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Curriculum Development from a Constructivist Perspective

Children at all grade levels can learn more effectively if we teach them to build relationships and connect new information with concepts they already know.

Although I am a school administrator charged with supervising the instructional program of a public school district, I still wonder about "curriculum." What exactly is curriculum? How is it developed? How do children experience it? Some years ago, as a young teacher, I defined curriculum as the body of knowledge I was to teach. This knowledge I divided into "content areas" and subdivided into "topics" and "skills" that students were to learn in doses of large "units" and smaller "lessons." I periodically tested my students to determine how much of the curriculum they were learning and which skills needed remediation. It was a wonderfully simple, logical paradigm based on the belief that most children can learn the same curriculum at about the same rate and in similar ways.

When units or lessons didn't achieve their aims, I blamed either myself ("I didn't have my usual charisma today") or the students ("The kids seemed flat"). I never thought to question the developmental appropriateness of curriculum. After all, it was *The Curriculum*, developed by important people who knew what students ought to be taught: people like state education department specialists, textbook publishers, master teachers, and university consultants. Doubting their expertise would have been doubting the very foundations of the pedagogical belief system in which I was educated and that I held dear.

But I should have doubted, because most curriculum pays little or no attention to the developmental abilities of children. As a result, children do not learn much of what is taught to them.

The Need to Consider Child Development

Curriculum developers come to their task from an adult perspective, using adult logic to set objectives, identify skills, define tasks, and measure success. To be effective, teaching must be guided by the logic of children at different stages of development. Adults must value and seek to understand the child's point of view, which reflects her cognitive structures at a given point in time.

For example, most adults view fractions as logical; they make sense in their adult world of numbers. Therefore, it makes sense to adults that fractions could be taught in the second grade and introduced to children as slices of a pie or strips of an evenly divided sheet of paper. Few second graders, however, possess a sophisticated, adult understanding of part/whole relationships. For them, it is entirely appropriate to view each slice

A teacher's questions can help a student reflect on his knowledge; taking this mediating role, a teacher helps a student evaluate a diagram relating smoking to respiration.

Photographs by Jackie Grennon

Students build a repertoire of experiences and actions out of which may emerge the ability to do more abstract formal reasoning. As students construct their own geodesic designs, for example, they are given the opportunity to use proportional reasoning, to coordinate multiple frames of reference, and to understand more complex part/whole relationships.

of pie as a whole, even though this is "wrong" from an adult perspective.

An understanding of the second grader's perspective can help the teacher select and develop cognitively appropriate activities. The second-grade teacher can develop activities that will enable his young students to begin to construct a more elaborate understanding of part/whole relationships. He might pass around cardboard pies and ask the children to cut or tear them into pieces. He might mediate this process by asking appropriate questions, such as, "How many parts did you divide your pie into?" and "Can you put the whole back together again?" These kinds of experiences help children gain a repertoire of experiences and actions that they can reflect upon and out of which will ultimately emerge new cognitive structures.

Constructivism as a Philosophical Base

Piaget has been the major figure in promulgating the constructivist perspective (Piaget 1954, Inhelder and Piaget 1958). However, Piaget viewed constructivism not as a theory of learning, but as a theory of development, stating that human beings develop through predictable stages, each of which is typified by the emergence of new cognitive structures that increase the complexity of our thinking. Piaget's research did not focus on learning because he viewed learning as externally provoked, development as internally spontaneous. He concluded that learning cannot account for development, but development accounts for learning: "Teaching children concepts that they have not attained in their spontaneous development . . . is completely hopeless" (Piaget 1954, p. 30). Therefore, it is often developmentally appropriate for children to be "wrong," to be cognitively unable to construct an adult understanding of specific concepts.

Constructivism can be defined as a psychologically based notion of development: we come to know our world by interacting with it and using our operative cognitive structures to "explain" what we have perceived. Constructivism is also a model of learning (Bruner 1985) since construction of knowledge is often accompanied by the emergence of new cognitive structures. Eventually our second graders will recognize that the pie is the whole and each slice cannot also be the whole; at this point they will have gained a different, more complex, understanding of part/whole relationships.

Curriculum from a Constructivist Perspective

In the Shoreham-Wading River school district, many teachers are developing and delivering curriculum from a constructivist perspective as part of the district's Cognitive Levels Matching (CLM) project. The CLM project edu-

To help students understand photosynthesis, a Shoreham-Wading River seventh-grade science teacher had students develop flowcharts in which a product and by-product are created in the presence of energy. For the student who created the figure at the right, the analogy worked this way: sunlight is to chlorophyll as muscle power is to milk and ice cream.

"Most curriculum development occurs with little or no attention paid to the developmental abilities of children. It is for this reason that much of what is taught to children is not learned by them."

cates teachers about the principles of child development and helps them integrate these principles into their work (Grennon 1984, Brooks 1984). In the process of developing curriculum, teachers are taught how to assess the cognitive abilities of their students and the cognitive demands of the concepts they teach, and how to create a better, or more developmentally appropriate, match between the student and the curriculum.

There exists a fine, increasingly indistinguishable line between curriculum development and curriculum implementation or instruction. Many state education departments have developed syllabuses for almost all curriculum areas, mandating or guiding what is to be taught and allowing local discretion only in how to teach it.

The following two examples describe curriculum development from a constructivist perspective, one at the elementary level and one at the middle school level, one resulting in a new written curriculum, and one an example of how curriculum development occurs through instruction.

Symmetry. Disenchanted with the isolation of different curriculums at the primary level (grades K-3), a group of teachers decided to develop an integrated arts curriculum. They based their decision on the constructivist notion that children learn when they are able to build relationships and make connections among common concepts.

One such concept is "symmetry" and the symmetrical design "A-B-A." In the new curriculum, the art teacher helps his first-grade children visually recognize shapes and patterns having an A-B-A symmetrical design, such as certain trees and buildings with center halls and identical wings to the left and right. The music teacher helps her students compose or perform pieces of music having an A-B-A symmetrical design, such as verse-refrain-verse songs and high-low-high sounds on instruments. The physical education teacher helps children move their bodies in A-B-A shapes, such as arm-trunk-arm. And the regular classroom teacher helps the children use blocks, chain links, unifix cubes, and other materials to create A-B-A designs and teaches them to recognize symmetry in disciplines such as math: $1+2=2+1$.

Photosynthesis. The New York State Education Department requires students to learn about life sciences in the seventh grade. One topic in the life science sequence is photosynthesis. The text used in our district (Heimler et al. 1984) describes photosynthesis in this way:

> Photosynthesis is the chemical change that produces food. In photosynthesis, carbon dioxide gas and water are combined to produce sugar and oxygen. The sugar may be changed to starch. Sunlight is necessary for photosynthesis. It supplies the energy for the chemical change. This energy becomes locked in the sugar and starch molecules that are produced.

$$\underset{\text{carbon}}{6CO_2} + \underset{\text{water}}{6H_2O} \xrightarrow{\text{energy}} \underset{\substack{\text{chlorophyll}\\ \text{glucose}}}{C_6H_{12}O_6} + \underset{\text{oxygen dioxide}}{6O_2}$$

Note in the equation above that oxygen is produced in photosynthesis (p. 176).

The reading level of this passage is appropriate for seventh graders, and the description of photosynthesis is technically correct and logical from an adult perspective. However, although they are able to memorize this information for a test, most seventh graders understand neither the explanation nor the symbols in the equation. From the students' perspective, the curriculum is not appropriately matched to their cognitive abilities.

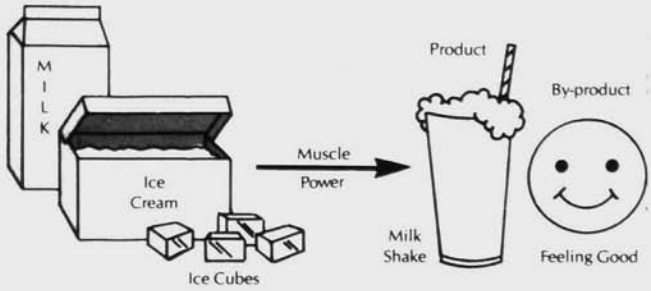

Fig. 1 Milk Shake

"Unlike competency-based teaching models, in which teacher reflection is often subordinate to written curriculums, the success of constructivist approaches to curriculum development and delivery is contingent on the thoughtful mediation of the teacher."

One of our seventh-grade science teachers who has a constructivist perspective (Grennon 1985) adapted this curriculum unit to match the instructional demands imposed by the cognitive abilities of her pupils. She recognized that to understand the textbook explanation requires abstract mental structures not yet developed in most 12- and 13-year-old children, structures such as the ability to coordinate multiple frames of reference (the interdependence of oxygen, carbon dioxide, sugar, etc.), and correlational reasoning (sunlight affects the plant's production of oxygen).

To help her students understand the process of photosynthesis, she decided to guide them in constructing it for themselves. She asked the students to think about how to bake a cake. They knew they would need eggs, milk, butter, and flour. She then asked if a cake would form if these products were placed on a table. The students responded that the products must be mixed together. She asked if mixing them together would make the cake. The students added that the mixed products must be placed in an oven and baked. She asked if there is a way to tell, before the cake comes out of the oven, that it is baking in the oven. After thinking a bit, the students agreed that the aroma of the baking cake is a way to tell. She asked if we bake cakes for their aroma. The students agreed that we bake cakes to eat them, not smell them. She identified the aroma as a by-product, then drew an analogy to photosynthesis: plants, using energy from sunlight and having a special ingredient in their leaves (chlorophyll), produce food for their own growth and survival while giving off oxygen as a by-product. Armed with that analogy, the students were then asked to draw a flowchart of another process, similar to photosynthesis, in which a product and a by-product are created in the presence of some sort of energy. An example of the work she received is in figure 1.

This teacher analyzed a highly abstract part of the curriculum and employed an analogy to help her students use their largely concrete cognitive structures to construct selected features of it for themselves. She asked them to seriate and use one-to-one correspondence in moving through the analogy and from the analogy to photosynthesis. Next, she asked students to classify certain outcomes as either products or by-products. Finally, she had them concretely illustrate the process in a drawing.

The Role of the Teacher

Curriculum development and delivery from a constructivist perspective is a highly complex, idiosyncratic endeavor. Unlike competency-based teaching models, in which teacher reflection is often subordinate to written curriculums, the success of constructivist approaches to curriculum development and delivery is contingent on the thoughtful mediation of the teacher. Although written curriculums are valued as general guides denoting what students should learn, the cognitive abilities of students often force teachers to shift direction. This requires teachers to think on their feet and reflect on their practice. Competency-based models view teachers largely as implementors of curriculum developed elsewhere in the local, state, or national hierarchy. Constructivist models view teachers as developers and deliverers of curriculum. If students are not constructing knowledge as anticipated by the teacher, the teacher must quickly analyze the reasons and alter the curriculum or develop a new curriculum.

This is not a revolutionary notion. Good teachers have always been able to read the class, shift gears, and adapt. Constructivism gives teachers another lens through which to read the class, an important one that has been largely ignored in our endless search for simple answers to complex problems. Models that attempt to be "teacher proof" miss an essential point: we are all constructors, students and teachers alike. Effective teachers are constantly constructing knowledge about the abilities of their students. They resist being tied to fixed, static curriculum sequences and seek opportunities to develop curriculum consistent with their expanding knowledge of students.

Nevertheless, teachers in Shoreham-Wading River report that approaching curriculum development from a constructivist perspective is difficult. In an elementary classroom reading lesson, for example, it is much easier to use prepackaged kits with all students than to assess which students comprehend the written word literally and which inferentially and then to develop appropriate curriculums for each group. However, our teachers also report that it is precisely this complexity that makes the constructivist perspective to curriculum development meaningful for them and their students.

Two Caveats

In closing, it is important to mention two caveats. First, we do not know yet

if teachers can be taught to be constructivist, or if one must have a psychological predisposition toward constructivism in order to develop curriculum in which construction of knowledge by students is enouraged and mediated. We are currently examining this question.

Second, as Bruner (1985) indicates, no one model explains all learning. Human beings cannot construct all knowledge. For example, we cannot construct the names of Columbus's three ships: this knowledge must be given to us for memorization and recall. Nor do we construct the knowledge to duck when an object is thrown toward us: this knowledge is learned behaviorally.

Constructivism, however, explains best how human beings come to know their world. Constructivist approaches to curriculum development and delivery value and encourage student and teacher thinking, the very sort of thinking we claim to want of our students but stifle with the managerial busywork of competency-based curriculum models.□

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