WHAT MIDDLE GRADE STUDENTS SAY ABOUT LEARNING SCIENCE WITH MULTIMEDIA

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Walk into Gail Sanderlin's[1] seventh grade science classroom and you won't find students sitting quietly at their desks. Instead, small groups of students are spread over the entire classroom, where strands of green crepe paper hang from the ceiling to simulate an underwater kelp forest. A group of three students stands at the teacher's desk, making faces while tasting an actual piece of kelp. A pair leans over microscopes set up on a countertop, peering at slides of kelp. A group of four fills a plastic jug with water, preparing to conduct an experiment to test which is stronger, a kelp blade or a leaf from a spider plant. Five students crowd around a table, flipping through books about animals who live in kelp forests. Two more sit at computers in the front of the classroom, searching the web to gather information for a project on what Ms. Sanderlin has called "kelp critters." The remaining students sit at desks around the room, writing in hand-made journals about their findings. Other days, students watch video of scientists working in a kelp forest. They participate in online simulations, for example, creating a marine reserve in a kelp forest while taking different stakeholders into account. Whether doing an experiment, collecting data, researching, reading, or writing, each student in Ms. Sanderlin's class is engaged in learning about kelp and kelp forests.

In Ms. Sanderlin's heterogenous science class, students are learning through hands-on activities and rich multiple media. This paper addresses what students in Ms. Sanderlin's class -- as well as students in eight other classes -- said about learning scientific content and concepts using a multimedia, inquiry-based science curriculum. . For our study, we

[1] A pseudonym. All names and identifying details have been masked to ensure participants' confidentiality and privacy.

selected schools and student populations that were diverse in terms of geographic location, socio-economic status, linguistic background, race, and ethnicity, including students who attended a school located on a Native American Indian reservation, those in an urban setting where most children live in homes where English is not spoken, those placed in self-contained special education classes, and those in schools with high poverty levels.

The JASON Multimedia Science Curriculum (JMSC) was developed in 1989 by the JASON Foundation for Education (www.jason.org), and is a multimedia, interdisciplinary, inquiry-based science curriculum that responds to the dual demands of teachers having to teach state standards while engaging students in scientific inquiry. The JMSC encourages interaction between students and real life science and scientists while teaching scientific content and concepts by selecting a unique research expedition site and topics each year, upon which a print curriculum, video, live satellite broadcasts, and a variety of online activities that include digital labs and electronic journals are based. In 2002, approximately 25,000 teachers and one million students, grades four through nine, utilized the *JASON XIV: From Shore to Sea* curriculum to explore the features of California's Channel Islands and study the Chumash people who once lived there.

In this curriculum students use computers to do online simulations known as digital labs, Internet research, and presentations. Through the curriculum, students are exposed to how scientific technologies (e.g., remote-operated vehicles, thermal imaging equipment, and satellite pictures) contribute to helping scientists answer research questions. They are also encouraged to understand the limits of any one technology and that multiple technologies might be needed to acquire more detailed information.

Theoretical Framework

Now more than ever, science educators are coming under mounting pressure to adhere to state science standards and frameworks, while being expected to create rich opportunities for students to explore scientific content and concepts, think critically, and use technology to facilitate project work (Yeh, 2001). At the same time, our nation's school children are becoming increasingly diverse in terms of race, ethnicity, culture and language. Ensuring that each and every student gains scientific knowledge, reaches high academic standards, and performs well on standardized tests is, therefore, no easy task. Indeed, it is a challenge that not only requires educators to examine their assumptions about teaching and learning (Kahn, 2003; Lee, 2001), but also calls for a curriculum that supports educators in meeting students' varied needs in multiple and innovative ways.

One challenge for teachers and the educational systems that support them is how to create learning environments and experiences suitable for all students, including those who receive special education services, those labeled "at risk," those who come from diverse linguistic or cultural backgrounds, and those labeled gifted and talented. While reform documents acknowledge that the challenge is helping all students reach high standards, they do not explicitly address issues of how such reforms might need to be adapted for different student populations (August & Hakuta, 1997; Chèche Konnen Center at TERC, 1999; Garcia, Ku, Reyes, 2001). Moreover, while certain members of the research community have emphasized the need to make science education accessible to linguistically and culturally diverse students (e.g., Lee, 2001, 2003; Lee & Fradd, 1998), and students with special learning needs (Kahn 2003), little research about how to promote science learning and achievement for all types of students is available. As Lee (2003) noted, "Research is still at the stage of conceptualizing issues that need empirical testing" (p. 480); therefore, it is necessary that researchers continue to probe ways by which diverse student populations access, engage with, and learn academic content.

The JASON multimedia science curriculum is designed to help teachers construct learning experiences congruent with what Bransford and colleagues refer to as the four essential elements for learning environments: learner-centered, knowledge-centered, assessment-centered, and community-centered (Bransford, Brown, & Cocking, 2000 p. 133). Furthermore, the curriculum seeks to expose students to "real science". In other words, it aims to teach them that scientists from a variety of fields collaborate and that their work is complementary; that multiple sources of data are necessary; that generating questions and collecting evidence are important; that scientific inquiry takes place over time; and that the scientific process is not linear (C. Joyce, personal communication). This mirrors effective practices of such projects as the Chèche Konnen project (Rosebery et al., 1992, cited in Bransford et al.).

Moreover, the curriculum operates in an environment akin to what Pasnik and Keisch (2004) call a "rich media" environment, characteristics of which they define as:

1. Contain a combination of the following web-based technologies: streaming video and/or audio, interactive animation such as Flash, printed text and/or interactive text, photographs and/or diagrams.
2. Are designed with an implicit understanding and inclusion of a cognitive framework. Various multimedia resources support this framework, working together to effectively communicate the intended message.
3. Enable users (teachers and students) to take an active role in building their own narrative, becoming producers and makers of meaning as they choose their individual/relevant learning path through the website (p. 3).

Research Methods

The findings reported here come from a larger, multi-year evaluation research project that examined the impact of the JASON Project on students and teachers[2]. During the 2002-2003 school year[3] we selected teachers at nine different school sites, working in a total of 30 elementary and middle school classes located in various regions across the country. These classrooms contained over 600 students in grades 5 through 7 who were labeled as special needs, gifted and talented, and at-risk, as well as students in heterogeneous mainstream classrooms. Schools and student populations were also diverse in terms of geographic location, socio-economic status, linguistic background, race, and ethnicity. See the Appendix for a list of participating classrooms.

Believing that student voices are under-represented in the current research on science education and that students have something important to say about their own learning, we collected data from the students by two separate means. First, we conducted focus group and individual interviews with approximately 100 students, and then, we administered a

[2] See Ba, Admon, & Anderson, 2002; Ba, Goldenberg, 7 Anderson, 2002, available at www.edc.org/cct.
[3] See Goldenberg, Ba, Heinze & Hess, 2003, available at www.edc.org/cct.

more widespread survey and a science content assessment to over 500 students. Both the interviews and the survey focused on how students experience the JASON curriculum in particular, as well as their thoughts on learning science in general. The science content assessment was designed to assess students' understanding of the key scientific content, concepts, and technologies presented in the JASON curriculum: (a) devising research questions; (b) the role of measuring and monitoring; (c) content knowledge about kelp forests, pinnipeds, or plate tectonics; and (d) knowledge about scientific technologies (e.g., the remote-operated vehicle) and how they contribute to helping scientists answer research questions, as well asthe limits of any one technology, and the need to use multiple technologies to gain more detailed information. In addition, we observed students' classrooms, interviewed teachers, and asked teachers to complete a survey documenting how they used the curriculum and its varied aspects.

Through qualitative analysis of the student interview transcripts and observation notes, and a systematic coding of the student survey and student content assessment, we examined classes from each school as a group, taking into account the unique context and specific student population, so as to identify common themes across the different sites.

Results

Despite varying school contexts, different levels of curriculum implementation, and diverse student populations, we saw remarkable consistencies emerge across the multiple school sites, in terms of how student populations experienced the multimedia components of the curriculum and what that meant to their understanding of scientific content and concepts, as well as their perceptions of scientists and doing science. Throughout the interviews and on the surveys, students reported that they enjoyed watching the video or Live Broadcast, participating in online simulations known as "digital labs," doing independent research on the Internet, reading books, and communicating with other students online. More importantly, they said that using these multiple media helped them learn science.

Multimedia components provided access to material

Students appreciated the variety of experiences that the multimedia components of JMSC – the print curriculum, videos, Live Broadcast, digital labs, Internet research, and other online activities – afforded them. All of the participating schools in this year's evaluation utilized the multimedia components to some extent. All of the teachers who participated used the videos. In all but two of the schools, students attended the hour-long Live Broadcast, either in a primary interactive network location, such as a science museum, planetarium, or special auditorium in a regional education center or in their classrooms by watching a taped broadcast from the National Geographic channel or the JASON-produced post-broadcast video. A sixth grade student in a gifted and talented enrichment class noted, "Actually here we watch live expeditions on JASON too and that's a lot better than reading from a book about it. You actually see it happening, see what they're doing."

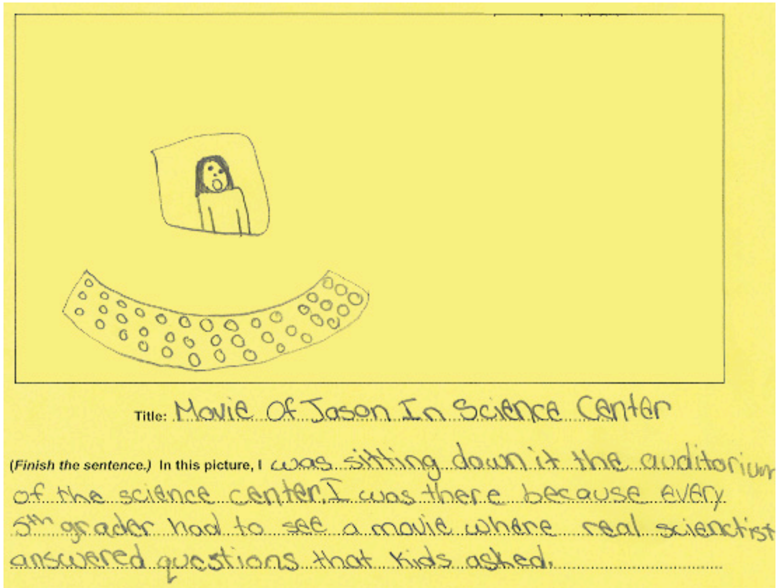
Also popular were the online activities provided through Team JASON Online (TJO). At eight of the nine sites, students engaged in online activities. In many classes, teachers encouraged students to use a presentation program, such as Powerpoint, to make their final JASON presentation or poster. Students in several classes also used the Internet to research their projects, either through links from TJO or their own Internet research.

Throughout the interviews and on the surveys, students reported that they enjoyed watching the video or Live Broadcast, participating in online simulations known as "digital labs," doing independent research on the Internet, reading books, and communicating with other students online. Close to twenty percent of the survey respondents drew a picture of themselves engaging in some kind of multimedia component of the curriculum; examples can be seen in Figure 1. Most of these illustrations revealed students doing research on the Internet or participating in digital labs.

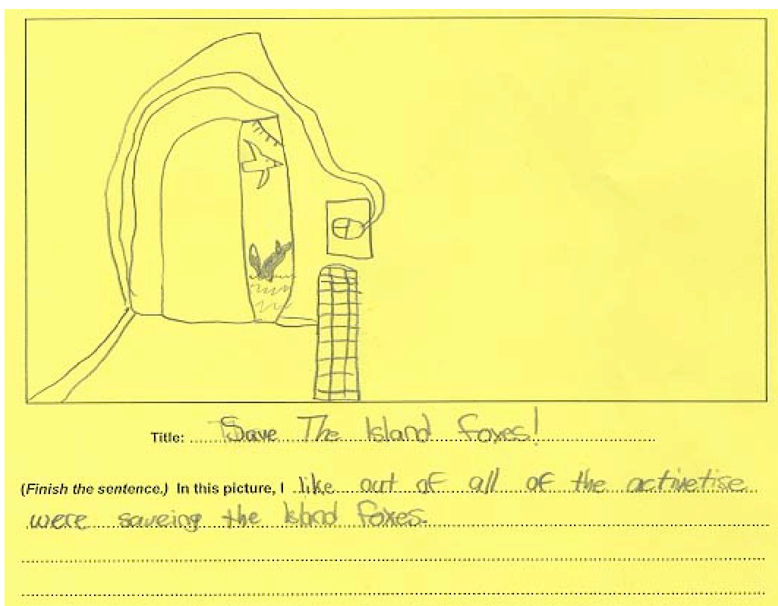
At one school, the teacher utilized all of the multimedia components to provide the sixth through eight grade students, all of whom are labeled special education, with multiple entry points into the subject matter. Due to disparate reading abilities of the students in her classroom, the teacher found that students struggle to learn the content if text is the only means by which the content is presented. The teacher in this classroom expressed her belief that technology provides a platform from which all of her students can better understand the material and better complete the tasks that they are asked to perform. By navigating through the project's web site, participating in the digital labs, watching the videos, researching on the Internet, reading in groups from text on the computer, writing collaboratively on the computer as well as writing in the JASON Journals, and listening to adapted versions of related novels read aloud, the students had more ways to access the content than they would have were they solely reading from textbook. In addition, because this teacher works in a self-contained special needs classroom where she is expected to teach all of the core academic subjects, she finds it challenging to conduct labs, experiments, and hands-on activities. The multimedia components of the curriculum, therefore, became all the more important for her students to be able to engage in science learning. In contrast, there was no computer use in the other special education classroom we visited. However, in that class, the teacher did use the videos and novels to teach some of the scientific content and concepts.

Video. Teachers indicated that video is an easy tool to use and can have a powerful influence on students. Access to television and video equipment was not an issue for the teachers in our sample. As will be shown below in the section on students and scientists, the prologue videos introduced them to the idea that scientists can represent a variety of ages, colors, shapes and sizes, and can work outside of the lab. In interviews, students described images that they vividly remembered from the JASON prologue videos

Figure 1: Multimedia activities



"Movie of Jason in Science Center:" I was sitting down in the auditorium of the science center. I was there because every 5th grader had to see a movie where real scientists answered questions that kids asked. [Grade 5, heterogeneous science class]



"Save The Island Foxes!:" I like out of all the activities saving the island foxes. (N.B. This is a TJO digital lab.) [Grade 5, urban school, heterogeneous science class]

Live Broadcast. At four of the nine sites, students attended the Live Broadcast at their local PIN site. At three of the sites, all students participating in the JASON Project attended the Live Broadcast as part of a culminating activity. Some students expressed that the JASON XIV Live Broadcast was memorable because it was a field trip outside of

the school, while some felt that it was a “boring” field trip. The Live Broadcast provided students with additional opportunities to view scientists and researchers, as well as the students and teachers who participated in the expeditions, doing scientific work.
The Live Broadcasts seem to be especially motivating for teachers. One long-time JASON teacher complimented JASON on improvements that they had made to the Live Broadcast. He also lauded his PIN site, saying, they “do a good job of getting kids involved” through assigning them jobs like assistant M.C.’s, computer technicians, and video technicians. However, he notes, “ kids still complain. They’re used to Disneyworld. Their expectations about production values outstrip the ability of the school to provide them.” Another long-time JASON using science teacher told us, “I enjoy the broadcasts but many of the kids do not. I’m not sure how to make them understand how neat that is.”

Computers. Teachers used computers in several ways in all the participating classrooms, save the one in the special education class mentioned above. The primary uses were: (1) online simulations known as digital labs (seven sites); (2) student journals (four sites); (3) Internet research relating to science curriculum topics (five sites); (4) presentations (three sites). Several teachers mentioned that they would have had students participate in message boards had they been functioning. Online chats – real-time conversations with authors and researchers – were not used; the scheduled chat times were cited as a major obstacle.

According to both teachers and students, computer use served a variety of functions. For example, for students in isolated environments like the Indian reservation, the JASON Project was a way to expose students to the world outside, and the Internet was an integral part of that strategy. With a stable Internet connection, students were able to do Internet research on their class animal. Said one of the teachers, “Next year, we hope to use the computers a lot more for assessments, chats, journaling and message boards.” At the school with a school-wide laptop program, several students reported using their laptop computers more with the JASON Project than they did with other curricula. One student explained one use, recounting, “We use [laptops] for research and the digital labs, like to track [the pinniped] migration route on the computer.”

Digital labs. The digital labs, which are in essence simulations, helped students understand complex science topics through combining visual aids, animations, and text with interactive exercises. However, our observations showed that not all digital labs are equal. "A Year in the Life of a Northern Elephant Seal," a simulation of satellite tracking technology that allowed students to observe migration patterns, "Navigating the Channel Islands," which had students pilot three boats from different eras across the channel, and "Save the Channel Island Foxes," where students made nature preserve management decisions with the goal of maintaining a viable endangered species population, did "explain things to [students] in a way they can understand," according to one of the teachers. A contrast was the lab on the Food Web, part of a generic Earth systems science resources, in which there was a low level of interactivity., Students who we observed at Brightway had a difficult time accessing information from the text on the screen or from the animation.

Electronic journals. Student electronic journals were another online activity used by students and teachers. Using the online journals, students typically write on a teacher-assigned topic, and submit it electronically to the teacher who can views them through the Teacher Center. Teachers can then respond to journal entries, and grade them if they wish. Teachers used the electronic journals used them in a similar manner to traditional paper journals: Teachers read over the journal entries and responded to them. Teachers reported that students enjoyed the journals, an assertion supported by evidence from student focus groups and interviews. A fifth grade teacher who had students write a paragraph two to three times during each unit noted:

> I'd be able to respond to [students] and I would *know* if they got the main idea. If I got a response like, 'I learned if you clicked this button, then this would happen.' No, that's not it. I wanted the deeper concepts. I wanted to know what they knew and remembered…. Their journals were awesome. When I could get into the journals, that was great. A blessing. I wouldn't even give quizzes.

Some teachers who used the electronic student journals expressed frustration about the technical difficulties and resulting freezes, and the curriculum's website. Even at the schools possessing the strongest infrastructures, teachers gave up on the message boards due to technical challenges, even though they had been popular in previous years. During some site visits, we even witnessed teachers on the phone with JASON's website staff, trying to figure out where the problems were.

Internet research. Teachers also had students do Internet research on a specified research topic. Generally, students started with the links provided at jason.org to help them find information on their topic. Some teachers also provided students with additional websites, such as ocean.com. One example is a project that Gail Sanderlin's students did called "kelp critters," in which each student researched and created a three dimensional model of a sea animal that lives in Channel Islands. One student chose a type of anemone called "light bulb turnicate" because, according to him, "It can zap stuff." Students explained that some of the animals they chose, such as the turnicate, were very specialized, and, so, they could not always find information on them in books. Students in a special education classroom enjoyed using the Internet to find information about the specific Channel Island that they had chosen to research, and appeared to have few difficulties navigating the sites pre-selected by the teacher or those they found through search engines like Google.

Presentations. Preparing a report and presentation on a topic related to JASON XIV was an activity conducted in nearly all the classes we visited. Several teachers gave students the option of using presentation software such as Powerpoint to organize their material, and many students took advantage of this option. Teachers in the two gifted and talented classes uploaded student presentations to class web pages.

Students' perceptions of scientists, doing science, and being scientists

Each year, the JMSC exposes students to scientists, researchers, and other experts working in the field through multimedia components such as the prologue video, Live Broadcast, and web site, as well as through activities in the print curriculum. Across all of the school sites, we found that students' images of what scientists look like and do were affected by their exposure to the curriculum. Moreover, students exhibited a curiosity about the Channel Islands scientists, their work, and personal aspects of their lives. We also found that through exposure to the curriculum, students were able to imagine themselves as scientists.

Images of scientists. When students described their images of a typical scientist and a JASON scientist, they contrasted the two. In the interviews, when asked to picture a typical scientist, students described men or women wearing a white lab coat and working in a laboratory with microscopes and test tubes and chemicals. When asked to picture a JASON scientist, students described men and women wearing shorts and t-shirts who work outside. Some students said that they had pictured scientists as old, but the JASON scientists as young, or as one student said, "all ages." In interviews, the majority of students said that before participating in the project they perceived scientists as "freaky," "old," and "weird with wacky hair," wearing "white robes with pens in the pocket," "big glasses" or "goggles," and "mixing chemicals." Through the videos, live satellite broadcasts, curricular activities, and novels, students said they learned that scientist "work outdoors," "out of the lab," "get dirty," and "wear regular clothes." A student in a gifted and talented class expressed this shift in perception, saying:

> Before the JASON Project, I pictured a guy in a white lab coat. Now, I know what it [a scientist] is a little bit better. Before the project, I didn't know that there were guys out of the lab."

Another student in the same class commented:

> I was just telling [my teacher] this a few minutes ago. Before this, I thought scientists were in white coats in labs with their clipboards writing down like b squared equals c squared. I found out that scientist can be really cool.

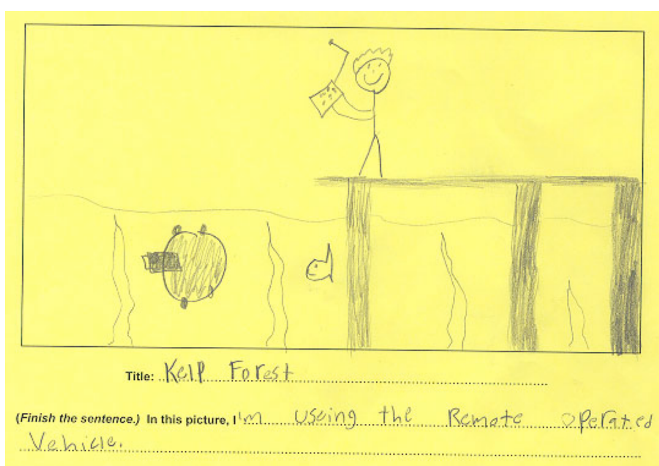
A seventh grader from a heterogeneous science class said:

> I see a different kind of scientist, people that go in the ocean and discover things -- Sylvia Earle in the submarine, Jane Goodall who lived with the apes -- not someone trying to look at microscope.

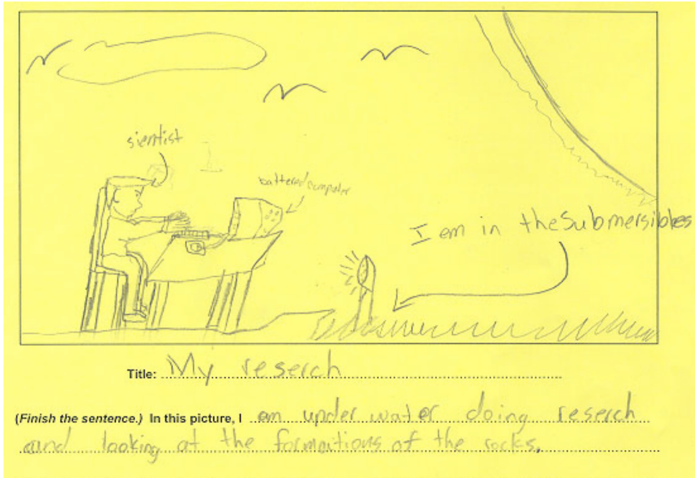
Understanding scientists' work. In addition, students indicated that their understanding of scientists' work was affected by their participation in the curriculum. Before participating in the JASON Project, students said, they thought that all scientists did was "use test tubes," "experiment," "study at a microscope," and "write down formulas." But after participating, they said that they recognized that scientists do a wide variety of things such as scuba diving, digging, taking samples, hiking, discovering, exploring, using technology, and studying plants and animals. Some students were impressed by the fact that some scientists were living in the field, "going outside" and "sleeping in tents." Others described the scientists portrayed in the curriculum as people who "learn more about our world," "do understandable things," "look up things that they don't know," "talk in words we understand," and "care about the work that they do."

Imagining being a scientist. The shift in perception of what scientists look like and do made students feel that they could better relate to scientists, and even aspired some to become one. A student from a special education classroom said, "I would love to be a scientist. Scientists are lucky -- they get to travel around the world. I would do anything for it, to get out of the state and get to do the things they do." In fact, several survey respondents even portrayed themselves within the research environment "doing" science and working with scientists (see Figure 2).

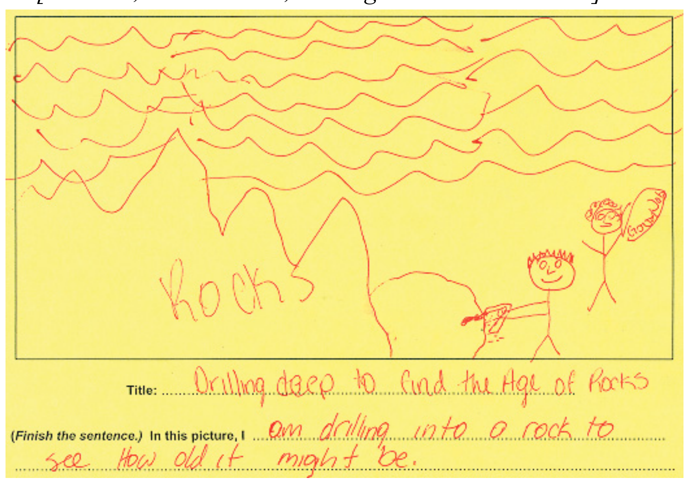
Figure 2: Students as scientists



"Kelp Forest:" I'm using the Remote Operated Vehicle. [Grade 6-8, special education classroom]



"My Research:" I am under water doing research and looking at the formations of the rocks.
[Grade 5, urban school, heterogeneous science class]



"Drilling deep to find the Age of Rocks:" I am drilling into a rock to see how old it might be.
[Grade 7, suburban school, heterogeneous science class]

Implications for Practice

With increasing pressure for *all* students to reach standards and perform well on standardized tests, it is essential that teachers be able to provide students with as many ways as possible to engage with and as many supports as necessary to learn the academic content.

Our work has shown that an interdisciplinary, multimedia science curriculum not only engaged diverse students in science learning in ways that students themselves found more powerful than in a typical science classroom, but also taught students 21st century skills. Most importantly, the curriculum broadened students' perspectives about what constitutes scientific experimentation and exploration, what real scientists are like, and the value of learning science in their own lives. These aspects of learning science in the upper elementary and middle grades are important, and supply a critical link between diverse groups of students and the field of science.

It is our hope that these research findings, along with examples of how the multimedia resources were used in real classrooms by real teachers, help teachers see how the needs of every student can be met.

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APPENDIX: Participating sites

School[4]	Teacher(s)	Category	Grade(s)	Subject(s)	No. classes	No. students
Brightway Elem.	Helen Tyner	At-risk	5	Science	6	160
Pine Mountain School	Julie Elliott Sarah Morton Susan Frank	At-risk	4-5 6-7 8	All (at-risk)	3	33
John Glenn Elem.	Carol Calloway	Gifted/Talented	4-6	Gifted/ Talented	1	11
Hunter Hill M.S.	Robert Mercer	Gifted/Talented	6	Gifted/ Talented	2	38
Hope M.S.	Linda Smith	Mainstream	7	Science	5	104
Sugar Grove M.S.	Sarah Terowsky	Mainstream	7	Science	4	100
Cedar Creek M.S.	Gail Sanderlin	Mainstream	7	Science	6	120
Monroe M.S.	Elise Maple	Special ed.	6	All	1	13
	Rhonda Charles, ESL teacher	[ESL]	6-8	ESL	[1]	16
	Ann Bass, JASON coordinator					
Liberty M.S.	Pam Cartwright	Special ed.	6-8	All	1	13
9 school sites	***12 teachers***				***30 classes***	***608 students***

[4] Pseudonyms are used. All names and identifying details have been masked to ensure participants' confidentiality and privacy.