SCIENCEQUEST:
AN INCLUSIVE INFORMAL SCIENCE EDUCATION PROGRAM

INTRODUCTION

Inquiry-based science education lends itself to a variety of inclusive practices (Haskell, 2000; Fernandez, Green, Parker, & Phelen, 2000). For example, students explore topics that interest them, are actively engaged in kinesthetic and multi-sensory activities, and work cooperatively in small groups (McLaughlin, 2005; Stainback & Stainback, 1996). Findings are beginning to emerge to indicate that practices such as these promote the development of science concepts in students with disabilities (Scruggs & Mastropieri, 1994; DiGisi, 2000).

The purpose of this article is to describe the inclusive practices embedded in ScienceQuest, an inquiry-based, informal science education program. Education Development Center, Inc. (EDC) designed, implemented, and tested ScienceQuest with funding from the National Science Foundation (NSF) from 2000-2005. The goals of the program are to help young adolescents (ages 10-14) to develop science concepts by participating in inquiry-based science explorations, work productively as part of collaborative teams, and develop technology skills related to website design. The program has been implemented in community technology centers, community-based organizations (e.g., Boys and Girls Clubs, YMCAs), and school-based programs. Adult, volunteer coaches work with small teams of 3-5 young adolescents which meet weekly over approximately 12 weeks to explore a science topic of their choosing (e.g., astronomy, animal life, and volcanoes). They follow an I-Search curriculum which guides teams to work together collaboratively to acquire and apply inquiry-based skills to develop science knowledge. The culmination of the team's exploration is the design and launching of a website to share with others what they have learned.

Including Students with Disabilities

Participants in ScienceQuest were mostly minority students, living in low-income, urban areas. Demographic data indicate that these populations are likely to have a greater percentage of youth with disabilities than the general population (Coutinho, Oswald, & Best 2002). Therefore, we have assumed, even in the absence of self-disclosure statements, that our participants included students with disabilities.

Additional evidence comes from astute observations by the coaches. For example, Caitlin, a coach in Boston, describes one of her students, Mike, which mirrors the behavior of children with learning disabilities and/or ADHD (APA 2000).

> One of my team members, Mike, was very enthusiastic about ScienceQuest, but had trouble working with the team. He was easily distracted, and felt a need to be the center of attention at all times. He would talk at length whenever the opportunity presented itself, even if he didn't have a clear thought to share. He also had problems with word choice, and often seemed to be unable to find the right word for a simple concept. If a task didn't interest him, he'd leave the group to wander around the science lab. Or, he might grab lab equipment (in spite of our strict "no touching the equipment without permission" policy) and wave it around to get attention or make a joke; in the past I had to keep him from piling junk onto a 3-beam balance or gesturing wildly with the pointy end of a compass. (CITE—What should we do? Put the date of the interview? Who knows it?)

Caitlin's description is echoed by similar examples from other coaches who report that their students had difficulties in organizing information, reading directions for experiments, taking notes, following directions, and maintaining their focus. Yet as we describe below, Mike, and other students with similar profiles in cities across the country, were able to successfully carry out the inquiry process and learn science concepts. The major reason was that the I-Search curriculum, which forms the centerpiece of ScienceQuest, embeds a host of inclusive practices.

INCLUSIVE PRACTICES IN THE I-SEARCH

Ken Macrorie first introduced the term "I-Search" to capture the kind of self-motivated and self-directed search for information that excites learners (Macrorie, 1988). From 1989-1991, with federal funding from the U.S. Department of Education, Office of Special Education Programs, EDC incorporated a modified version of Macrorie's I-Search into an interdisciplinary curriculum unit for students in the middle grades. The goal was to promote the inclusion of students with disabilities in general education classrooms while seeking to build students' inquiry skills (Zorfass & Copel, 1998). With the help of EDC, teachers across the country successfully implemented I-Search units (Zorfass, 1992; 1996).

Going beyond the formal educational settings, EDC next adapted the I-Search to the informal educational environment for the ScienceQuest program (Zorfass & Dorsen, 2001). Five inclusive practices characterize the I-Search curriculum used in ScienceQuest:

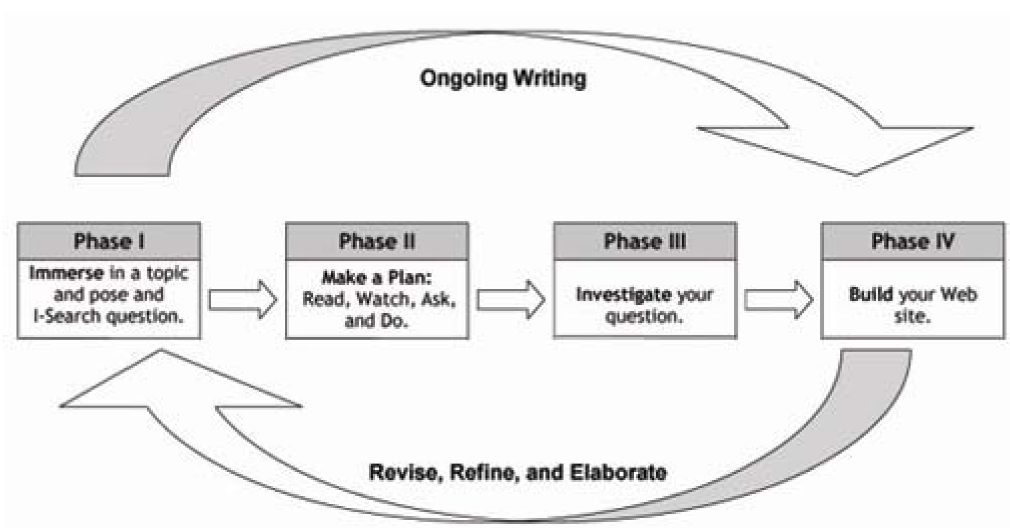
- Students are guided through four phases of the inquiry process.
- Students are motivated to explore questions of their choosing.
- Students explore topics and gather information through varied media and experiences.
- Students have multiple means for processing and expressing information.
- Students use technology tools.

These practices also adhere to the principles of differentiated instruction (Tomlinson, 1999) and Universal Design for Learning (Rose & Meyer, 2002). Below, we describe how these inclusive practices come alive in ScienceQuest.

Students are Guided through Four Phases of the Inquiry Process

Research indicates that students with disabilities, "at-risk" and "struggling" students, and second language learners benefit from clear direction about *how* to proceed and *what* the expectations are (Delpit, 1996). Responsive to this need, the I-Search process gently guides students through four distinct phases of exploration, as shown in Figure 1.

Figure 1: Phases of the I-Search Process



Each of the four steps of the I-Search has its own goal and set of activities.

- Phase 1, Immersion: The coach helps the ScienceQuest team explore varied topics by doing experiments, going on trips, talking to experts, and surfing the Internet. The goal is for teams to discover a search topic or question they feel passionate about.
- Phase 2, Making a Plan: The coach helps the team to decide how they will gather information by reading, watching, asking and doing. The goal is to plan to use a variety of information sources and activities, from field trips to experiments, from adult experts to Internet sites.
- Phase 3, Gathering and Integrating Information: The team uses their search plan as a guide, but remains open to discovering new avenues of exploration. The goal is to make sense of and form concepts about their science topic.
- Phase 4, Sharing Knowledge: The coach helps the team design a website that describes the learning process and recounts the team's discoveries.

While the steps of the I-Search are concrete enough to be helpful, they also leave plenty of room for maneuverability, an important element of informal education. As teams carry out the four phases of inquiry, detours and back-tracking are expected. For example, once a team starts to gather information they may decide to revise their question as some other topic becomes more intriguing. While students are developing their website, they may find the need to return to the information gathering mode to fill in emerging gaps. The I-Search is a merely supportive structure that ensures students have a roadmap for inquiry

Students are Motivated to Explore Questions of their Choosing

Motivation plays a key role in learning, especially for young adolescents who struggle to learn. Guthrie and Davis (2003) advise educators to create opportunities for intrinsic motivation—the desire to learn for its own sake—by giving young adolescents a chance to become engaged and make choices about learning. Promoting student motivation is a defining characteristic of the I-Search. In Macrorie's words, a quest for knowledge is like "an itch that needs to be scratched" (Macrorie, 1988, page—need to look back at my book to find the page; see Chapter 1 or 2) The itch is the intrinsic motivation, the desire to explore a topic because the learner wants to know.

After carrying out varied immersion activities in Phase 1, everyone on a ScienceQuest team should be "itching." It is during this time that coaches help students to appreciate that science is "all around them." If they engage in a cooking activity, then they are doing chemistry. If they peruse sports magazines, then they have opened the door to exploring physics. If they conduct a survey of physical traits inherited from parents, then they are dipping into biology. In designing immersion activities, coaches consider students' expressed interests and learning styles, the school's curriculum, available resources, and their own backgrounds. The goal is for teams to become genuinely excited about a topic and pose a question to sustain a search for relevant information. For example, one team's shared passion for paintball became the eventual basis for an I-Search about gas-powered projectiles, which delved into physics concepts.

Students Explore Topics and Gather Information through Varied Media and Experiences

Once students become hooked on a topic or question, the remaining phases of the I-Search process guide them to gather information through varied media and experiences. Four simple verbs capture a host of strategies for a productive search: *read, watch, ask*, and *do.* Students can read books, articles, text contained on Internet sites, posters, and magazines. They can watch videos, slides, TV shows, and Web-based or CD-ROM simulations. They can ask questions of experts and survey individuals either in person or online, conduct interviews, send emails, or write letters. "Doing" has limitless possibilities, including carrying out experiments, building models or prototypes, and going on field trips to zoos, hospitals, museums, and farms. For one student who used a wheelchair due to a neuromuscular disorder, "doing" included such activities as building a papier-mâché model of a planet with the assistance of another student.

Encouraging students to read, watch, ask and do guarantees that students with diverse abilities and needs will be able to pursue activities that align with their own learning styles. Those that rely on auditory information may prefer to hear a talk from a zoo guide. Those that need visual stimuli may appreciate the images of animals on a website. Tactile learners may engage best when holding a sea star, feeling cornstarch harden in a mixture or building a papier-mâché model of the sun. At one site the highly active nature of young adolescent boys was channeled into ball-throwing activities that demonstrated Newton's laws of motion.

Through these varied activities, the strengths that each team member brings can contribute to the success of the group. In Caitlin's group, Mike, mentioned above, was drawn more towards independent computer-based learning than group interaction. On one occasion, while the rest of the team brainstormed ideas to make a better balloon car after their original experiment failed, Mike wandered over to the bank of computers. He began doing a Google image search for “balloon car,” turning up a number of photos of different styles of cars, all of them radically different from their failed model. Noticing what he had found out of the corner of her eye, Caitlin called over the rest of the team so Mike could share the results of his search. Group conversation, technology mediated experiences, images and opportunities to compare designs all contributed to Mike’s success with the group.

<u>Students Have Multiple Means of Processing and Expressing Information</u>

In Phase 3 of the I-Search, students not only gather information, but also integrate it to build understanding. To be fully inclusive, the I-Search recommends that the coaches use selected research-based instructional strategies, all of which are easily integrated into an informal learning program. These include scaffolding instruction, using journals, and graphic organizers, among others.

“Scaffolding” is a term used to describe the kind of help educators give students to guide their learning and develop more powerful thinking tools for managing the learning tasks. In scaffolding, teachers use dialogue with students to support and clarify their thinking (Hogan & Pressley, 1998). Caitlin used scaffolding to help Mike carry out an experiment when he became distracted while building a rocket with his team. Caitlin noticed that he had constructed his rocket upside down—with the fins on the top, away from the engines. Below is an excerpt from their interaction that illustrates how she helped to ensure his engagement with the activity.

> Caitlin: Mike, your place for the fuel is down here. Do you want the fins at the top?
>
> Second Adult: Where was the picture of the rocket? Here, the fins they had are at the bottom.
>
> Caitlin: …why don’t you try rebuilding that? Remember, we’ve got plenty of stuff if you decide you want to do a new design or try again.
>
> Mike attempts to reattach his fins to the bottom.
>
> Mike: I need some help to do this thing.

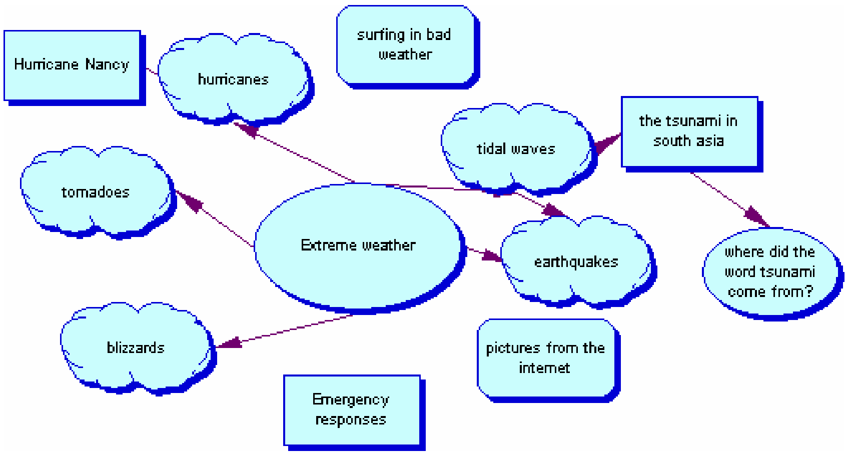
+

Caitlin: Sure, I'll help you, Mike. Not a problem…you want me to tape that down for you?

Having students keep a science journal is a recommended strategy for inquiry projects, capturing both the process and what was learned (Dahl & Franzen, 1997; Yorks, 1996). A journal combines the concept of a diary, with its focus on self-discovery, and the class notebook, which concentrates on what students are learning. These kinds of journals have a place in informal learning in either print or electronic versions. As teams engage in activities, they document what they did and what they learned. In one instance, to support students who were reluctant to read and write, one coach served as keyboard scribe, taking dictation from the team and keeping their ideas organized in a Microsoft Word document. Another team used journals that had prompting questions for note taking. In it, one team member wrote about the "walk-about" from earlier that day: "I learned more about nature. That cats are small animals. Why can cats fit in smal places? I wont to learn about it." Picking up on the growing enthusiasm spearheaded an exploration on animals so the coach engaged the team in other activities related to the cat family, particularly large cats. The coach recalled, "As we casually talked about how lions and domestic cats are related, this one student had tons of questions, and her questions sparked more conversation with the other team members." These aspects of the process were well documented among the journals kept by both the youth and the coach.

Another effective strategy for learning supported by recent research is using paper or computer graphic organizers (IARE, 2003; Gordon, 2002). Some teams have used a web drawing on newsprint to show how they would gather information by reading, watching, asking, and doing. Others have used creative graphic organizers to record and make links across different pieces of information they were gathering. Graphic organizers also helped some teams to plan their multi-page Websites (see Figure 2).

Figure 2: Example of a Graphic Organizer



Students Use Technology Tools

There is a growing literature about the value of using low-, mid-, and high-tech tools to support the inclusion of students with disabilities (Woodward & Reith, 1997). From the beginning, EDC highlighted the use of technology within the I-Search as a way to improve success for students with disabilities in inclusive settings (Zorfass, 1994). Low-tech tools can include sticky notes, highlighter pens, and raised-line paper. Some ScienceQuest teams used sticky notes to record ideas and then rearranged them on newsprint into an ordered web of meaning. Mid-level tech tools include tape recorders, video cameras, digital cameras, and portable keyboards, such as AlphaSmarts™. Many of these tools were perfect for recording information on field trips and during interviews. High tech software tools are computer-based. Some teams found *Inspiration*™ to be helpful. Others sought programs where text could be read aloud to students, or where students could be guided to write outlines (e.g., *Draft:Builder*).

The high-tech tool of the computer is the prime vehicle for sharing information in ScienceQuest where each team builds a website as a culminating activity. There are directions and tools for Web design and production on the ScienceQuest website (www.edc.org/sciencequest). While ScienceQuest has certain expectations for the sites (text combined with graphics, navigation buttons, content that identifies the question/topic and findings, etc), originality is encouraged. For example, one bilingual team reasoned that if their website was presented in both English and Spanish, every team member's family would be able to read and appreciate the final product. Some teams relied heavily on graphics drawn from websites to enhance their text. Others used digital photos of their activities as a way to convey what they did and learned. Some groups documented only their team's discoveries, while others gave detailed instructions for replicating experiments.

It is also important to note that students who are traditionally marginalized and rarely have a chance to act as authorities or leaders at school can be particularly motivated by the opportunity to create a website that shares information for visitors, students and adults. The potential of their work being available all over the world, as well as to the important family and friends locally, through the Internet, provides both motivation and pride.

IMPACT OF INCLUSIVE PRACTICES ON STUDENTS

Did the I-Search process help students with disabilities learn science concepts? Case examples provide strong evidence. For example, a ScienceQuest team of sixth graders in Columbia, South Carolina explored plant life. CITE – url or other). During the course of Phase 3 the team carried out a number of motivating experiments that helped them understand plant life systems. In one experiment, which focused on the effects of light on plant growth, the team generated the following hypothesis: The plants in the dark will be smaller, lighter in color; and have fewer leaves. They placed one group of plants in a closet. Both groups were on the same watering schedule. Every week the team measured the height of the plants, counted how many leaves each plant had, and described the color of the plants to see how healthy they were. For the experiment which focused on determining the impact of fresh water vs. salt water, the team wanted to know if plants watered with saltwater would grow more slowly, not grow as big as the fresh water plants, or be darker than the freshwater ones. These and other activities included all students. Everyone could find a way to successfully participate, which is the crux of inclusion. One of the team members explained when we visited:

> I'm in the plant group, and today we are going to see if the dye that we put in the plants in…if the petals are going to change color or not. And we're also going to see if the plants in the dark and the plants in the light. . . if they grew or not, and if the plants with the salt water and the plain water grew or not. And we're gonna water plants today, and we're going to see if the celery changed colors, and we're gonna see if the bean I planted grew or not. One of the people in the group, she had said, "Why don't we keep track of what we're doing?" So we got construction paper and pen, and we write down what happens to

> the plants. . . We count the number of petals on the plants to see if the plants grew. [Do we need a date of a visit to be consistent with the other quote?]

Later, in Phase IV, her team summarized their understanding of the concepts they developed through their experiments on their website (http://www.geol.sc.edu/cbnelson/ScienceWeb/TeamWebsites/Spring2004/Plants/index.htm). In terms of water uptake, for example, they stated, "We learned that when a plant is cut from its roots it's still living, it also able to take up water. We learned that plants take up water from the bottom and move it up to the other parts of the plant."

ScienceQuest demonstrated that the dual challenges of integrating quality science activities in an after school setting to a group of diverse learners is not only possible, but can support all youth gain knowledge and enthusiasm for learning.

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