At the age of 4, Jacob announced to his teacher, “When I grow up, I’m going to be a oceanographer or . . . a squid . . . ‘cause they’re scary and they squirt black ink at everyone! Then I can squirt black ink at you, but you can’t squirt black ink at me!”

Although becoming either an oceanographer or a squid seemed noble goals, his Early Childhood Accelerated Program (ECAP*R) teacher, Mrs. Valerie Weeks, began to wonder what would happen if science was presented to young, potentially gifted children in a developmentally appropriate way. The ECAP*R program (Gould, Thorpe, & Weeks, 2001), located in Wichita, KS, is affiliated with Rainbows United, Inc., a not-for-profit agency serving children from 0 to 5 years with a wide range of abilities and needs. The ECAP*R program serves potentially gifted children who are 3 to 5 years old and has provided an important niche for children whose parents are unable to find challenging, but developmentally appropriate preschool programs for them. Jacob was one of those students. He had been asked to leave two different preschool settings due to behavioral problems such as bickering, fighting, and shoving other children.

At the same time, Jacob showed several indicators of early giftedness (Davis & Rimm, 1998; Piirto, 1999). For example, he knew many varied facts about the ocean and the creatures that live in it. He could complete fairly complex math problems in his head. He read at the fourth-grade level. Jacob’s last teacher suggested to his mother that he might have Attention-Deficit Hyperactivity Disorder (ADHD). Soon after, he was evaluated and accepted into the ECAP*R program, where he was introduced to a curriculum that was sensitive to his level of development and his need for mental stimulation. Jacob’s behavioral problems didn’t disappear; he still had difficulty with interpersonal relationships. However, his behavioral problems moderated, and it became clear that he was simply an active little boy who needed the right kind of mental stimulation. Jacob’s behavioral problems didn’t disappear; he still had difficulty with interpersonal relationships. However, his behavioral problems moderated, and it became clear that he was simply an active little boy who needed the right kind of mental stimulation. Without the types of experiences that a program like ECAP*R provides to meet Jacob’s developmental and intellectual needs, he could possibly remain “at risk” for school and social failure. He is not alone.

Jacob’s future career aspirations became the impetus for “Science Starts Early,” which was developed by Valerie Weeks, ECAP*R program coordinator, teacher, and cofounder, in collaboration with Sarah Evans, assistant professor of biology at Friends University in Wichita, KS. The intent was to expose young, potentially gifted children to basic scientific principles that would allow them to explore the world around them. Active learning and experimentation became two foundational elements of the program. Developmentally appropriate critical thinking that leads to incisive questioning became the third.

Attitudes Toward Science

In her work at Friends University, Dr. Evans teaches two groups of adult learners. The first group of students is composed of non-science majors. At the beginning of each semester, Dr. Evans informally interviews each member of the class. She asks two questions: “What kind of science background do you have?” and “What are your future goals?” Over the last several years, a consistent majority of the students indicated that they had negative experiences in science classes as far back as elementary
school. These same students usually added that they are taking science now because it is a requirement and they find science difficult and boring. As for their future plans, they wish to become accountants, managers, Web designers, or members of another profession not related to science. Of more concern was the frequently verbalized idea that they couldn't pursue a profession because it might require a science background. They saw themselves as incapable.

The second group of students is composed of biology and chemistry majors. Dr. Evans also conducts an informal interview with each of these students at the beginning of the semester and asks the same questions, but receives far different responses. These students consistently answer that they have had positive experiences with science that got them interested in becoming researchers, physicians, environmental scientists, naturalists, and even zoo keepers. The prevailing negative feeling toward science does not seem to be present with this group of students.

What is the cause of the attitudinal differences these two groups have toward the study of science? Over the past decade, research related to this area has focused on adolescent girls and, to a lesser extent, all students and two school subjects some students avoid: science and mathematics. Relevant literature was distilled in the 1992 report conducted by the American Association of University Women entitled How Schools Shortchange Girls: A Study of Major Findings on Girls and Education. This report found that there may be a complex interaction of social reasons that explain why some students don't pursue the study of science; these include lack of confidence, relevance of science, differences in play experiences, stereotypes about who takes science, and lack of support for persisting in the study of scientific areas. The report concluded, in general, student's interest in and enthusiasm for math and science decline the longer they are in school . . . most students who dislike science say science is "not interesting." Adolescent girls are more likely than adolescent boys to find science uninteresting. Adolescent boys are more likely than girls to discount the importance of science itself. (p. 30)

However, other reasons may also be factors. The way science has traditionally been taught in schools, especially in secondary schools, may be unappealing to some students. A competitive classroom atmosphere involving informational lectures followed by paper-pencil tests may not create personal investment in the subject. A lack of personal investment may then lead some students, especially girls, to find science boring (Baker & Leary, 1995; Joyce & Farenga, 2000; Rop, 1997; Schweigardt, Worrell, & Hale, 2001).

The ramifications of not pursuing science at early ages may alter a student's career path in unexpected ways. A student who opts out of science in middle school may later find that there isn't time in his or her school schedule to take all the science needed for admission to selective college programs. The lack of an appropriate science background may result in not being admitted to a medical major or the loss of the opportunity to become an anthropologist or a paleontologist.

The children admitted to the ECAP*R program have advanced abilities and may be representative of those who will impact the scientific future of this country. Because of their potential, another goal of Science Starts Early is to plant a seed of inquiry among very young children—especially girls—that will hopefully continue throughout their lifetimes.

Curricular Design

Science curricula for children in the early learning stages, although rare, are available. One program developed specifically for preschool children by Lucia French of the University of Rochester is entitled ScienceStart! (Jacobson, 2002). It is based on the assumption that children are instinctively curious and interested in how things work. Wanting to understand the ways things work and curiosity about the surrounding world are important qualities for participating in the process of scientific inquiry.

Science Starts Early takes advantage of this natural curiosity, which may be more pronounced in potentially gifted children.

The Science Starts Early Curriculum

To create the Science Starts Early curriculum, Mrs. Weeks and Dr. Evans decided on the curriculum together by selecting scientific concepts to be studied. Science textbooks designed for older elementary children through the fifth grade served as important references in the selection process. The other concepts selected for study came from questions verbalized by the children. For example, one day, Lauren demanded, "Mrs. Weeks, tell us about the black holes in space. I want to know all about black holes in space." That interchange led to a multiweek unit studying the planets and the universe.

In this school/university partnership, Mrs. Weeks lays the foundation and Dr. Evans provides hands-on science experiences. Two to three times each week, Mrs. Weeks prepares the children by teaching the vocabulary needed to discuss a scientific concept. After teaching the appropriate vocabulary, she then begins to expose the children to a scien-
Hypotезize and Experiment

Approximately once every 2 weeks, Dr. Evans visits the classroom and involves the children in an experiment. Recently, they studied "Things That Sink and Things That Float." After a demonstration, children found an object in the room from the many they play with during the day (although the classroom gerbil was placed off limits). Once the objects were selected, the children came together in a circle to hypothesize about their items and conduct the experiment (see Table 1).

Dr. Evans asked the children to hypothesize whether the item would sink or float. With Jacob's intense interest in oceanography, he was particularly good at this, so he helped the other children—whether they wanted him to or not. During each session, the experimental process continued with other topics. To date, the children have studied chemical reactions, solubility, microbes, invertebrates, density, paper chromatography, and volcanoes. Still to come are magnetism, friction, and properties of light.

For the study of invertebrates, Dr. Evans brought in a microscope with a monitor so everyone could look at a sample of pond water at the same time. Maggie, age 5, found this particularly interesting. She insisted that she be allowed to come up to the front of the room and point out all the creatures moving around so that no one else would miss seeing them. She particularly liked it when an organism was eating or digesting its food, and she wanted to give the organism part of her lunch. Steven, 3 years old, was fascinated by the process of viewing the invertebrates, but became upset when he realized that what he was viewing through the microscope wasn't a video because he had wanted to take the video home to show the whole family.

Invention Convention

Each year, the young scientists share their new knowledge with other children and invited guests at an Invention Convention. Each young scientist creates an invention and prepares it for an exhibit. Once the young scientist develops an idea, the parents help him or her prepare the invention and take pictures of each step during the process. The pictures are then attached to a poster board forming an exhibit. The parent helps the child write an explanation of each step as the invention is created. The explanations are attached to the poster board. Two days before the convention, the posters are set up and children from the surrounding area are invited to view the Invention Convention. Professors and students from a nearby university judge the exhibits at the convention. During the actual convention, the young scientists explain their inventions to anyone who stops at their poster exhibit.

In past years, the young scientists have invented some clever, useful things. One young boy created a cane for his grandmother that had double use. After having her hip replaced, his grandmother needed support to walk. The young inventor simplified her convalescence by attaching a pillbox to the bottom of her cane. Now his grandmother no longer has to carry around extra bottles of pills and, more importantly, she won't be able to forget them. One young girl added a bell to the family's entry door for the family cat to ring. The cat no longer needs to claw at the door, but can announce its presence by ringing the bell with its paw—a very dignified solution to a common problem. Another young boy created something guaranteed to make his father's life much easier: He invented a Plexiglas cover to protect the pages of a book from water so his father could read while in the shower.

At the end of the convention, all the young scientists receive prizes awarded by the judges. The young scientists experience explaining their inventions to the judges and receive feedback about them. The feedback is positive and encourages the young scientists to keep inventing.

Final Thoughts

Through the 2 years Science Starts Early has been part of ECAP*R, Mrs. Weeks has found that the children understand and relate to science concepts much better than she anticipated at the beginning of the program. She said, "I'm always surprised at how much information they retain and how well they seem to understand science concepts. The depth of their understanding continually surprises me." Their level of understanding was made clear to her during the study of black holes brought about by Lauren's question. The children learned that some scientists think the sun is expected to burn out in approximately 5,000 years. Mrs. Weeks didn't think the children had any concept of a 5,000-year time frame. However, when one child appeared worried about the possibility that the sun might burn out and what would happen to him and his pet frog, several other children replied that 5,000 years was "a long, long time away, so don't worry about it." The problem was solved.

Science Starts Early has proven to be a winning program at ECAP*R and has generated a great deal of interest among the children. After spending several months hypothesizing and experimenting, Jacob is more certain than ever that he wants to be a form of sea life, most likely a squid—just as long as he is the scariest. Maggie still wants to see microbes eating their lunch. Steven hopefully all the science projects are made into a video. Mrs. Weeks and Dr. Evans hope they have helped the children form a lasting interest in science. The children in the ECAP*R program are all in agreement: Science that starts early is fun.
Table 1
Sample Experiment: Things That Sink and Things That Float

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Discuss the concept to be the subject of today’s experiment. Discuss why an object might sink or float.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration 1</td>
<td>Show the students a round piece of modeling clay. Ask the students to hypothesize what will happen when it is placed in a beaker of water. Place a round piece of modeling clay into a beaker of water. Observe as the clay sinks to the bottom of the beaker. Discuss why the clay sank.</td>
</tr>
<tr>
<td>Demonstration 2</td>
<td>Take same piece of modeling clay and shape it into a saucer. Ask the students to hypothesize whether it will sink or float. Place the clay in the water. Observe as the clay floats on the water. Discuss the difference in shape between the ball and the saucer. Discuss the concept of an air pocket and creation of hollow space. Discuss weight, shape, and other characteristics of the clay that caused it to float.</td>
</tr>
<tr>
<td>Demonstration 3</td>
<td>Using the same clay shape as in Demonstration #2, ask the students to hypothesize what will happen when the clay saucer, now floating, is filled with water. Fill the clay saucer with water. Observe as the clay sinks to the bottom of the beaker. Discuss why this happened. Discuss the characteristics of the clay that caused it to sink and the differences between the saucer being filled with air or filled with water. Discuss why the clay sank and the characteristics of the clay that caused it to sink.</td>
</tr>
<tr>
<td>Experiment</td>
<td>Have the students choose an object from the classroom. Student shows the class the chosen object. Discuss the characteristics of the object that might determine if it sinks or floats (shape, weight, materials that it is made of). Hypothesize whether the object will float or sink in water. Student places object in water. Class makes observations. Discuss the observations, whether the hypothesis was correct, and why. Each student has a chance to show their chosen object to the class and put it in water to see if their hypothesis was correct. Have the students complete the experiment with the items they have chosen.</td>
</tr>
</tbody>
</table>

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