Children's Need to Know: Curiosity in Schools

SUSAN ENGEL
Williams College

In this essay, Susan Engel argues that curiosity is both intrinsic to children's development and unfolds through social interactions. Thus, it should be cultivated in schools, even though it is often almost completely absent from classrooms. Calling on well-established research and more recent studies, Engel argues that interactions between teachers and students can foster or inhibit children's curiosity. She offers an explanation for why curiosity is not a priority in our educational system and calls for greater attention to children's interests and explorations, which, she argues, are the mechanisms that underlie authentic learning.

Several years ago, I found myself sitting in the corner of a fifth-grade classroom in a rural public school observing a science class unfold. As I looked around, I saw many of the accoutrements of an apparently good classroom. There were posters on the walls showing reptiles and fish, a diagram of the periodic table, and a photograph of a scientist in a lab coat peering into a test tube. Along one counter were several microscopes, an empty terrarium, and some bins filled with droppers, measuring devices, and scoops. The desks formed a horseshoe, all facing the front, where the teacher's desk, a tall counter from which she could make demonstrations or set out materials, was placed. Behind the teacher's desk was a wall covered with a blackboard and a screen for showing movies or presentations.

A group of twenty-one boys and girls, all around ten years old, were sitting behind their desks. The teacher, Mrs. Parker,[1] was explaining that the students were to form small groups and work on an activity to learn about how the ancient Egyptians had first invented wheels for transport in order to carry stones for their huge pyramids. She then organized the children into groups of three and invited each group to come up and get the materials they needed—a flat piece of wood with a metal eye at one end, some round wooden dowels, and a small measurement device that records Newtons, the amount

Harvard Educational Review Vol. 81 No. 4 Winter 2011

of force required to pull an object at a given speed for a given distance. The device had a string with a hook attached to it so that children could hitch it to the bar. She also gave each group a worksheet to fill out, which included step-by-step instructions about what to do with the materials and a series of questions. Each group was to try pulling the wood piece along the floor, measuring how easily they could drag it both with and without dowels underneath it. By this time, it had become clear to me that the idea was for each group to "discover" that pulling the board was a lot easier with the dowels serving as wheels.

The children happily sorted into their assigned groups, materials in hand, and found a space on the floor to settle down and work. As they began completing the steps outlined on the worksheet, the noise level rose. Mrs. Parker wandered around, looking down on the groups from above, encouraging, giving tips, and reminding them to answer the questions on the worksheet. Several times she noted that they were "moving right along," "making good progress," or "getting there." I looked around the room to see who was pulling the wooden bar, who was recording the measurements, and who was watching quietly. Then I noticed one group that seemed to have forgotten the worksheet and was instead intrigued by the equipment. The children were trying to figure out different ways to use the bar with the spring scale attached—yanking, pulling, and even at one point holding the string up high so that the bar was simply swinging in the air, hanging from the device. Then they stood the dowels up like columns and tried to balance the bar on the dowels. Finally, they tried surfing the bar along the surface of the dowels, which they had laid down to create something like a conveyer belt. At this point, Mrs. Parker also noticed what they were doing. She called out to the group, over the heads of her students, in a loud clear voice for all to hear, "Ok, kids. Enough of that. I'll give you time to experiment at recess. This is time for science."

On the face of it, the teacher was doing just the kind of hands-on activity promoted by many educators. She was giving the kids a chance to learn through active participation and to discover a principle for themselves rather than just memorize a rule or formula. And the children did indeed seem happy and engaged. But just when the children in one group began to make the activity their own by following their own curiosity regarding the tools for the experiment—"What will happen if we pull it this way? What happens when we hang it that way?"—she stopped them. They had deviated from her plan. Ironically, this took place just as the children became interested in formulating and answering their own questions—when curiosity, the mechanism that underlies the best learning, kicked in.

Why Curiosity Belongs in the Classroom

While Piaget (1969) described curiosity as the urge to explain the unexpected, Kagan (1972), who has a greater interest in the emotional side of early devel-

opment, has described curiosity as the need to resolve uncertainty. Though differing in emphasis, both Kagan and Piaget highlight the idea that children's development is spurred by their efforts to understand the unknown. This concept is as vibrant as ever, and has fueled the last decade of my own research.

Novelty is not everything, however. Sometimes children are most eager to learn about something with which they are already familiar. Take, for instance, the five-year-old who, obsessed with dinosaurs, can't seem to get enough new information about the names of dinosaurs, their attributes, and their habits. The paradox here is that curiosity involves an attraction to what is unknown, but, at the same time, children are often most curious about things with which they are somewhat familiar and about which they have some ongoing interest. Because of this paradox, research on children's interest offers important insights about the development of curiosity.

Renninger (1992) has shown that when children between the ages of three and five play with a toy in which they have shown some prior interest (one they have previously shown a preference for, spent extended time playing with, or actively chosen from an array of toys), they employ a wider range of gestures to find out about the object and they play with the object for longer. So, for instance, a child who has shown an interest in toy vehicles is much more likely to spend time examining a new toy truck or trying to race it in new ways than he is to pick up an unfamiliar toy gardening tool. Renninger's (1992) research shows that for individual children, some objects invite more exploration than others. Interest often goes hand in hand with curiosity.

The precise interaction between novelty on the one hand and interest (which may depend on some familiarity) on the other in arousing curiosity is not yet fully understood. Because a child might become curious when confronted with something perplexing and novel but might also be curious when given a chance to explore something she already has encountered and liked, perhaps a modification of earlier definitions is called for. I would suggest that curiosity is simply *the urge to know more.*

Perhaps unsurprisingly, interest continues to be important throughout the developmental process. When elementary school–aged children read texts on topics in which they have a sustained interest, they learn more information, discern more details about the narrative form, and remember what they have learned for longer. In an intriguing amplification of this idea, Garner, Brown, Sanders, and Menke (1992) have shown that when children encounter what the authors call "seductive details," they learn much more from the text. These are details that are vivid and intriguing but that do not support the main idea the children are supposed to be learning. The current emphasis on using textbooks in schools rests on an often unarticulated assumption that simplifying and condensing material helps children learn information. However, the research by Garner et al. suggests that students learn better when texts are complicated, idiosyncratic, and have some style to them. These details seem to invite attention and probing—in other words, they make the readers eager

to know more. And a curious reader, it turns out, is a more skilled and thorough reader.

Inviting children to explore what interests them can help them learn science as well. Kuhn and Ho (1980) gave elementary school students a variety of liquids and asked them to figure out which liquids, when poured together, caused the mixture to bubble. They were particularly interested in the process by which the students discovered that manipulating one variable at a time is the best way to do a scientific experiment. Their findings, which have been supported by more recent studies (Cook, Goodman, & Schulz, 2011; Wirkala & Kuhn, 2011), have shown that children learn this principle well when they are given a chance to follow their own hunches, try things out, and make mistakes. In other words, when curiosity rather than a script guides their actions, children not only stay interested but also develop an understanding of the scientific method.

But natural science is not the only subject taught in school in which children benefit from uncertainty. Lowry and Johnson (1981) explored a similar concept in the realm of social studies. They put fourth-grade students into small groups and asked them to spend one week studying strip mining and another week focusing on whether wolves should be designated an endangered species. Half of these groups were encouraged simply to learn facts about the material together and help one another. The other groups were presented with the same material but were encouraged to focus on unresolved controversy and their own differences of opinion surrounding the material. At the end of the work period, those children who had focused on controversy had learned the material much more thoroughly. Moreover, they were much more likely to forgo a subsequent recess to see a supplementary film on the topic.

The evidence is quite clear: when children are curious, they learn. It turns out that curiosity in school is not merely a nicety but a necessity. So, where does it come from?

The need to know itches certain people more than others, and it may be that the most curious become scientists, doctors, or journalists. But *all* children, when they are young, are eager to learn more about the unfamiliar. Anybody who has ever watched toddlers has seen the way in which they tirelessly explore the physical world around them. They put things in their mouths, open lids, peer inside spaces, take things apart, and put things together. Many of their gestures seem aimed at gaining information about the physical world around them. A closer look reveals just how powerful and formative these explorations are in shaping a child's early acquisition of knowledge.

Babies: Born Curious

As far back as Darwin, child observers have noted that children watch, imitate, and tinker in order to understand how things work. The most influential of these child observers was Piaget (1969), who was among the first to closely doc-

ument the tireless efforts of babies and toddlers trying to make sense of what they see and hear. He showed that these seemingly casual and fleeting gestures contributed to a child's intellectual development. He revolutionized the way we think about children by demonstrating that a child's actions with objects lead to increasingly sophisticated ways of thinking. For instance, he famously argued that children are neither taught nor born with the understanding that number is an abstract property; rather, they discover it. In one classic example, he described a child who, playing with collection of small stones, realized that no matter how he arranged them (straight line, circle, or scattered), the number of stones remained unchanged. Through the child's own impulse to examine the stones and test out different possibilities with them, he learned a crucial principle of abstract thinking: the conservation of number.

Piaget (1969) placed particular emphasis on the ways in which a child expands her intellectual repertoire when she encounters something that contradicts what she already thinks she knows about the world. For instance, imagine a toddler dropping a ball on the ground and watching the ball bounce back up a few inches. She might try this seven times and watch with interest, taking pleasure in the outcome she quickly expects. Then imagine that the eighth time she drops the ball, it unexpectedly bounces much higher, hitting the ceiling. This kind of surprise, stemming from something a child does not expect, is the germ that, according to Piaget, propels intellectual development. In other words, children gain knowledge when their curiosity is piqued.

Gopnik, Meltzoff, and Kuhl (2000) published *The Scientist in the Crib: What Early Learning Tells Us About the Mind,* which argues that, from infancy on, children are testing their theories about how things work by "collecting data"—trying out different actions on the world and watching to see what happens. The authors describe the way in which two-year-olds seem to deliberately test the reaction of adults around them. While folk wisdom and many grandmothers say this is just naughtiness, developmental psychologists view everyday life as the child's laboratory. When you tell a child she must not touch the glass vase, she immediately wants to know what will happen if she does. In this case, the experiment is aimed at understanding two aspects of the world—the physical (what actually will happen to the glass when you touch it) and the social (what will that particular adult do when his rules are violated). And this brings us to a crucial idea: children's curiosity unfolds within a social context. Not only are they curious about people; their curiosity is influenced by those around them.

Toddlers: Safe Havens and Expeditions

Salter Ainsworth and Bell (1970) set out to show, empirically, that Bowlby (1969) was correct in arguing that children require a close, sustained relationship with a caregiver in order to thrive and grow. In order to do this, they put a one-year-old in a room with his or her mother, some toys, and, in

some cases, another person. At some point, the mother left the room. The researchers noted the toddler's reaction to this separation. Then the mother returned. What happened next was the essential piece of the attachment puzzle: What would the child do when the mother returned? Would she break out in relieved smiles and rush into her mother's arms for reassurance and comfort? Would she seem disinterested and aloof? And perhaps most importantly, after reuniting, would the child then go back to exploring and playing with the toys in the room?

It turned out that those with a "secure" attachment joyfully greeted their mothers and then happily returned to exploring their physical environment. Those with a more troubled attachment (termed insecure, anxious, or ambivalent) happily greeted their mothers and then turned to the toys in the room—however, they had trouble focusing on their own exploration, distracted by fear that their mothers might leave again or upset with them for having left. The implication of this work is clear: the quality of a child's attachment has a powerful influence on the vigor and depth of her exploration of the world around her. Insecure children are less likely to make physical and psychological expeditions to gather information. These data are typically used to show how important secure attachment is. Less attention has been paid to an equally important conclusion: human relationships are a key ingredient in the child's ability to investigate the physical environment. Indeed, a series of experiments has shown that children with secure attachments do in fact exhibit more curiosity as they get older (Saxe & Stollock, 1971).

In many instances, we think of children becoming more independent of the adults around them as they grow older. They learn to walk and can get places on their own. They learn to talk and can communicate with people who don't know them well. They become more able to function without the security of a loved one nearby. And yet, in the case of curiosity, adults only become more important as children develop. When it comes to finding out about the world around them, toddlers acquire a particularly potent way of using their parents. They ask them questions.

As anyone who has lived with toddlers knows, once they have learned the enormous power of *wh* questions, their question asking can seem incessant. They ask about what the day will bring, why things happen a certain way, what objects are made of, what the objects can do, what will happen under various circumstances, ad infinitum. They use *why*, *when*, and *what* much as a mountain climber uses a pick—to gain a foothold on the vast world of knowledge they are so eager to grasp and master. Observers of young children have learned a great deal about development by cataloging those questions.

When psycholinguist William Labov and his wife Teresa had a fifth child, Jessie, they decided to record everything she said during the first few years of her life. That project produced an unusually detailed and comprehensive corpus of data (Labov & Labov, 1978). The Labovs were particularly interested in using Jessie's language record to learn more about how children acquire

syntax. One form that intrigued him was the question form. As a side benefit, he accidentally provided us with a wonderful picture of question asking. On one day, when Jessie was just over three, Labov counted 115 *wh* questions among Jessie's verbalizations. That day was not unusual—in general, she asked an enormous number of questions of all kinds. For example, her questions included: "Where the boy?" "What's this?" "Why Mommy put up curtains?" "Why you pick Macaroni?" "Why you drink milk?" (Labov & Labov, 1978). By isolating her *wh* questions and looking at them as a group, one can quickly see that she is using them almost doggedly to get a purchase on the social and physical complexities that surround her.

As children get older, they yearn to understand what lies beyond the apparent; they want to know about what they can see in front of them but also what they cannot see. This is where parents are particularly useful. In the early 1980s, British psychologists Tizard and Hughes (1984) undertook a study of three-year-old girls at home and at school. To do so, they equipped thirty children with tape recorders and recorded all of their conversations for two and a half hours at home and for five hours at school. They found that the girls asked an average of twenty-six questions per hour when they were home with their mothers. One child asked 145 questions during a home observation period. Though parents and children talked about all kinds of things, many of them quite practical (what the child was allowed and not allowed to do, what the tasks of the day were, and so forth), one of the most common forms of conversation involved discussing things children didn't understand. More than 60 percent of the girls' questions to their parents were phrased so as to acquire new information or to learn more about something. They called these discussions "episodes of cognitive search" to capture the way in which such exchanges allowed children to expand their intellectual horizons. Take the following conversation between a child aged three years and ten months and her mother, excerpted from Tizard and Hughes's (1984) data:

Child: Is our roof a sloping roof?

Mother: Mmm. We've got two sloping roofs, and they sort of meet in the middle.

Child: Why have we?

Mother: Oh, it's just the way our house is built. Most people have sloping roofs, so that the rain can run off them. Otherwise, if you have a flat roof, the rain would sit in the middle of the roof and make a big puddle, and then it would start coming through.

Child: Our school has a flat roof, you know.

Mother: Yes it does actually, doesn't it?

Child: And the rain sits there and goes through?

Mother: Well, it doesn't go through. It's probably built with drains so that the water runs away. You have big blocks of flats with rather flat sort of roofs. But houses that were built at the time this house was built usually had sloping roofs.

Child: Does Lara have a sloping roof? (Lara is Beth's friend).

Mother: Mmm. Lara's house is very like ours. In countries where they have a lot of snow, they have even more sloping roofs. So that when they've got a lot of snow, the snow can just fall off.

Child: Whereas, if you have a flat roof, what would it do? Would it just have a drain?

Mother: No, then it would sit on the roof and when it melted it would make a big puddle." (p. 124)

As the authors point out, this child, not yet four years old, is using the conversation to think through a complex and abstract topic. Tizard and Hughes (1984) comment, "Beth pursues it with a penetrating, remorseless logic" (p. 125). While not all children are as bright as Beth, or as eager to think something through so fully, having conversations as a way to pursue knowledge is common.

More recently, Chouinard (2007) observed children talking at home with their mothers. The children in her study asked an average of seventy-six information-seeking questions per hour. She found that the children asked two types of questions: those that sought facts about the world and those that sought explanations. Before age two and a half, the children in her sample most often asked their parents for factual information; but as they got older, more and more of their questions sought explanations that went beyond straightforward information. "Question-asking," she concluded, "is not something that happens every now and then—asking questions is a central part of what it means to be a child" (p. 25).

Harris (in press) has pointed out that children are not timid investigators either. They know the difference between a question that is answered and one that is not, and they persevere. By the time children are two and a half, more than half of their questions to adults are part of a sequence, often involving follow-up questions to an initial question. Often they press for more information, push back when a parent doesn't really address their question, or puzzle over some piece of the answer that doesn't quite make sense to them. Harris has shown that children seem to have a very sharp sense of what they wanted to know and whether the answer given to them closes that epistemic gap. Clearly, children don't simply ask questions to pass the time of day or to gain adult attention. Their perseverance is one sign that they really want to know the answer. Does this tenacity follow them to school?

Childhood: From Intrepid Explorer to Well-Behaved Scholar

Based on the above research, it seems reasonable to assume that the kinds of question asking and data gathering so common to toddlers and preschoolers are even more useful once children begin formal learning, where, in theory, the acquisition of knowledge and intellectual skill take center stage. But while

curiosity, the engine of intellectual development, is possibly the most valuable asset a child brings to her education, is there a place for curiosity in school?

A systematic look at children's opportunities to express curiosity in school suggests that rather than waxing once formal education begins, curiosity wanes. When Tizard and Hughes (1984) followed their young subjects to preschool, they found that children's questions dropped from an average twenty-six per hour to an average of two per hour. It is possible that the drop in children's questions is merely a temporary dip. Perhaps when children first get to school, other dynamics take precedence—children learn to work in groups, to follow instructions and enact routines, and to respond to the demands of adults who are not their parents. It's conceivable that question asking resurfaces as children move farther into their school years and begin focusing on the acquisition of information. If so, we would see question asking and inquiry return to greater frequency once children got past preschool. Some years ago, I had a chance to see if this was the case.

In 2006, I set out to get a detailed picture of children's curiosity at school (Engel, 2009). I was particularly interested in what *kinds* of curiosity children express. My Williams College students and I observed kindergarten and fifth-grade classrooms over a period of three months, making five two-hour visits to each classroom and videotaping children at different times of the day while they engaged in a variety of activities. When we began our study, we wanted to examine individual differences between children (assuming that some would be very curious while others would not). We were also interested in seeing whether specific places or activities in a classroom elicited more or less curiosity—for instance, the block corner and the work table or math and geography. Finally, we were interested in comparing classrooms to one another; one might be a beehive of question asking and exploration, while in another we might hear few questions and see little exploration. It turned out to be impossible to make the kinds of comparisons we wanted. Why? Because there was such an astonishingly low rate of curiosity in any of the classrooms we visited. We counted the number of "curiosity episodes" that occurred in each session of each classroom we visited. This included any time a child asked a question in order to learn more about people, places, events, or ideas or any time they tinkered with an object, opened something up to look at it, or used other gestures to learn more about something. In the kindergarten classrooms, there were anywhere from two to five episodes of curiosity in any given two-hour stretch of time. In the fifth grade, the absence of curiosity was even more dramatic, with typically zero to two episodes per visit. In other words, among roughly twenty-two children, curiosity was visibly expressed, on average, less than once in each two-hour period. This means that many children are spending hours a day in school without asking even one question or engaging in one sequence of behavior aimed at finding out something new.[2]

Looking at these transcripts, we were astonished by the lack of curiosity expressed, particularly because the classrooms we observed were not over-

crowded or underfunded, a typical explanation for a constricted classroom environment. The teachers were, by and large, kind, and the tenor of the rooms was friendly. So what is going on? Why is it that young children seem to be brimming with just the kind of curiosity that drives learning, yet older children, who might benefit so much from the same kind of curiosity, seem to express so little in formal learning settings? What might account for the difference between the kind of exploration and question asking noted in toddlerhood and preschool and the stunning lack of such inquiry in school-aged children? What happens during childhood to prune away so much spontaneous investigation and eagerness for new information? The answer lies in part, once again, with the adults.

Invitations and Prohibitions

By the time children go to school, their impulse to explore and inquire is subject to subtle cues from adults about what is appropriate. Henderson and Moore (1980) examined the effect of adults on children's exploration of objects in a classroom setting. First, they asked parents and teachers to rate children's inquisitiveness as high, medium, or low. Then they assigned each child to one of three conditions. In the independent condition, the adult experimenter responded to questions only by reflecting them back at the student or briefly answering them if they were repeated. Otherwise, they did not interact. In the active interest condition, the experimenter was extremely attentive and encouraged the student's behavior with smiles, eye contact, and occasional interjections. In the focusing condition, the experimenter encouraged exploration actively by pointing out novel features, asking leading questions, and positively reinforcing exploration. Both of the latter supportive conditions resulted in significantly more exploratory behavior than the independent condition, though they did not differ meaningfully from each other. This effect was strongest for the students whose parents and teachers identified them as having low levels of inquisitiveness. In other words, the less curious you seem in general, the more your expression of curiosity is influenced by the adults around you.

In another study, Moore and Bulbulian (1976) asked three- and four-year-olds to arrange a miniature farm set. A female experimenter sat nearby and either behaved in a friendly and approving way (smiling and making encouraging comments) or behaved in an aloof and critical way. The children were then asked to feel seven toys that they couldn't see (hidden by a curtain) and guess what the toys were. Children in the friendly, approving condition were quicker to begin exploring, engaged in more blind manipulations, and were more likely to guess the identity of the hidden object at the end of the session. In contrast, children in the aloof, critical condition showed significantly less task-related curiosity and exploratory behavior, an effect that was particularly pronounced among girls. This study shows that one adult can influence a sin-

gle child's expression of curiosity. But what effect might a teacher have on a whole classroom of children?

To find out, my student Hilary Hackmann and I built a curiosity box based on one used by Henderson and Moore (1980). The box had eighteen little drawers on it, and in each drawer was a small novel object. We placed the box in kindergarten and third-grade classrooms and watched to see who came up to it, how many drawers each child opened, and how long the child spent examining the objects inside the drawers. We found that the older children were, on the whole, just as curious as the younger children (Hackmann & Engel, 2002). Just as many third graders came up to the box, opened the drawers, and examined the objects as did kindergarteners. However, not all classrooms invited the same levels of curiosity. In some rooms, many children approached the box, and did so quickly, taking their time to examine several objects. In other rooms, regardless of grade, few children investigated the box. This suggests that the classroom environment is as important an ingredient in a child's curiosity as his or her age. But what is it in a classroom that serves to encourage or discourage investigation? We found that there was a direct link between how much the teacher smiled and talked in an encouraging manner and the level of curiosity the children in the room expressed (Hackmann & Engel, 2002).

Smiling and encouraging children to explore are just two ways a teacher might influence children's curiosity. In what other ways do teachers affect children's tendency to inquire? What about the teacher's own curiosity? Might that not also shape a child's inquiry?

In order to answer that question, my student Madelyn Labella and I designed a study in which eight- and nine-year-olds were brought into a lab, one at a time, to do a science activity (Engel & Labella, 2011). When the child came into the room, materials were set out on a table, and a worksheet lay nearby. Madelyn explained that she and the child were going to do a fun and interesting activity and then fill out the worksheet that went with it. Madelyn modeled her behavior on the prototype of a friendly, knowledgeable, and warm science teacher. As the child embarked on the activity, Madelyn explained various concepts, gave gentle guidance, and made friendly conversation. The activity, called Bouncing Raisins, required the child to mix baking soda, vinegar, and water and then drop raisins into the mixture. In this mixture, little bubbles form on the raisin and the raisin eventually rises to the surface. As the activity unfolded, Madelyn directed the child's attention to the instructions on the worksheet and helped him or her fill out the questions at the bottom of the sheet, making the format of the session closely comparable to a common school science activity.

As they neared the end of the activity, Madelyn did one of two things. For half the children, she said something like, "You know what? I wonder what would happen if we dropped one of these (picking up a Skittle from the table) in the liquid instead of a raisin?" With the other half of the children, instead

of picking up a Skittle and dropping it in, she simply cleaned the work area up a little, commenting as she did it, "I'm just going to tidy up a bit. I'll put these materials over here." In other words, some of the children saw the adult/teacher show interest in exploring further and deviating from the script, while others did not. Then Madelyn left the room, claiming that she had to get some materials for the next activity and that she would be back in a few moments. As she left, she said, "Feel free to do whatever you want while you are waiting for me. You can use the materials more, or draw with these crayons, or just wait. Whatever you want to do is fine." Then she walked out. The camera, which had been on for the whole time, remained on so that we could watch to see what the children did when left alone. Children who had seen Madelyn deviate from the task to satisfy her own curiosity were much more likely to play with the materials, dropping raisins, Skittles, and other items into the liquid, stirring it, and adding other ingredients. Children who instead had seen her tidy up tended to do nothing at all while they waited. We take these data to suggest that the teacher's own behavior has a powerful effect on a child's disposition to explore (Engel & Labella, 2011).

Given the clear power of teachers to encourage (or discourage) investigation, why don't they place more emphasis on it? The answer is neither obvious nor simple.

What Gets in the Way

When teachers fail to promote curiosity, or actively discourage it, they do not do so because of mean-spiritedness or ineptitude. Far from it. Kind and skilled teachers often unwittingly and subtly push inquiry aside. The root of this tendency lies in two traditionally opposed schools of thought.

In an effort to meet current state and federal standards, many public schools are consumed with training children rather than educating them (plenty of independent schools also focus on the rigid acquisition of information and rote skills, often under pressure from parents). Young students spend their days identifying letters, reciting written words, answering specific kinds of questions, and enacting routines. Older children spend their days practicing specific academic formulae, rehearsing information, and learning how to follow written instructions. Teachers feel compelled to make sure children learn what is included on standardized tests. Many of them feel that there isn't time enough in the day to allow children to get off task; following their interest or probing a tangent is a luxury they cannot afford.

My observations in kindergarten, first-, and fifth-grade classrooms provided evidence of this (Engel, 2006). Most of the time teachers had very specific objectives for each stretch of time, and they put a great deal of effort into keeping children on task and reaching those objectives. In the fifth grade, for example, these goals included mastering specific math skills, learning about particular events in history, and learning how to use various forms of grammar

in writing. Mastery rather than inquiry seemed to be the dominant goal for almost all of the classrooms observed. In fact, it often seemed that finishing specific tasks was more salient than actually learning the material. When children asked questions to seek nonsocial information, it was rare for a teacher to pursue the topic. It was not unusual to hear a child express interest in something and for the teacher to ignore the interest or explain that it was off-topic.

For instance, the following exchange occurred during a science class in one of the fifth-grade groups.

> *Child:* I've been a little curious this class. What is that [pointing to some words on the board]? I can't understand it.
>
> *Teacher:* Umm, that was for another class [returns attention to the material she has been focusing on].

Teachers feel they should emphasize routines, follow scripts, and make sure children master preset academic goals, especially in the early grades, and in classrooms that teach students whose families have low incomes (Engel, 2009). The push toward testable mastery of concrete information and skills may buttress an underlying implicit idea about children: that they will only learn what they are taught, that they will not learn if they are not offered an extrinsic reward (or threatened with punishment), and that they are best off learning what adults decide they should learn.

But the view I have just described is not the only educational approach that underemphasizes curiosity. Even models of education that are widely regarded as progressive rest on implicit beliefs about the nature of development that, paradoxically, also deemphasize the role of others in the child's intellectual growth.

Paul Harris has spent the past ten years examining the ways in which young children learn from what others say about the world around them. In particular, he has focused on the conditions under which children accept what adults say about things they cannot directly assess for themselves—germs, God, and oxygen, to name three vivid examples. He points out that there is a strong tradition of viewing children's explorations of the world solely in terms of what they can learn from direct interactions with objects, places, and events (Harris, in press). This view dates back to Rousseau (2003), who urged society to allow children the freedom to explore the world around them and to grow up free from adult constraint. Implicit in Rousseau's argument is the idea that adult customs and ideas interfere in some way with the "natural" growth of the child's mind. This idea is given a scientific base in Piaget's (1969) work on child development, which emphasized the child's spontaneous discovery of basic laws of nature by playing on his or her own with everyday objects. Maria Montessori (1964) also pushed the idea that children would learn what they needed to if given time with the "right" materials.

Although many who base their classroom practices on Montessori and Piaget value discovery, they underplay the role of adults in that discovery. In many Montessori schools, the student's day is conceived of as a series of playful encounters with objects designed to lead the child toward important intellectual discoveries (e.g., pattern detection, cause and effect, or numerical operations). In fact, some of the best Montessori schools are notable for their quietness. When a visitor wanders into a classroom, children are busily working on their own, manipulating blocks, taking apart puzzles, and playing various games with a range of materials. What they are not doing is talking—with one another or with adults. While there are wonderful opportunities for many kinds of learning in this setting, the children miss out on the unique opportunities afforded by asking questions and discussing answers. As I described earlier, talking about what interests or perplexes children gives them a chance to cultivate and expand their curiosity as an intellectual tool.

Perhaps due to the two perspectives above, teachers rarely treat curiosity as a top educational priority. When we gave public school teachers from a school district in suburban Massachusetts a list of twenty-five qualities and asked them to circle the five they most wanted to nurture in their students, over 75 percent circled "curiosity" (Hackmann & Engel, 2002). Yet, when we asked teachers to *come up* with the five qualities they most wanted to encourage in their students, few said "curiosity." Teachers may passively endorse curiosity—who would say they didn't want children to be curious?—however, they don't seem to think of it as something they need to actively encourage, nurture, or guide.

Even when curiosity is valued, it may be a fragile goal. My student Kellie Randall and I were interested in how teachers respond when children deviate from a task to learn more about the materials. To do this, we invited teachers to participate in a study that we described as an attempt to find out more about how children learn (Engel & Randall, 2009). Each teacher came to our lab and was told we'd be videotaping them helping a nine-year-old student complete a science activity—the same Bouncing Raisins experiment described above. We explained the activity, showed them the materials, and gave them a sheet that included instructions as well as a series of questions about what they observed. Then we introduced them to the child they'd be working with and left the room.

However, not all of the teachers heard the exact same instructions. Half of the teachers were told, "Please help this student learn more about science." As the experimenter left the lab, she said to the teacher and child, "Have fun learning about science!" The other half of the teachers were told, "Please help this student fill out the worksheet." To this group, the experimenter said, "Having fun doing the worksheet!" All other parts of the instructions and activity were identical in both conditions.

Unbeknownst to the teachers, the child was not an actual subject in the study but our confederate, trained to respond in a particular way. Halfway through the activity, the child picked up a candy, rather than one of the rai-

sins, and dropped it into the liquid. If the teacher asked the child what she was doing, the student was trained to reply, "I just wanted to see what would happen." We were particularly interested in what happened next. We wanted to see what the teacher would do when the child strayed from the task. We also wanted to see if the orientation the teacher was given toward the activity might affect his or her reaction. The results were striking. Teachers whose attention had been drawn to "learning about science" responded with interest and encouragement to the child's deviation, saying things like, "Oh, what's that you're doing?" or "That's great. Maybe you should also try putting one of these in" or "How interesting. What's it doing?" But those teachers who had been subtly encouraged to focus on completing the worksheet said things like, "Oh wait a minute. That's not on the instructions" or "No, that doesn't go in the liquid." It seems that teachers are very susceptible to external influences; their understanding of the goal of teaching directly affects how they respond when children spontaneously investigate (Engel & Randall, 2009).

The Craft of Curiosity

From Piaget (1969) to Gopnik, Meltzoff, and Kuhl (2000), we see overwhelming evidence that children are naturally curious. But what specifically are they curious about? Though my own research has revealed such a paucity of expressed curiosity in classrooms, the data have provided us with intriguing clues about the topics that elicit children's curiosity and the ways in which curiosity unfolds when it is expressed. Just as the children in the studies of Tizard and Hughes (1984) and Chouinard (2007) asked questions about things that went beyond the ordinary, the practical, and the obvious, students in our research also seem drawn to the invisible and the exotic. In our studies and observations, we found that children's curiosity is often sparked by the introduction of intangible concepts, like why some people do not believe in God. But what especially piques their curiosity are abstract ideas and unfamiliar places. And children often find objects or topics in the world around them as starting points for further exploration. Children might express curiosity about places and ideas they encounter in visual form. For instance, one kindergarten student we observed asked why there was a letter A next to the names of some of the children on an attendance sheet on the wall, which led to a discussion of what it means to be "absent." In another kindergarten class, a teacher was reading a story about plants. The child pointed with his finger to an illustration saying, "Are venus flytraps really alive? Do they really catch?"

The children we observed were also very interested in their teachers. Many elementary school–aged children participated in extended discussions that began when a teacher said something about his or her personal life, such as describing an event recalled from childhood. Based on what we have seen in early childhood, these conversational germs are worth pursuing. They can lead to the exchange of valuable intellectual material, encourage children to

pursue their curiosity, and provide teachers with information that can guide the planning of curriculum.

What Curiosity Is Not

Because classrooms often have twenty or more students, teachers need to acquire a set of skills that build on, but differ from, the ones that seem to come so naturally to many parents. The teaching of question asking and answering among school-aged children is not as intuitive as one might think. It is all too easy to mistake active hands-on learning for learning that cultivates curiosity.

For example, in one kindergarten classroom that we observed, a teacher walked into the room holding a clear plastic bag that held water, algae, and a fish. Several children were immediately interested in the bag and its contents. One of the children said, "I know what that is. That's an allergy in there." A little while later, the teacher gathered the whole group to sit on a rug near the aquarium while she stood in front of them holding the clear bag.

Teacher: What do you think is in here? What is this stuff?"

Child 1: I know what it is. I know. It's a, it's a—it's a allergy.

Teacher: It's an algae eater. Not an all*ergy* eater but an *algae* eater. Who knows what algae is?

Child 1: It's like stuff that get on there [pointing to the glass walls of the aquarium].

Teacher: Yup. Now is that dirt? What is it?

Child 2: Some people do have allergies.

Teacher: That's true.

Child 1: Like allergies on a fish tank.

Teacher: Some people do. That's true. What—what's in? What is this stuff? What actually is it?

Child 1: Allergies.

Teacher: It's algae yes, but iiis iiit [drawn out as if to elicit a guess] . . . dirt?

Six children together: No!

Teacher: Iisss iiit—what is it?

Child 3: It's like sand.

Teacher: Same idea, but it's something else. Hmm. Is it an animal?

All children: No!

Teacher: No. Is it alive?

Four children: No.

Child 1: Yeah!

Teacher: Yup, it's plants. It's teeny teeny teeny tiny plants. And this kind of fish is a vegetarian. It's an herbivore. And it eats—now why haven't these [pointing to fish already in the fish tank], our two Oscars, the two big fish, why haven't they been eating it?

Child 1: Because they don't like it.

Teacher: They're a different kind of eater. What kind are they?

Child 1: Meat eater.

Teacher: Which is a . . . ?

Child 4: Plant eater.

Child 1: Carnivore!

Teacher: Which is a carnivore? We have carnivores . . .

The group gets interrupted when the teacher tends to a child's runny nose. When they return to the discussion, they talk about some other fish in bags, which the teacher has brought in.

Child 1: Are they called *Oscarosaurs?*

[The teacher continues with what she is saying.]

Child 1: But can there be a Oscarosaur? Can there be Algiosaurs?

[The teacher does not hear this or doesn't respond to it, and the group continues identifying the other fish she has brought in.]

In this example, the teacher brought in materials that immediately captured the children's interest and attention. She used a kind of kindergarten version of the Socratic method to engage them. Her questions seemed to be a mechanism for getting the children to articulate or guess at the information she wanted them to learn. In several places in this exchange, when her question didn't elicit the right answer, she asked a follow-up question that helped narrow down the children's field of guesses. Such fine-tuning in the teacher's questions resembles the kind of scaffolding described by Rogoff (2003). The original question seemed to be beyond the child's reach. The teacher provided a narrower question in order to make it more likely that the child would guess the correct answer. In the initial passage, the teacher asked ten questions, but not one question was posed by a child. Later, after the runny nose, one child did ask a question, wanting to know something about the connections between dinosaurs and the fish and algae they were viewing, but his question was not addressed.

This example illustrates an important but easily overlooked distinction between children's engagement and children's curiosity. A teacher can be talking about things that captivate the students, and the students can be deeply interested in a topic and quite engaged in a discussion or activity. But that doesn't mean the children are asking questions or having a chance to pursue

those questions. In the example above, the children were clearly interested in the bag and its contents. The children attended to the teacher's questions and tried their best to answer most of them. Yet there is no overt evidence that the children were forming their own questions or were engaged in any visible behavior (linguistic or otherwise) aimed at finding answers to those questions.

Curiosity doesn't thrive merely because it's tolerated or allowed now and then. It must be encouraged, facilitated, and guided. Children use adults as a powerful source of information to answer their questions and satisfy their curiosity. But the role of adults goes beyond this. Adults can help children expand and refine their questions. They need to invite and encourage children to pursue their curiosity. They also need to help children become more systematic and probing in their investigations and explorations. This represents a shift in the way we see the traditional role of a teacher, from one who answers questions to one who elicits them.

Conclusion

When Mrs. Parker chided those fifth-graders for experimenting during science class, she missed a golden opportunity. Instead of stopping them, she might have asked them what it was they wanted to know about the various pieces of equipment. One of the most valuable functions a teacher can serve is to help children become more aware of, and deliberate about, their own curiosity. This doesn't mean that teachers need to let children's every question and random moment of tinkering derail the lesson plan. But they can plan significant portions of the curriculum around the goal of helping children figure out just what it is they want to know and then showing them how to go about getting the answers to their questions. For example, at a suburban, K–8 school where I supervised curriculum and teaching for a long time, instead of hiring a science teacher we hired a young science major who was planning to get a doctorate in earth science. We asked that she use the children as her science apprentices for her own research. We also asked that she spend significant parts of each week helping her students figure out what they wanted to know about the natural world. With her guidance, they collected data to answer their questions. Key to the experience was that it provided the children with the opportunity to learn how to satisfy their curiosity with sustained and thoughtful efforts. It also gave them repeated chances to decide when their data had answered their question and when it had not. By working side by side with someone engaged in her own research, the students had a powerful model of genuine curiosity at work. As I showed earlier, this kind of modeling is crucial in encouraging children to follow through on their own hunches and questions in a deliberate and fruitful manner.

Though scientists have yet to devise a widely accepted measure of curiosity, there are already simple ways for teachers to get a sense of whether curiosity

is flourishing in their classrooms. At the same K–8 school, teachers regularly scheduled time for conversations with small groups of children. Teachers kept journals of these conversations and then discussed them in faculty meetings so that they could share techniques for helping children develop their questions and satisfy their curiosity. Reviewing their exchanges showed the teachers when curiosity was being encouraged and when it was not. Similarly, videotaping various activities and times of the day and then counting episodes of curiosity (as described earlier in this paper) may also provide a valuable metric of curiosity in classrooms. This analysis is essential given the research that supports how curiosity is fostered in a social context and needs to be cultivated through interactions with adults.

If we are to teach children to expand on their intrinsic curiosity and make it a centerpiece of educational achievement, we will need to change the way we prepare teachers as well. In order to cultivate children's curiosity, teacher preparation might emphasize techniques for guiding investigation and scaffolding conversations. Teachers also need to learn how important it is to create time in the day for children to explore. But just as importantly, in graduate school, teachers need the time and encouragement to feel curious themselves and the chance to see what it's like to follow the answer to a question, wherever it may lead them. Developing their own capacity to be curious and to act on that curiosity is one of the most substantive and useful skills teachers can acquire.

These are just a few of the ways curiosity can become the center of a classroom. But in order to help children become eager and skilled at acting on their curiosity, those who determine our curriculum and educational priorities will have to make room for this emphasis. Preparing for standardized tests, mastering predetermined sets of skills and facts, and moving at a preset pace take away from the types of curiosity-driven learning that are well documented to be critical in science and essential in every discipline.

Children often have a good sense of what they need to know if they are given a chance to be interested in the people, objects, and events around them; complexity, unexpectedness, and uncertainty draw them in and lead them on. Teachers can provide chances for this and then guide them in trying to satisfy their curiosity. If teachers are to promote curiosity, administrators and policy makers will need to emphasize its value. We need to imagine schools as places where curiosity not only survives but flourishes. If curiosity is understood as essential, no less so than solving a geometry problem or writing a good essay, we might see very different classrooms and very different graduates.

Notes

1. This teacher's name is a pseudonym.
2. It's worth noting here that most researchers have looked at the expression of curiosity (in questions and behaviors) rather than trying to capture the internal experience of curiosity. It can be argued that when children don't express their curiosity in questions

and exploratory behaviors, they have no way of getting encouragement, input, or guidance from others. So, in some sense, curiosity unexpressed remains curiosity undeveloped. However, ultimately, researchers will want to know about not only the kinds of curiosity children express but those that remain internal.

References

Bowlby, J. (1969). *Attachment and loss.* (Vol. 1). New York: Basic Books.

Chouinard, M. M. (2007). Children's questions: A mechanism for cognitive development [Monograph]. *Society for Research in Child Development, 27*(1), vii–ix, 1–126.

Cook, C., Goodman, N. D., & Schulz, L. E. (2011). When science starts: Spontaneous experiments in preschoolers' exploratory play. *Cognition, 3,* 341–349. doi:10.1016/j.cognition.2011.03.003

Engel, S. (2006). Open Pandora's Box: Curiosity in the Classroom, Occasional Paper, Child Development Institute, Sarah Lawrence College, Bronxville, NY.

Engel,S. (2009). Is Curiosity Vanishing? *Journal of the American Academy of Child & Adolescent Psychiatry, 48*(8), 777–779.

Engel, S., & Labella, M. (2011). *Encouraging exploration: The effects of teaching behavior on student expressions of curiosity.* Manuscript submitted for publication.

Engel, S. & Randall, K. (2009). How teachers respond to children's inquiry. *American Educational Research Journal, 46*(1), 183–202.

Garner, R., Brown, R., Sanders, S., & Menke, D. J. (1992). "Seductive details" and learning from text. In K. A. Renninger, S. Hidi, and A. Krapp (Eds.), *The role of interest in learning and development* (pp. 239–254). Hillsdale, NJ: Lawrence Erlbaum.

Gopnik, A., Meltzoff, A. N., & Kuhl, P. K. (2000). *The scientist in the crib: What early learning tells us about the mind.* New York: Harper Perennial.

Hackmann, H., & Engel, S. (2002). *Curiosity in context: The classroom environment examined.* Unpublished honors thesis, Williams College.

Harris, P. H. (in press). *The cautious disciple: How children learn from others.* Cambridge, MA: Harvard University Press.

Henderson, B. B., & Moore, S. G. (1980). Children's responses to objects differing in novelty in relation to level of curiosity and adult behavior. *Child Development, 51*(2), 457–465.

Kagan, J. (1972). Motives and development. *Journal of Personality and Social Psychology, 22*(1), 51–66. doi: 10.1037/h0032356

Kuhn, D., & Ho, V. (1980). Self-directed activity and cognitive development. *Journal of Applied Developmental Psychology, 1*(2), 119–133.

Labov, W., & Labov, T. (1978). Learning the syntax of questions. In R. N. Campbell & P. T. Smith (Eds.), *Recent advances in the psychology of language* (pp. 1–44). New York: Plenum Press.

Lowry, N., & Johnson, D. W. (1981). Effects of controversy on epistemic curiosity: Achievement and attitudes. *Journal of Social Psychology, 115*(1), 31–43.

Montessori, M. (1964). *The Montessori Method.* New York: Schocken Books.

Moore, S. G., & Bulbulian, K. N. (1976). The effects of contrasting styles of adult-child interaction on children's curiosity. *Developmental Psychology, 12*(2), 171–172. doi: 10.1037/0012-1649.12.2.171

Piaget, J. (1969). *The psychology of intelligence.* New York: Littlefield, Adams.

Renninger, K. A. (1992). Individual interest and development: Implications for theory and practice. In K. A. Renninger, S. Hidi, & A. Krapp (Eds.), *The role of interest in learning and development* (pp. 361–396). Hillsdale, NJ: Lawrence Erlbaum.

Rogoff, B. (2003). *The cultural nature of human development.* New York: Oxford University Press.

Rousseau, J. J. (2003). *Émile: Or treatise on education* (W. H. Payne, Trans.). Amherst, NY: Prometheus Books. Originally published 1782.

Salter Ainsworth, M. D., & Bell, S. M. (1970). Attachment, exploration, and separation: Illustrated by the behavior of one-year-olds in a strange situation. *Child Development, 41*(1), 49–67.

Saxe, R. M., & Stollak, G. E. (1971). Curiosity and the parent-child relationship. *Child Development, 42*(1–2), 373–384.

Tizard, B., & Hughes, M. (1984). *Young children learning*. Cambridge, MA: Harvard University Press.

Wirkala, C., & Kuhn D. (2011). *Problem-based learning in K–12 education: Is it effective and how does it achieve its effects?* Manuscript submitted for publication.