# Kids at Work: Exploring How Children Construct an Understanding of Science and Its Usefulness in Two Sixth Grade Classrooms

Barbara A. Beyerbach
Rhonda Mandel
Suzanne Weber
C. Thomas Gooding
State University of New York at Oswego

*This paper reports on the qualitative data collected as a case study of two elementary classrooms, one implementing a "Kids at Work" field trip based unit of instruction, and one implementing a more traditional unit. "Kids at Work" is a new model for cooperative partnerships between schools, industry and higher education to improve school science and mathematics instruction, by highlighting applications in the workplace. The evaluation study has indicated that the program improves instructional practices in elementary science teaching, improves children's attitudes toward the usefulness of science, and increases parental and community knowledge of and support for improved science. This paper provides an in-depth examination of the implementation of a unit in two sixth grade classrooms, based on participant observation and interviewing of students in each context. The qualitative data help to highlight how differences in instructional contexts translate to differences in students' career awareness and desire for a career in science.*

## Introduction

The "Kids at Work" program is a new model for cooperative partnerships between schools, industry, and higher education to improve school science and mathematics instruction. It is designed to stimulate teachers' and children's interest in and understanding of science and mathematics by highlighting applications in the work place. This paper reports on the component of the qualitative evaluation of the project involving participant observation and interviewing children in two classrooms, one involved in the "Kids at Work" papermill unit on ecosystems, and one implementing a more typical ecosystems unit.

In the "Kids at Work" program, a local business makes an industrial site available for visits by children from neighboring schools. A team of teachers, with the help of advisors from business and a state university and/or teacher center, develops science and mathematics activities for the children to do in the classroom before and after the field trip. The field trip is correlated with the school science and mathematics curriculum at a particular grade level. The classroom activities are explicitly designed to show how school science and mathematics are used by adults in the workplace. The units and tours also highlight women and other members of historically underrepresented groups in professional and technical positions so that children have opportunities to interact with, for example, female and minority chemists and plant managers. The "Kids at Work" units use an instructional model based on the learning cycle (Biological Sciences Curriculum Studies, 1989; Karplus & Thier, 1967; Rennier & Marek, 1988) which is an inductive teaching strategy consistent with constructivist learning theory.

## Overview of the Complete Evaluation Design

A multimethod evaluation of the "Kids at Work" model began in April 1991. Though this paper reports only on the qualitative studies of two sixth grade classrooms, a brief overview of the entire evaluation design and conclusions is presented to illustrate how these case studies fit into the overall evaluation design.

Quantitative survey data on children's attitudes toward science were compiled from two sources. The first was the

New York State Elementary Science Program Evaluation Test (ESPET), which encompasses a survey of fourth grade students and their teachers, administrators, and parents. The ESPET was conducted in the spring of 1991 and again in the spring of 1993. The second source was the Science/ Mathematics Attitude Questionnaire, a science and mathematics attitudinal instrument developed from Rennie's (1986) model. It was administered in 1993 to students both participating and not participating in the "Kids at Work" case study of two grade-six classrooms.

Qualitative data from participant observation and student interviews in a variety of elementary classrooms implementing "Kids at Work" units and those not involved with the project were also collected. During the 1991-92 school year, students in six classrooms, grades K-6, were observed for a total of 22 sessions. In 1993, intensive observation and interviewing of students occurred in two sixth grade classrooms, one involved in the project and one not involved. Observations ranged from a single lesson and a teacher interview, to others spanning half- or full-day visits during which classroom activities, and/or field trips occurred. Activities during visits, as well as when the participant observer was not present, were videotaped. This information was supplemented by teacher and student interviews and open-ended surveys.

The qualitative and quantitative data supported the conclusions that the "Kids at Work" Program:

1. improves instructional practices in elementary science teaching by incorporating more hands-on, inquiry teaching strategies;
2. improves elementary children's attitudes toward the usefulness of science in school, in the workplace, and in daily life; and
3. increases parental and community knowledge of and support for improved science instruction in the schools (see Beyerbach et al, 1995 for complete summary of evaluation findings).

"Kids at Work" has been validated through the New York State Sharing Successful Programs, which is a state-level dissemination network supported by the National Diffusion Network.

This report focuses on themes relating to student perceptions of science usefulness and career-related applications in the two contexts. It provides an in-depth examination of the implementation of a unit of instruction in two sixth grade classrooms--one a "Kids at Work" classroom implementing the papermill unit on ecosystems and one a non-"Kids at Work" classroom implementing an ecosystems unit without a related field trip.

## Methods of the Qualitative Investigation

The qualitative assessment design included participant observations of two sixth grade classrooms in 1992-93 by three "Kids at Work" staff researchers. The participant observers interacted informally with students as they worked in small groups and occasionally posed a question in large-group instruction. Field notes were recorded, and all lessons were videotaped for later analysis. In addition, students in the two classes were interviewed individually or in focus groups, using a semi-structured interview protocol which focused on children's conception of science, children's enjoyment of science, children's perception of need for science, and children's awareness of science usefulness.

The population of the qualitative study was comprised of 43 students in two classrooms in a rural elementary school serving a middle- to lower-socioeconomic clientele. The students involved in this study were all Caucasian, ages 11 to 13 years. Both teachers were in their second year of teaching; and both were also non-traditional graduate students enrolled in a master of science in education degree program at a state university.

The purpose of the case study was to examine the effect of a "Kids at Work" field trip on concepts, attitudes, and a desire for future learning in science on sixth grade students during a unit of environmental study. The first research question addressed was, "What is the influence of a field-trip-based unit on children's conceptions about the nature of science?" Question two was, "Does a field trip during a unit of study positively influence student's attitudes toward the usefulness of science as reflected in interviews with the students?" The final question addressed was, "What was the influence of the field trip unit on student's awareness of science careers and their motivation to choose careers in science or mathematics?"

An interview protocol was developed by members of the "Kids at Work" staff. The questions were grouped to explore five general areas relating to the research questions: (a) general conceptions of science and its utility--eight questions asked before and after the unit implementation in both groups (e.g., "What do scientists do? What do you do when you do science?"); (b) conceptions as to how science is personally important--five questions asked to both groups before and after unit implementation (e.g., "Do you use science outside of school? Describe when and how."; (c) pre-visit specific conceptions as to how science relates to a particular work place--two questions asked to both groups before the units ( e.g., "How do you think science is used by workers at the paper plant?"); (d) attitudes toward field trips-- three questions asked to both groups before and after the unit (e.g., "Do field trips help you learn? How is learning on a field trip different from learning in a classroom?"; (e) comparison of opinions about the field-trip experiences with those about traditional science instructional experiences to typical science--ten questions asked after the unit only to the "Kids at Work" group to understand their reactions to the field trip and unit (e.g., "How was learning during the papermill unit different from other science units you've done?").

Question 1, regarding the influence of a field-trip-based, inductive unit on childrens' conceptions of the nature of science, was examined by listening to children's responses to area (a) questions about general conceptions of science and area (b) about the personal importance of science. The investigators wanted to determine whether involvement in a unit which emphasized how science is used in the real world, changed the meaning of what science is. Question 2, on students' attitudes toward science usefulness, was explored by examining their responses to areas (b), importance of science and when it is used, and areas (c) and (e), how science relates to the workplace. Question 3, on awareness of science careers, was explored by examining responses to area (d) on the role of field trips in learning, and area (e), comparison to typical science, as well as area of (b), importance of science. We were searching for instances where students used examples of careers they had explored on the trip to explain how science is used and/or how they might use science in their future life.

The "Kids at Work" program, as well as the overall evaluation design, targeted students' attitudes because attitudes are important in determining science achievement and advancement in science courses, and there is widespread concern about attitude decline in the intermediate and middle school years (Mullis & Jenkins, 1988). Science attitudes are also affected by the instructional environment (Schibeci & Riley, 1986; Talton & Simpson, 1986; Yager & Pennick, 1986). The investigators sought a closer look at how home, school, and community experiences interact to influence attitudes toward science and its usefulness. Three interviewers from the "Kids at Work" staff came to the classrooms to interview the subjects personally. The interviewers became familiar to the children as they were frequently observing them and informally conversing with them during the implementation of the units.

## The Pre-Unit Interviews

The pre-unit interviews occurred the first week of October, 1992. Interview stations with chairs and tape recorders were set up in the hallway outside of the regular classrooms. During the interviews, students were encouraged to respond freely to all questions, but not all students responded to every question. Upon completion of the interview, students returned to the classroom and another group or individuals joined the interviewers.

## Case Description of the Implementation of the Units in the Two Classrooms

*"Kids at Work" Classroom*

After the pre-unit interviews, the "Kids at Work" group was introduced to the "Kids At Work" papermill unit. Chris Van Alsberg's *Just A Dream* was read aloud. The content of the book was discussed in reference to the global environmental impact of cutting the forest. The students, in following lessons, played "Tree Trivia," a game that incorporated environmental knowledge and mathematics skills. They studied the composition and the inner layers of the tree by using "Tree Cookies," a hands-on activity that requires the use of measurement, computation, observation, and analytical skills. In the third lesson, with the use of an overhead projector and transparencies, the students were shown a cut-away view of a paper-making machine and were guided sequentially through the paper-making process. The students made paper themselves and predicted how the process they used would compare to the industrial method. Other pre-trip lessons involved safety considerations in a factory, the various occupations required to operate the plant, vocabulary specific to the paper making industry, and the students' general expectations for the field trip. The day prior to the field trip, the students viewed a video, "From Tree to Paper." The video documented paper -making, beginning in the forest and proceeding to the delivery of the product to the consumer.

On November 6, 1992, the day of the field trip, students were assigned to groups by the teacher. One member of each group was selected to record all safety signs. Students were alerted to watch for people doing various jobs in the plant and all evidence of science and mathematics being used. Upon reaching the site, the students were greeted by the assistant plant manager. He gave them a brief overview of the plant's history, a summary of plant safety procedures, and a general description of the route of the tour. Groups were assigned to a member of the papermill staff, and each child was given a hard hat, ear plugs, and safety glasses. The group started the walking tour at Lake Ontario, where the pulp is delivered by ship. They continued through the plant and observed the chemical addition; the slurry processing; the computer room; the rollers and dryers; the testing laboratory; and the cutting, boxing, and trucking of the final product. The students then reassembled as a class and participated in a general question-and-answer session with the tour guides.

After returning to school, a classroom discussion immediately followed to allow for clarification and elaboration of the tour. Students also made connections with the previously taught lessons. The following day the students made paper again, using slurry from the papermill and experimental material such as shredded denim, cooked rice, and paper towels. These samples were saved, decorated, and given as holiday greeting cards to parents.

*The Comparison Classroom*

The first lesson in the ecosystem unit was a textbook reading followed by discussion of the food chain and energy pyramids. Students were assigned further reading for the next day and were given a packet of work sheets to be completed by the end of the unit. Succeeding lessons continued with the reading, discussion, and worksheet format until seven different biomes were covered. Upon completion of the unit, students were assigned a biome of North America and were instructed to illustrate it on a map and create an acronym description. The students presented the completed product to the class. The maps and acronyms were then displayed in the classroom.

## Post-Unit Interviews and Data Analysis Procedures

A post-unit interview session with students from the "Kids at Work" classroom was held November 19, 1992. The post unit interviews for the comparison group were conducted December 9, 1992. After completing the interviews, the tape recorded conversations were transcribed by "Kids at Work" staff members. The interviews were then coded according to categories relating to the five areas explored by the research questions. For example, comments relating to what science means were coded as *science definition*. Other codes used in this study were: *science use*--student comments about how students or others used or could use science; *science enjoyment*--comments about students' leisure time use of science, and the particular areas of science enjoyed in school; *science job*--statements by students concerning understanding of jobs requiring science knowledge and the students' desire to have a job in a science-related field; *scientists*--students' perceptions of who a scientist is and what a scientist's duties entail; and *need for science*--students' concepts of for whom and for what purposes science was used. The coded data were entered into *The Ethnograph* (Seidel, Kjolseth, & Seymour, 1988), a computerized program for sorting and analyzing qualitative data. Emerging themes in all coded categories were compared between groups to determine how the field trip and related unit influenced student perceptions in reference to science and its usefulness.

## Findings

The analysis of the interview data indicated that the field trip unit had little impact on students' understanding of the nature of science, and that both groups enjoyed science. The field trip-based unit did have an impact on students' career awareness, understanding of science usefulness, and desire for a career using science. Following are reports on the data substantiating each of these findings.

*Conceptions about the Nature of Science*

There were no discernable differences between the understanding of the nature of science between the "Kids at Work" and comparison groups. Generally, in the pre-unit interviews, there was a heavy content focus on nature (plants, animals, and environmental causes). For example, when asked the question, "What is science?", some replied:

"Like you see an insect on the ground, you know what it is."

"When I think of science, I think like plants and animals."

"We use science when we are talking about animals that are going to be killed."

These responses seem to reflect the content area that was being taught in both groups.

In the interviews after the "Kids at Work" group had gone on the field trip, subjects from both the "Kids at Work" and comparison group mentioned chemistry, earth science, biology, and geography. Some answers in both groups exhibited confusion about understanding the definition of the term (i.e., "If you get lost...you can use the sun to find if you were north or south"). Conversely, when others were asked what they thought about science, they responded with such statements as, "I think about all those neat chemicals and everything." Again, the similar responses from both groups appeared to reflect the experience of the subjects with the specific science content of current instruction.

In addition to the focus on content, it was found that there was an emphasis on the process of doing science in both groups in the pre-interviews and post-interviews. There were frequent responses relating to experimenting, dissecting, and using a microscope. In response to "What is science?" some replied,

"You experiment with it and start out with easy stuff and go on to the hard things."

"Um...science you have to dissect things and scientists invent things."

"I think about science as weird...like a lot of things...exploring, experiments, investigating."

*Attitudes Toward the Usefulness of Science in Daily Life*

All 16 students who responded to this question in the "Kids at Work" group included comments about science utility in the pre-unit interviews. Most responses tended to be related to activities they had done or they had observed grown-up members of their family doing. When posed the question "Do you only use science in school?", typical responses included,

"At home we're trying to build a compost pile."

"Some people...know about it because they cut down trees."

"Teachers do, and they teach their kids."

"Yeah, when taking care of the grass."

"My dad works with pigs and they have animal science."

"Doctors use it if they have to do surgery...it's called...physiology."

There were 25 different categories of use with a total of 43 responses in the pre-unit interview for the "Kids at Work" group. Responses were more global than the post-trip responses for this group. For example: plants, recycling, medicine, insects and animals, and animal study were some of the more popular categories mentioned.

During the post-trip interviews in the "Kids at Work" group, 13 of 15 students who responded to this question identified uses of science. Twenty-four different categories of science utility were generated--e.g., tree identification, problem solving, chemistry, mechanics, recycling, measurement, paper making, and teachers. There were 58 comments relating to science utility. When asked, "Do you only use science in school?", responses included,

"My mom is a nurse. She uses science."

"...and some teachers do to make things with their class."

"If you have animals you use science...and recycling."

"Yeah, I count the stars and make a star chart."

"Whale watchers and deep sea divers use science."

Fifteen of the 58 post-trip comments were directly from the papermill experience.

"Chemistry...how much chemicals go in the paper."

"The mechanics use science. They had to fix the machine."

"What kinds of trees, hardwood and soft wood trees that you would have to use to make certain kinds of paper."

"People at the papermill use science to know what kind of chemicals to put on the paper."

"You have to know science to make the slurry and how to add things to it."

In summary, in the pre-unit interviews in the "Kids at Work" group, students tended to cite uses of science not directly related to school science, whereas in the post-unit interviews a substantial number of uses cited appeared to be directly related to the unit and field trip.

In the comparison group pre-unit interviews of 12 students who responded to this question, 11 students included comments about science utility. Twenty-two categories were included incorporating 29 total responses. The responses were mostly generic and linked science utility to parents or self as was the case in the "Kids at Work" groups' pre-unit interviews. When asked, "Do you only use science in school?", responses included,

"If I'm at a friends's house and playing school and I'm the teacher, then I would use it."

"My parents are landscapers. They use it."

"When I help my brother...I put baking soda and vinegar together...that's about it."

"My mom uses science when she cooks."

No change was seen in the post interviews. The students continued to cite parents or personal experiences. Of 11 students, 10 responded about science utility generating 23 categories (e.g., scientist, plants, gardening, cooking, chemistry, and medicine) and 37 instances of use:

"My mom uses science outside...to tell me about insects."

"I made this awesome thing at home...I put in chemicals and it bounced."

"Oh, gardening you have to figure out how many chemicals to put on plants."

"When people recycle they use science."

*Awareness of Science Careers*

The field trip expanded awareness of science-related careers in the "Kids at Work" group. This group showed a gain in the number of careers generated, with 15 items directly related to the papermill. For both groups, many careers mentioned were parent, significant others, or self-related, except for the papermill generated careers in the "Kids at Work" group.

*Desire for Science Careers*

While most students in both groups enjoyed science and recognized a need for science, with the majority of those students responding that science was needed for a job, a strong difference in the desire for a job using science in the future between the groups emerged.

In the "Kids at Work" group, in the pre-unit interviews, 50% of the students wanted a job relating to science and this increased to 60% in the post-unit interviews. The pre-trip activities focused on predicting and anticipating the kinds of mathematics and science applications children might see, which may explain this high initial interest. Responses to the question "Would you like a job using science when you grow up?" were similar in the pre-trip interviews and the post-trip interviews. For example,

"Yes, I'd like to be a scientist. I'm good at math and science. That would be fun."

"...if I learn more, I want to be a marine biologist."

"I'd like to work with computers."

"I'd like to be a teacher and study things in the rain forest."

It was evident, in comparing the pre-unit responses of the groups, that the "Kids at Work" group was able to offer specific career titles versus the general areas mentioned by the comparison group. In the post-unit interviews the "Kids at Work" group became more job specific in response to the question of the desire to have a science-related job in the future, e.g., "Yes, because I want to be an astronomer." A focus group responded to the question with separate career choices,

"Yes, an oceanographer."

"...an electrician",

"...a teacher".

In the pre-unit interviews, only 13% of the comparison group wanted a job using science. Responses to the question "Would you like a job using science when you grow up?" varied. A focus group of four answered in unison "No." Others answered, "Yes, teaching...my specialty would be science." "Well, to be a scientist...you are just working 24 hours a day, so probably not." These statements suggest that the comparison group did not have a clear concept of the utility of science in adult careers.

In the post-unit interviews, the increase to 36% of those in the comparison group who would want a science-related job still did not suggest a greater understanding of the utility of science; however, there were more students who were environmentally aware of the earth's current condition. For example,

"I think so, like people who protect the earth. We talked about them."

"Yes, I'd like to work to save the rain forest."

It seems that early in the year there was a heightened career awareness in the "Kids at Work" group and, as the study continued, more students developed a high interest in specific areas of science. Careers mentioned in the post-unit interviews, for example, electrician and computer operator, were directly related to the field trip as these types of workers were observed by the students.

*Responses to field trips*

Not surprisingly, students in both classes reported they enjoyed learning through field trips. Typical comments included:

"It is interesting to see and learn about things you know."

"...it's more fun than sitting in a classroom and reading from a textbook."

"When I go on field trips I like to have hands-on experiences."

"You learn more and if I like it, I might want to go back."

"I like to walk around and observe and look at how things are done."

When the "Kids at Work" group were asked what they expected to see on the papermill trip most responded with recycling, machines, and paper making without further elaboration.

After the field trip, students in the "Kids at Work" classroom responded enthusiastically, discussing their favorite parts of the field trip.

"Yeah, the slurry...when he picked it up it looked like dough."

"Broke...when they have broken paper, they just put it in again and start over."

"They really showed you how to make paper, the process used and packaging."

"Yeah, we saw the dryer, the roller...how they flatten it...the whole operation."

"Yeah, they don't really teach it to you...they let you see it. They make it more interesting."

"I liked the drying and measuring the chemicals."

"The guy said you have to wear certain kind of gloves and a suit for adding chemicals."

"There were a lot of signs, like traffic and danger."

"Most of my friends liked the slurry."

There was a significant change in the "Kids at Work" students' vocabulary. The most easily identifiable was the omission of "stuff" as a descriptor. The students now had a reference point for using newly acquired words and were able to use them in meaningful contexts.

## Discussion

What differences did these diverse instructional contexts make for students' learning outcomes? The field trip centered unit seemed to heighten students' awareness of career connections and the usefulness of science and also increase their desire for a career using science. The field trip unit had less influence on students' understanding of the nature of science, which was defined in both groups primarily in terms of nature. Students in both groups also had a similar focus on processes relating to science--"exploring, experimenting, investigating." In terms of science enjoyment, most students in both groups enjoyed science, particularly when they were actively involved in experiments and projects; however, many more students in the "Kids at Work" classroom indicated they were considering a science-related career. In the post-unit interviews, the "Kids at Work" group was able to offer specific career titles and descriptions, whereas the comparison group continued to offer more global responses. The "Kids at Work" unit had the most striking effect on students' perception of science usefulness. During the pre-unit interviews, responses from both classes tended to be related to activities they or significant adults engaged in. The class involved in the "Kids at Work" field trip was able to comment on many new science-related careers directly relating to the papermill trip, while the comparison group continued to cite parents or personal applications of science. Though the field trip seems to be a central component in influencing students' attitudes and career awareness, it is important to note that there were other differences between instruction in the two classrooms that undoubtedly influenced the learning in these two contexts.

The "Kids at Work" classroom experienced hands-on activities that were inductively structured, integrated literature, and career awareness activities. The comparison classroom experienced more lecture and worksheets. The results we describe are part of a total package, and as Jane Stallings has indicated regarding program evaluation, it ". . . would be foolhardy to parcel out the effects of various program components. . . With the contributions of so many constituents, a synergy is created that challenges current evaluation methodologies" (1995, p. 6).

## Educational Significance

This work indicates that school/business partnerships can provide important opportunities for linking educational goals to applications of learning in the workplace by broadening the range of careers with which students are familiar and providing for interactions with role models in various careers. These experiences are likely to influence scientific understanding, career awareness, and subsequent career choice (Auster & Auster, 1981; Bailey & Nihlen, 1989; Seligman, Weinstock, & Heflin, 1991). We believe that early experiences such as those provided by the "Kids at Work" model will have the effect of reducing career foreclosure due to sex-role stereotyping and, as these children move into the middle school years, ability/status considerations. The effect of career foreclosure is cumulatively restrictive unless children are continuously exposed to an expanding range of plausible and interesting career choices (Stroeher, 1994; Weeks and Porter, 1983) such as those investigated by children in the "Kids at Work" program. The qualitative data reported in this study helps to portray an understanding of how differences in classroom contexts translate into differences in perceptions of science usefulness and connectedness to students' lives.

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## Author Note

We gratefully acknowledge Robert Schell for his contributions to the statistical design and analyses, and Cynthia Hawthorne and Linda Downing for their work on the qualitative analyses. The work described in this article was partially funded by the National Science Foundation grant TPE-9054603; Dwight D. Eisenhower Title IIA funds administered through the New York State Education Department; and contributions from business members of the Project SMART Kids at Work Partnership Program.

*Barbara A. Beyerbach is Professor of Curriculum Instruction in the School of Education, State University of New York at Oswego, Oswego, NY.*

*Rhonda Mandel is the Interim Associate Provost at the State University of New York at Oswego, Oswego, NY.*

*Suzanne Weber is Associate Professor in the School of Education, State University of New York at Oswego, Oswego, NY.*

*C. Thomas Gooding is the Acting Provost at the State University of New York at Oswego, Oswego, NY.*

Reprints should be requested from the first author.