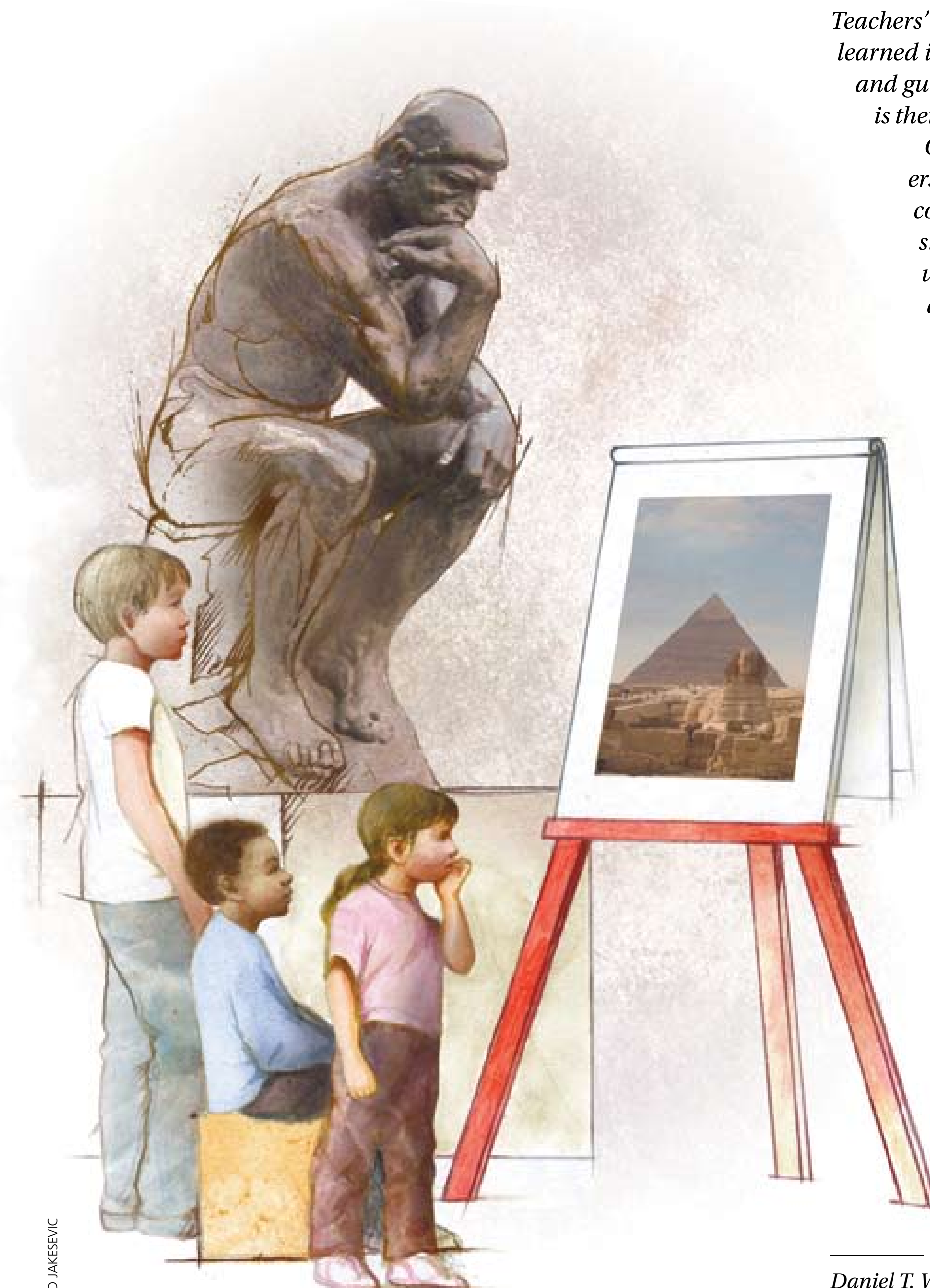
ASK THE COGNITIVE SCIENTIST

What Is Developmentally Appropriate Practice?



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How does the mind work—and especially how does it learn? Teachers' instructional decisions are based on a mix of theories learned in teacher education, trial and error, craft knowledge, and gut instinct. Such gut knowledge often serves us well, but is there anything sturdier to rely on?

Cognitive science is an interdisciplinary field of researchers from psychology, neuroscience, linguistics, philosophy, computer science, and anthropology who seek to understand the mind. In this regular American Educator *column, we consider findings from this field that are strong and clear enough to merit classroom application.*

By Daniel T. Willingham

What is "developmentally appropriate practice"? For many teachers, I think the definition is that school activities should be matched to children's abilities—they should be neither too difficult nor too easy, given the child's current state of development.* The idea is that children's thinking goes through stages, and each stage is characterized by a particular way of understanding the world. So if teachers know and understand that sequence, they can plan their lessons in accordance with how their students think.

In this column I will argue that this notion of developmentally appropriate practice is not a good guide for instruction. In order for it to be applicable in the classroom, two assumptions would have to be true. One is that a child's cognitive development occurs in discrete stages; that is, children's thinking is relatively stable, but then undergoes a seismic shift, whereupon it stabilizes again until the next large-scale change. The second assumption that would have to be true is that the effects of the child's current state of cognitive development are pervasive—that is, that the developmental state affects all tasks consistently.

Data from the last 20 years show that nei-

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ther assumption is true. Development looks more continuous than stage-like, and the way children perform cognitive tasks is quite variable. A child will not only perform different tasks in different ways, he may do the same task in two different ways on successive days! As a result, research on children's development can be useful to teachers, but perhaps not in the way they expect.

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It would be great if teachers could know in advance whether their students were capable of understanding a story, project, or activity. Imagine how much more productive lesson planning would be if developmental psychologists could tell teachers, "Students in kindergarten will generally be able to do tasks of type X, but will not be able to do tasks of type Y." Or "all students will be able to do task Z, but kindergartners will do it using Method #1, whereas first-graders will do it using Method #2."

Teachers who have taken a course in cognitive development may think that such specific guidance is not so far in the future. After all, it was some 50 years ago that the acclaimed psychologist Jean Piaget proposed his four-stage theory of cognitive development. Unfortunately, researchers are far from being able to provide teachers this type of guidance—and probably will never be able to do so. To better understand why, let's review Jean Piaget's theory. Although development psychologists no longer believe that his theory is right, it is a good starting place because so many people are familiar with Piaget's stages of development, and because the research prompted by his theory showed that development does not proceed in discrete stages with pervasive effects. That research is vitally important to our thinking about child development and classroom practice.

Jean Piaget's Four Stages of Development

Piaget proposed that children go through four major stages of development. Each stage is a long plateau during which cognitive change is absent or modest, followed by a large, rapid shift in thinking marking the movement to the next stage.

The first stage, lasting from birth until about age 2, is the *sensorimotor* stage, in which infants gather information and express their knowledge about the world through their senses and through movement. Piaget proposed that children in this stage live very much in the present moment and that they have only a rudimentary understanding of space, time, and causality. He believed that deferred imitation, in which the child imitates an observed action after a delay, indicates that she is moving into the next stage—*preoperational*.

The preoperational stage lasts from about ages 2 to 7. Mental concepts become more complex because the child can represent ideas via language. Children are able to use mental symbols—for example, they can pretend that one object is another in play. Still, their ability to use these symbols in an organized way is not complete. One limitation (which Piaget called "centration") is the tendency to focus on just one aspect of a complex situation. For example, if you show a 5-year-old child identical glasses containing the same amount of juice, she will say that they are the same. If, as the child watches, you transfer the contents of one glass into a taller, narrower glass she'll say that it now has more than the other (Piaget 1952). She makes this error because she focuses on one feature—the height of the juice in the glass—and ignores another, equally important feature—the width.

Children in the preoperational stage also have difficulty understanding that others do not see the world as they do (a phenomenon Piaget called egocentrism). Suppose a child in the preoperational stage is shown a series of drawings with an accompanying explanation from an adult. Max puts a chocolate bar in a cupboard. When he's out of the kitchen, his mother moves the chocolate bar to a drawer. Where, the experimenter asks the child, will Max look for the chocolate bar when he returns? Most 4-year-olds incorrectly answer "the drawer." About one-half of 4- to 6-year-olds get the problem right, as do most of the children older than 6 (Wimmer and Perner 1983). It is only at the end of this stage that children understand that others think differently than they do.

> Data from the last 20 years show that development looks more continuous than stage-like, and the way children perform cognitive tasks is quite variable.

The third stage of development is the *concrete operational* stage, lasting from about ages 7 to 12. According to Piaget, children in this stage are able to reason logically about concrete objects—thus they know that when juice is poured into a different container, it must be the same amount, however different it might look. They still have difficulty thinking about highly abstract situations, however. For example, they have trouble contemplating different conceptions of justice, or radically different worlds such as one might encounter in science fiction.

The final stage of development is the *formal operations* stage, which begins at about age 12 and continues throughout adulthood. Piaget believed that children in this stage can think about pure abstractions, and they can apply sophisticated reasoning strategies to them. For example, they can think about morality in the abstract, and consider the extended implications of a different view of morality. They can think systematically about complex situations, for example, using the scientific method of isolating variables to understand cause and effect.

If Piaget's theory were right, knowledge of cognitive development would be quite useful to classroom practice. We would know, for example, that kindergartners, who are in the preoperational stage, would have a difficult time understanding other cultures. Their egocentrism would make

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* There is no formal work to verify or disprove my impression, so I conducted an informal survey of math teachers in which I simply asked them to define the term in a few sentences. Of the 25 who instruct K-3 students (usually taken to be the critical years for developmentally appropriate practice), all defined it largely in terms of readiness: does the child have the cognitive (and perhaps, emotional) capabilities to understand and benefit from a lesson?

it hard for them to comprehend that other people have different thoughts, beliefs, and experiences than they do. We might also conclude that science and mathematics would need to be quite concrete until children reached about the sixth grade. Before then, they would not be able to apply sophisticated reasoning to abstractions because they are in the concrete operational stage.

Unfortunately, Piaget's theory is not right. He is credited with brilliant insights and many of his observations hold true—for example, kindergartners do have some egocentrism and 9-year-olds do have some trouble with highly abstract concepts. Nonetheless, recent research indicates that *development does not proceed in stages after all*.

As I said at the outset, teachers generally think of developmentally appropriate practice as instruction that is sensitive to a child's stage of development, which is assumed to affect his or her thought processes quite broadly. But this characterization of development—discrete stages with pervasive effects—has been carefully tested in the context of Piaget's theory and has been found not to be true. The problem is not simply that Piaget didn't get it quite right. The problem is that cognitive development does not seem amenable to a simple descriptive set of principles that teachers can use to guide their instruction. Far from proceeding in discrete stages with pervasive effects, cognitive development appears to be quite variable—depending on the child, the task, even the day (since children may solve a problem correctly one day and incorrectly the next).

Development Does Not Occur in Discrete, Pervasive Stages

It is easy to see why Piaget (and others) believed that development occurred in stable, pervasive stages. Many parents, for example, have observed seemingly sudden shifts in their children's thought and behavior. In addition, the types of changes in cognition that Piaget observed were initially supported in laboratory studies.

To better understand why developmental psychologists (and thus teachers and parents) thought development occurs in stages, let's consider egocentrism, which Piaget initially tested with the three-mountain task (Piaget and Inhelder 1956). Children were shown a tabletop model of three mountains. The experimenters placed a doll in a chair on the side opposite the child. The child was shown several photographs and was asked to choose the one corresponding to what the doll would see from her vantage point. The experimenters reported that 4-year-olds are unable to do this task, thus showing an inability to appreciate others' points of view.

This finding certainly rings true to me. Like many parents, I have had countless conversations like this one with my 2-year-old daughter, Sarah, while in the car:

> Sarah, looking out the window: What's that?
> Dad: What's what?
> Sarah: That!
> Dad: Describe it. What color is it?
> Sarah, increasingly frustrated: *That!* Right there!

She cannot understand that I don't know what she is looking at. Young children's thinking does indeed seem egocentric.

But it turns out that our perceptions about what children know depend on the task we use to probe their knowledge. Betty Repacholi and Alison Gopnik (1997) used a different task to test young children's egocentrism and showed that children as young as 18 months can behave in ways that are not egocentric. In their experiment, 14-month-old and 18-month-old children first had an opportunity to sample a food that toddlers typically like—

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Goldfish crackers—and one that they typically do not—raw broccoli. Predictably, most of the children preferred the crackers. Later, each child observed an adult experimenter try each of the foods. In the critical condition, the child saw the experimenter show strong disgust after tasting the crackers ("Eww! Crackers! Eww! I tasted the crackers! Eww!") and an equally strong indication of pleasure after tasting the broccoli. Later, this same adult, seated across a table from the child, put a tray on the table with a bowl of broccoli and a bowl of crackers, put her hand equidistant from the bowls and said, "Can you give me some?" If the child is egocentric, he will not be able to conceive that the experimenter could want the yucky broccoli, and so he will give her some crackers. And about 90 percent of 14-month-old children do just that. Even though they have seen the experimenter express disgust after tasting the crackers, they seem unable to understand that someone would have a different preference than they do. The 18-month-old children, however, get it. Seventy percent of these children offer broccoli to the experimenter. (They aren't just shrewder than their younger counterparts, hoarding the crackers for themselves. In another condition, the experimenter indicated that she liked crackers, and the same percentage of 18-month-old children willingly shared the yummy crackers.)

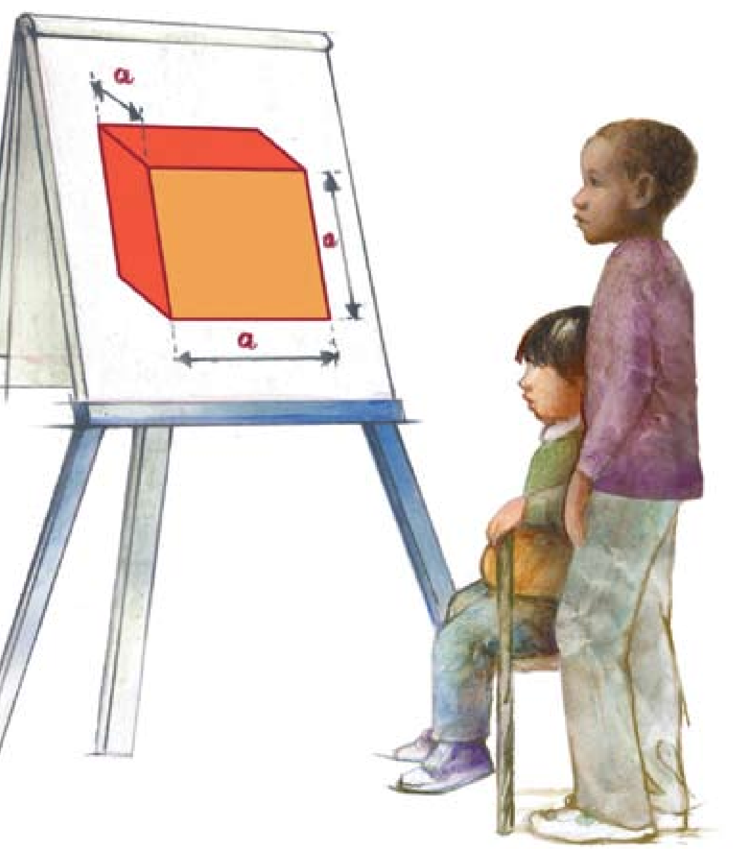
Here is still another way that we could measure egocentrism. Children as young as 6 months show distress when another child cries. We cannot conclude, however, that this is a show of sympathy—that is, that the infant understands that the other child is upset. It may be that hearing a baby cry is disturbing, and the child cries because *he* is upset, not for the sake of the other child. But sympathy quite clearly emerges between the first and second year. By the age of 2, children less often cry when they see someone in distress, and more often offer comfort, including voicing concern (saying "I'm sorry") or offering physical comfort like a hug (Zahn-Waxler et al. 1992). That's not to say that 2-year-olds always behave in this sympathetic manner when they see someone in distress. But they often do, and it's a clear sign that they understand someone else's mental state—that they are not behaving egocentrically.

These experiments tell us that there is not a rapid shift whereby children acquire the ability to understand that other people have their own perspectives on the world. The age at which children show comprehension of this concept depends on the details of what they are asked to understand and how they are asked to show that they understand it. This pattern of task dependence holds for other hallmarks of Piagetian stages as well. The implication is that stages, if they exist, are not pervasive (i.e., they do not broadly affect children's cognition). The particulars of the task matter.

Here's another example that explores how recent research is refuting the notion of discrete, pervasive stages of development. Suppose I give the juice-in-the-glass task to a group of children and all of the 5-year-olds say the narrow glass has more than the wide glass, about one-half of the 6-year-olds say that and one-half say they are equal, and all of the 7-year-olds say they are equal. We'd probably be inclined to interpret this result as consistent with a stage theory that predicts that children learn the conservation of liquid principle around age 6.

There is, however, an assumption embedded in this interpretation. We're assuming that the performance of the 6-year-olds varies because we happened to test some before they had mastered the concept and some afterwards. We assume that if we had administered the test to each 6-year-old twice on consecutive days, then he or she would be a solver or a nonsolver each time. In fact, that's not the case. Children are frequently inconsistent in how they perform cognitive tasks.

Here's an example using a conservation-of-number problem that is conceptually similar to the juice-in-the-glass problem. The child is shown two rows of objects, say, pennies. Each row has the same number of pennies and they are aligned, one for one. The child will agree that the rows are the same. Then the experimenter changes one row by pushing the pennies farther apart. Now, the experimenter asks, which row has more? (Pennies might also be added to or subtracted from a line.) Younger children will say that the longer line has more pennies.



When Piaget (1952) developed this task he argued that children go through three stages on their way to successfully solving this problem. Initially they cannot process both the length of the rows and the density of coins in the rows, so they focus on just one of these, usually saying that the longer row has more. The next stage is brief, and is characterized by variable performance: children sometimes use row length and sometimes row density to make their judgment, sometimes they use both but cannot say why they did so, and sometimes they simply say that they are unsure. In the third stage, children have grasped the relevant concepts and consistently perform correctly.

Robert Siegler (1995) showed that children's performance on this task doesn't develop that way. Ninety-seven 4- to 6-year-olds who initially could not solve the problem were studied, with each child performing variants of the problem a total of 96 times over eight sessions. After each problem, children were asked to explain why they gave the answer they did, so there was ample opportunity to examine the consistency of the children's performance and their reasoning. The experimenter found a good deal of inconsistency. Children used a variety of explanations—sophisticated and naïve—throughout, even though they became more accurate with experience (the experimenter provided accuracy feedback, which is a big help to learning). It was not the case that once the child "got it" he consistently used the correct strategy. If the child gave a good explanation for a problem, there was only a 43 percent chance of his advancing the same explanation when later confronted with *the identical problem*.

This variability in children's thinking is not limited to Piaget's conservation-of-number task. The same variability is observed in mathematics (Siegler and Jenkins 1989) and scientific reasoning (Metz 1985, Schauble 1990). All in all, children's performance as they learn seems better characterized by variability than by consistency (Siegler 1994). So for teachers, changing strategies and experimenting with different methods of presenting and solving problems may be a more effective way to improve instruction than trying to match instruction to children's developmental level.

Children's Cognitive Abilities Vary by Task and Day, Not Just by Age and Individual Developmental Pace

Having reviewed some key research, we're ready to ask: how can we apply our knowledge of cognitive development to the classroom? I have argued that an important characteristic of development is variability. Everyone appreciates that there is great variability among children of different ages, and most people appreciate that there is also variability among children of the same age—children change with age, but not at the same pace, so 5-year-olds, for example, differ. What I have added here is evidence for two other types of variability. There is variability across tasks, meaning that children use or fail to use a cognitive concept—for example, knowledge that others' thoughts may be different from their own—depending on the task in which the concept is embedded. There is also variability within children. Day to day, the same child may perform the same task in different ways.

The documented variability in children's performance has changed the way developmental psychologists think about cognition. Until about 40 years ago, most thought of children's minds as a set of machinery. As children developed, parts of the machine changed, or parts were discarded and replaced by new parts. The machinery didn't work well during these transitions, but the changes happened quickly. Today, researchers more often think that there are several sets of machinery. Children have multiple cognitive processes and modes of thought that coexist, and any one might be recruited to solve a problem. Those sets of cognitive machinery undergo change as children develop, but in addition, the probability of using one set of machinery or the other also changes as children develop.

This conclusion doesn't mean that there is no consistency across children in their thought, or in the way that it changes with development. But the consistency is only really evident at a broader scale of measurement. A geographic metaphor is helpful in understanding this distinction (Siegler, DeLoache, and Eisenberg 2003). If one begins a trip in Virginia and drives west, there are very real differences in terrain that can be usefully described. The East Coast is wet, green, and moderately hilly. The Midwest is less wet and flatter. The mountain states are mountainous and green, and the West is mostly flat and desert-like. There is no abrupt transition from one region to another and the characterization is only a rough one—if I tell you that I'm on the East Coast and you say, "Oh, it must be green, wet, and hilly where you are," you may well be wrong. But the rough characterization is not meaningless. Similarly, all children take the same developmental "trip." They may travel at different paces and take different paths. But at a broad level of description, there is similarity in the trip that each takes.

Obviously, the description of multiple sets of cognitive machinery rather than a single set complicates the job of the developmental psychologist who seeks to describe how children's minds work and how they change as children grow. Worse, it negates the possibility that teachers can use developmental psychology in the way we first envisioned. There is a developmental sequence (if not stages) from birth through adolescence, but pinpointing where a particular child is in that sequence and tuning your instruction to that child's cognitive capabilities is not realistic. Nonetheless, information gleaned from cognitive developmental studies can still be informative.

What Does This Variability Mean for Teachers?

1. *Use information about principles, but not in the absolute.* The initial hope was that developmental psychologists could articulate cognitive principles that would characterize children at different ages, and thus could be used to predict their success on a variety of tasks. That won't work, but not because the principles are wrong—it's just that they are not absolute. Centration—the tendency to focus on a single dimension of a situation when more than one dimension is important—is a common feature of preschoolers' thinking. But whether centration is a feature of their thought depends on the task, and when it is, they can often be guided to attend to more than one feature. Thus, knowing principles of cognitive development like centration or egocentrism is useful because they may give you insight into how children are thinking, and may help you guide them to think more productively. But like any useful tool, overuse will lead to trouble.

2. *Think about the effectiveness of tasks.* Children sometimes understand a principle embedded in one task and fail to understand it in another task. Thus, a description of the principle does not provide a foolproof guide to what children will understand, but knowing which tasks have worked well in the classroom and which have not is obviously useful. I am sure that you keep track, at least informally, of how well an activity works, and either repeat or discard that activity for future classes. (I'm a fan of recording such impressions frequently in a teaching diary, as one's memory is never as reliable as one hopes.) But why limit yourself to your own experience? Do you share this sort of information with other teachers? If the teachers in your grade don't already meet regularly, consider setting up such a meeting for the express purpose of exchanging information about projects, activities, books, and other specific tasks that have (or have not) worked well in the past.

3. *Think about why students do not understand.* An important message from the research cited here is that any one task that the child attempts at any one time is not a perfect window into the child's abilities. Children's cognition is variable. That means

that if they fail to understand a concept, the problem may not be the concept—it may be some other feature of the task.

For example, suppose you read *Make Way for Ducklings* to a preschool class. Midway through the story you ask, "What do you think will happen next?" and you are met with blank stares. You might think to yourself, "That question was developmentally inappropriate. It was too abstract to ask them to think about the future." Maybe. But maybe no one has ever asked them to make a prediction about a story, and so they were just unsure of what to do, and would have answered readily if you had said, "Do you think the ducks will go back to the park or stay where they are?" Or maybe they hadn't understood the story very well to that point, so they knew what you were asking, but they just didn't know what might happen next. Or maybe they just don't know that much about ducks.

If a child, or even the whole class, does not understand something, you should not assume that the task you posed was not developmentally appropriate. Maybe the students are missing the necessary background knowledge. Or maybe a different presentation of the same material would make it easier to understand.

4. *Recognize that no content is inherently developmentally inappropriate.* If we accept that students' failure to understand is not a matter of content, but either of presentation or a lack of background knowledge, then the natural extension is that no content should be off limits for school-age children. Jerome Bruner suggested this provocative idea as follows:

> We begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development. It is a bold hypothesis and an essential one in thinking about the nature of the curriculum. No evidence exists to contradict it; considerable evidence is being amassed that supports it. (Bruner 1960, p. 33)

Bruner goes on to suggest that children can get an intuitive grasp of a complex concept before they have the background and maturity to deal with the same topic in a formal manner. For example, 6-year-olds may not be ready to understand the formulae associated with projective geometry, but they can get an intuitive understanding of some of the principles by experimenting with placing rings of different sizes between a light source and a screen, and seeing that the size of the cast shadow depends on its distance from the light. Similarly, the notion of probability is embedded in games that children play using dice, and this understanding can be expanded to include the notion of a distribution. Thus, one approach is to help the child gain an intuitive appreciation of a complex principle long before she is prepared to learn the formal description of it. Without trivializing them, complex ideas can be introduced by making them concrete and through reference to children's experience.

There is a developmental sequence (if not stages) from birth through adolescence, but pinpointing where a particular child is in that sequence and tuning your instruction to that child's cognitive capabilities is not realistic.

Of course, as teachers, you must also consider the cost if students do not fully understand a concept the way you had intended. The cost may be minimal, and the content may be worth knowing—even if in an incomplete way. For example, suppose your preschool students have learned about Martin Luther King, Jr., but you are having a hard time getting them to understand that he was a real person who is no longer here, and that fictional characters such as Mary Poppins are not here and never were. If it's hard for a 4-year-old to conceive of people living in different times and places, does that mean that history should not be taught until the child is older? Such an argument would not make much sense to a developmental psychologist. For children and adults, understanding of any new concept is inevitably incomplete. The preschoolers can still learn something about who King was and what he stood for. Their mistaken belief that they might encounter him at a local store, or that he lives at a school that bears his name, will be corrected in time. Indeed, how do children learn that some people are fictional and some are not? Not by a magical process of brain maturation. Children learn this principle as they learn any other—in fits and starts, sometimes showing that they understand and other times not. *If you wait until you are certain that the children will understand every nuance of a lesson, you will likely wait too long to present it.* If they understand every nuance, you're probably presenting content that they've already learned elsewhere. ☐

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