Making Sense of Student Thinking

Developmental theory can help teachers understand and foster cognitive processing.

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I am a middle school teacher learning to get better at this complex enterprise called teaching. Students are randomly placed in my class by the year in which they were born. Although their backgrounds are relatively alike and they will probably achieve developmental milestones at similar ages, their thinking and learning processes vary a great deal. This variability is most remarkable during adolescence, when some students begin to think in ways that include formal operational structures, while others continue to refine their concrete operational schemata (Inhelder and Piaget, 1958). How does a teacher respond to students of varying cognitive styles in ways that encourage cognitive growth?

This article analyzes a set of teacher-student interactions from the perspective of "cognitive levels matching"—the theme of a project in the Shoreham-Wading River, New York, school system. These examples illustrate how teachers can interpret students' cognitive processes and subsequently use these interpretations in instruction and student evaluation.

The Classroom Activity

I designed an activity for my middle school students intended to integrate the methodologies and questions used

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HAPPINESS IS A WARM PUPPY

Upon further discussion, Karen was not quite sure what specific information she would need or what type of graph could support her conclusions. Her theorizing about possible correlations was an almost intuitive response to her data. The logic required for appropriate follow-through was not yet in place. What could Karen and I learn about the teaching/learning process from this interaction? First, a mutual understanding between us of the need for accurate communication of data analyses was generated through the joint review process. Second, Karen discovered an error in her work through our interaction but without being told she was wrong. Third, appropriate teacher intervention requires a holistic view of the learner, as well as cognitively appropriate questioning skills and considerable understanding of children's thinking patterns. Karen is a child who deals with disequilibrium in slow, quiet ways. Her body language and frequent silences were clues to her disequilibrium. I decided that Karen needed psychological space and time to consider the issues. She was aware that her logic was no longer convincing, but did not yet have a substitute. She needed time. Finally, this evaluation exercise was transformed into an educational event by using it as a springboard for teacher/pupil dialogue, rather than solely for the purpose of assigning a grade to the product.

The Student's Point of View

Jeff's project (see Figure 2) serves to illustrate the importance of student elaboration, which affords the teacher a glimpse at the student's frame of reference. Encouraging students to reveal their point of view, and then acknowledging that point of view, are two critically important elements of developmentally based teaching practices.

Initially, it appeared that Jeff did not understand the bar graph as a classification scheme that uses axes to represent categories and points along the axes to represent members of a set. I told him that drawing bars on the graph that "spill over" each other in order to meet the vertical axis on the left was confusing. Jeff claimed that the color code and numbers along the horizontal axis made the distinctions among specific questions quite clear and explained that this type of visual display was helpful. It is interesting to note that several other students became involved in the discussion, all of whom tried to convince Jeff that "this isn't the way you do it." Jeff maintained his position. For him, it was valid and I acknowledged its validity. For Jeff, the salient, distinguishing dimension was color, and not the space over the horizontal axis.

From a developmental perspective, the most interesting element of Jeff's work was that he treated each bar on the graph separately. For Jeff, the graph is not an array that compares results among questions, but instead a series of discrete questions with separate answers. This view not only characterizes his general work, but can be seen in other facets of his project. For example, Jeff could not generate any concluding statements. There was no "larger picture." I repeatedly asked him if he could generalize from any information in his work. He said, "No, except for two questions, the answers are all different." I asked him if the students *mostly* liked or disliked the class. Somewhat impatient with my "ungrounded" probings, he told me to look at the graph. "It depends on the question," he added. I asked if he could write a "summing up" statement. He said, "The graph says it. There's no need to write anything."

The serial approach that characterizes Jeff's response to this task also typifies his responses to other tasks.

Figure 2. Jeff's Project.

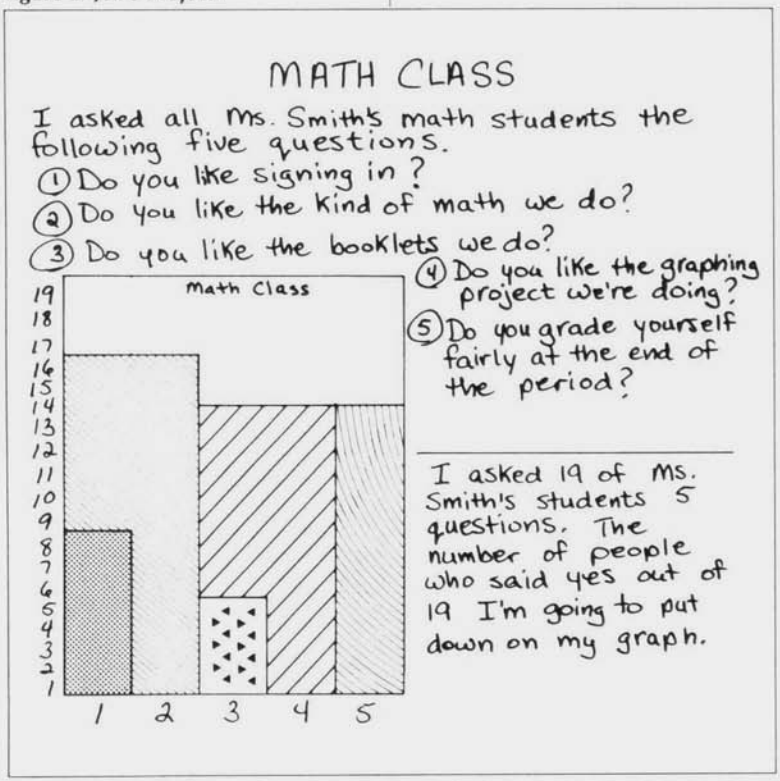
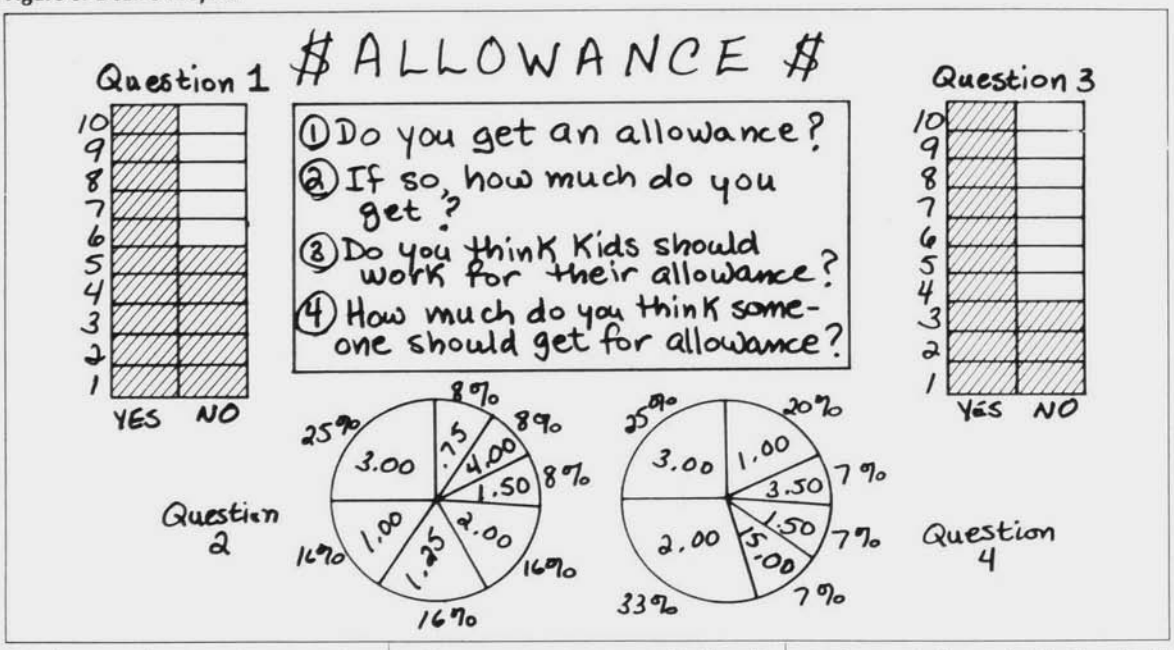


Figure 3. Dean's Project.



The larger educational prescription for this child involves consideration of factors beyond the scope of this article. However, the inclusion of Jeff's project reinforces the point that providing students with opportunities to elaborate on their work is an important factor in applying developmental theories to education. Having asked Jeff to redraw his graph without "spillovers" would have taught him little except that schools are places to please the teacher.

Integration

Dean's work (see Figure 3) provides an example of sophisticated integration of stages of thinking. Dean essentially constructed a classification of classification systems and grouped those systems according to suitability for different tasks. Such mental operations infer a hypothetical view of systems. Thus, his work evidences a way of thinking that incorporates some of the components characteristically considered part of formal operational thought, although the roots of the work are grounded in a scheme considered part of concrete operational thought.

This concept of integration of stages, which Kohlberg and Mayer (1972) say "... should be the focus of education" (p. 492) can be readily seen in teaching intellectually gifted children. Many studies report that, with rare exceptions, even highly gifted children do not attain formal operational thought before the typically designated ages, although they do use formal operational thought schemata at the earlier ages of the typical range of onset (Carter and Ormrod, 1982). Informal classroom observations can also lead to the generalization that gifted youngsters often exhibit highly integrated classification abilities, which allow them to see relationships between seemingly disparate sets of data. One kindergartner, after a music lesson in which he listened to and compared train sounds, said that a circus and a train are alike because "they both move from place to place."

Dean writes:

> For my math project, I picked the topic allowance because I was curious of how other kids get their money. Out of the four different kinds of graphs—the line graph, bar graph, circle graph and pictograph—I picked these graphs because they clearly showed the results of the questions. In this project, I learned a lot about the different kinds of graphs. . . .
>
> Overall, most people got an allowance of an average of about two dollars. Most people thought that kids should work for their allowance and should not get more than four dollars with one exception.

Dean's project involved a great deal of arithmetic manipulations and proportional reasoning. First, he changed absolute numbers into percentages to produce a circle graph. He then divided the number under consideration by the total and multiplied by 100. When asked to explain his computations, he used an analogic line of reasoning (a:b::c:d), although he did not specifically use this formula in his computations.

To draw the graph, Dean initially equated degrees and percentages. With his protractor, he then drew wedges in the circle graph. He asked me why there was so much of the circle left over. I responded by asking him how many degrees form a circle. He replied, "360 degrees." He looked confused, was silent for a moment. I then asked if that piece of information gave him a clue. His response implied an internal answer of "yes." He asked, "But how do I change from percentages to degrees?" I replied, "The same way you change from other numbers to percentages." I encouraged him to think about it for a while and to come back with more questions if he needed help. Dean then produced the final project shown in Figure 3.

As we reviewed his work, I noticed that the sum of the percentages did not equal 100. I asked Dean what the total percentage of a circle graph equals. After a moment, he said, "100 percent, I guess," as he began adding the figures. As he formed 97 percent on the paper, he looked up and said, "I had to round off, you know. That's

close enough. I can't do all those calculations again, unless you let me use the computer." We agreed that, for our purposes, his figures were "close enough."

Dean's comment that the circle graphs "clearly showed the results of the questions" is an example of the classification of classification systems. The graphs alone are classification systems that compare two sets of data. Dean then compared the graphs based on the category attribute of clarity.

Dean states on his poster that the average allowance is about two dollars. I asked him how he generated that figure. He said, "Well, I looked at the graph and there's a lot of people who get two dollars, and there are some who get more and some who get less." I asked him how he could get an exact number if he wanted one. Through his hesitation, I inferred that he was somewhat stumped by the necessity to multiply before he could "add and divide," a procedure he knows as the averaging algorithm. He replied, "Well, I guess you could do it, but I don't know how. I still think it would be two, though. Together we concluded the interchange by agreeing that rounding off to "two" appeared "reasonable."

"Teachers need to attend not only to the cognitive development of students, but to the vulnerable emotional states that various teaching practices can generate."

Between the Lessons

The delicate factor in bringing students to the leading edge of their intellectual abilities lies in the teacher's understanding of the inextricable tie between affect and cognition. As was shown in the example of Karen, when a student has put a great deal of work and energy into the production of a project, the teacher must be sensi-

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tive to the child's ego investment in the work. Not every opportunity for cognitive growth must be seized. With such pressure, children would live in a constant state of tension and frustration.

I have tried to discuss some often overlooked teaching moments, those that occur "between" the lessons and that weave themselves into the classroom without plans or prediction. The artifacts of such moments frequently find their way to science fairs, literary magazines, or school newspapers. But the vital processes that precede the product, whether a work of art or a newly acquired skill, are less readily studied.

Translating developmental theory into instructional programs that facilitate cognitive development and promote skill acquisition is a complex task, complicated by both theoretical and practical difficulties. On the theoretical level, the translation process relies on substantial teacher interpretation, the advantages of which are not yet supported by research, although some informal case studies are available (Brooks, Fusco, and Grennon, 1983). On the practical level, teachers daily confront many interfering realities—minimum competency tests and criterion-referenced management designs, for example—that thwart their willingness to engage in the demanding translation process. Nevertheless, despite the complexities, it is possible to apply developmental theory to classroom practice.□

References

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