls tend to be tinkerers, though this is by no means always true. Historically, schools have tended to place a higher value on the more formal, abstract style of the planner, than on the informal, concrete, dialogic style of the tinkerer. But fortunately many teachers are working to resist this bias. A few generations ago, schools forced left-handed people to write with their right hands. Forcing a tinkerer to act like a planner (or vice-versa) is equally harmful.

Finally, a good learning environment should be a *congenial* one. It should be friendly, welcoming, and inviting to the learner. Above all, it should be as free as possible from pressures of time. Creativity cannot be dictated by the clock. There must be time to muse, to talk, to daydream, to walk around and investigate what other people are doing. There must be time for false starts, time for getting stuck (and unstuck) - even time for (what looks like) doing nothing. Moreover, a good learning environment provides learners with time and space not only to do certain types of constructive work, but also to meet and form relationships with other people who are similarly interested in doing such work. This way, the joys and even occasional frustrations that are a part of constructionist learning can he shared with others in our midsts - others who, quite possibly, we come to regard as our closest friends: people who love what we love.

Aaron Falbel

Aaron Falbel worked **as** a research assistant with the Epistemology and Learning Group under the direction of Prof. Seymour Papert at M.I.T. For the past nine years, the principal focus of **his** research has been the social context of learning.

1) Massachusetts Institute of Technology in the USA