Views of Science as Represented in Urban Schoolchildren's Photographs

John Settlage, Cleveland State University

Introduction

Emerson (1849) cautioned us against relying too heavily upon past experiences since these become fixed and of diminishing value: "The actions and events of our childhood and youth, are now matters of calmest observation. They lie like fair pictures in the air." To better understand the issues of teaching in urban schools, the author, a university-based science teacher educator, sought a classroom in which he could team teach science. Near the conclusion of the first year of this on-going experience, it seemed necessary and prudent to assess the children's perceptions of science. This study reports on the findings using photographs and individual interviews to determine whether the students were translating classroom activities into their daily lives.

Although an exploratory study, there were three central research questions:

1. What did the students perceive "science" to involve and include?
2. How were the students able to connect and extend the school science into their daily lives?
3. How might they choose to represent these ideas photographically?

Because of the possibilities the electronic media provides, this study includes raw data in the form of interview excerpts and representative photographs. This arrangement was selected because not simply because the electronic nature of the document lent itself to that option but because it was the best way to allow the reader to judege for themself the veracity of the claims put forward.

Background

Preparing future elementary teachers for field experiences and possible careers in urban schools is my central professional responsibility. Without much background in teaching science firsthand in an urban setting, it seemed inevitable that my qualifications might be questioned by my students and, in truth, such doubts would be legitimate as I harbored uncertainties myself. Rather than waiting for these doubts to be spoken, I contacted an administrator of an urban elementary school and he identified a teacher with whom I could work.

Having a building principal connect me with a teacher willing to host my efforts at team-teaching science, I learned a great deal about my abilities to function in this environment. We (the teacher, the students and I) benefitted from the recent district-wide adoption of kit-based, hands-on science materials. The abundance of equipment and the absence of textbooks gave plenty of incentive to examine the implications of a social-constructivist epistemology while teaching urban third graders. Time and again, the primary limitation seemed to be in my efforts to organize lessons and provide clear instructions: the children were more than capable learners of the science content.

Near the end of the school year, I felt a need for a culminating activity, to provide a capstone to the year for the students and for me to assess the influence of science upon them. While the students seemed to enjoy science, I was uncertain about its significance beyond the time I was in their classroom. I stumbled upon the idea of providing each child with a single-use camera and allowing them to reveal their attitudes and understandings through their photographs.

The struggle to translate sensations into written word is part of the sense-making process of this researcher and has been identified as a methodology in its own right (Richardson, 1998). Despite all efforts to the contrary, the act of making public the work done in an urban school invites the disdain of professors who see such work as beneath that of academicians. In sharing my school adventures at conferences I have discovered that there is an entire subcommunity of university-based science teacher educators who regularly immerse themselves in classrooms. To do such can be regarded as quaint but, as it confers no advantage in terms of the currency of the realm (i.e., tenure), it is seen as community service and not a mechanism for professional advancement. And to go even further and attempt to publish one's experiences can make one the target of claims of self-aggrandizement. In truth, one goal of this manuscript is to encourage other researchers to broaden their experiences, perhaps even returning to classrooms in ways akin to that related here.

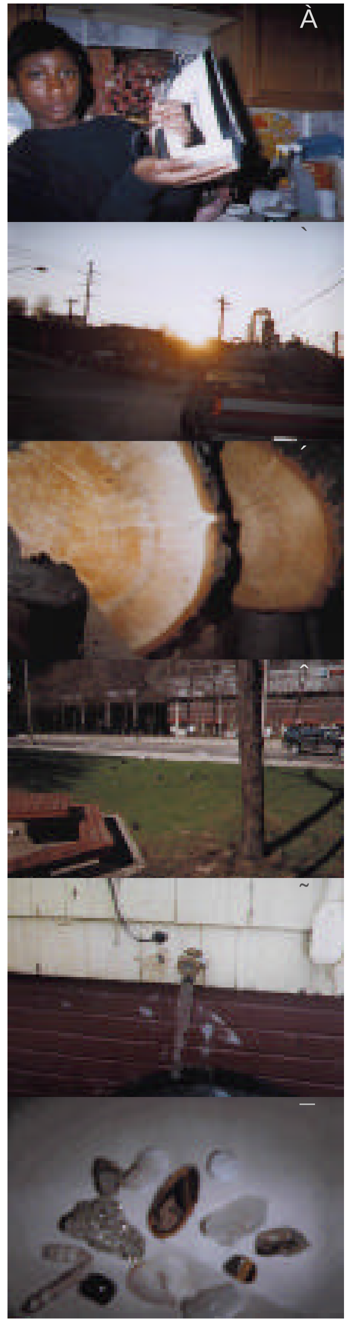
Teaching science in urban schools is an area that researchers (Gabel, 1994) and reformers (Glenn Commission, 2000) consistently fail to investigate and address. Since few insights were forthcoming from the research community, the author chose to investigte urban schoolchildren's views of science by asking them to take photographs Their directive was quite simple: take pictures of things that you think are science. Their pictures as well as interviews about their photos serve as the raw data of this study.

Having Children Photograph Science

Prompted by science education faculty bold enough to take an active role in teaching science within urban schools (e.g., Meadows, 1997), the author entered into a team teaching arrangement with a third grade teacher in a Cleveland public school. The children participated in an abundance of hands-on experiences during the twice weekly science lessons. The Measurement and Earth Materials units from FOSS and the Sound unit from Insights (EDC, 1995) were taught as per the district guidelines.

Attempting to render the classroom buzz and blur into an informative research paper that was true to the students and their teachers was problematic. Research by Naizer (1997) on the use of photographs for assessing student understanding promised a path out of the tumult. In April, twenty-four children were provided with fifteen exposure, single-use cameras for the purpose of taking photographs around their homes. The children were given brief instructions about how to take a picture as well as a record sheet for writing down what they were attempting to photograph.

The record sheet prompted the child to take 15 photos: one of themselves (partly so the prints could be reunited with their owners), two pictures of where they lived, two pictures of what makes them feel good, and ten pictures of science. Twenty-one of the cameras were returned and color double prints were made. About half of the cameras were returned within a week and the remainder trickled in over a period of three weeks.



Each child was interviewed about their pictures. They were asked to explain what was being shown in each photo and describe, for those ten pictures, what the "science" was in each image. These conversations were tape recorded and transcribed. The researcher was a participant-observer in this study: he was one of the subjects' science teachers, was the person who provided the cameras, conducted the interviews, and interpreted the results. Consequently, there is no illusion that this piece of research preserves any tinge of objectivity. Instead, the reader has been provided with a selection of representative photographs and interview excerpts in effort to lend authenticity and trustworthiness to the inferences (Adler & Adler, 1998).

What the Photographs and Interviews Revealed

One child was unable to describe the science in the pictures he took, leaving the author with twenty sets of photos to analyze. The pictures were scanned into a computer and the interviews were transcribed to align words with images. This process led to the emergence of the categories around which this report is structured.

Contrary to the adage about a picture and a thousand words, a photograph alone disclosed little until its meaning until the child provided a spoken caption. The photographs without annotations are essentially pieces of art left open to individual interpretation. Without knowing the photographer's intent it was virtually impossible to ascertain the underlying "science" within the images. A sampling of pictures is shown here to provide the reader with a sense of the image diversity. Here can be seen an iron (#1), a sunset (#2), a log (#3), a park (#4), water flowing out of a tap (#5), and a rock collection (#6). All of these were purported to show science.

As the interviews took place, certain themes seemed to emerge. Subsequent to the interviews, as utterances were matched with images, the viability of the categories and the goodness of fit of the photos could be assessed. Ultimately each photo was placed within a single category — no picture was allowed to have joint membership. The following sections describe each of the categories along with sample pictures.

Unexpected Assistance with the Photographs

Providing children with cameras for the purpose of taking pictures of science around their homes was thought to be a way for them to take charge of their learning. If teaching photography skills was the primary goal of this research, it would have been less expensive to use cameras already on hand and have the children take pictures around the school. However, the goal was to determine how much of the science learned at school would be recognized and applied by the children once they left the building. Single-use cameras marketed as "wedding packs" were chosen for this project because of their built-in flash and the fifteen color prints.

The interviews revealed substantial involvement by adults with the children's photography project. It is impossible to know if this assistance was requested or volunteered; there were instances, when asked to explain why a particular picture represented "science," the child said they were told it was a good idea.

A criticism of much educational research is the danger of objectifying the people being observed. This tendency was avoided by placing the children in control of what the researcher saw. The practice of allowing people to represent themselves through their own photographs has been used within psychology research (see Ziller, 1990) and this method showed promise for this inquiry into the particular issues of urban elementary science education.

Interview Excerpts

Charice:	And this is science, but I don't know why.
Prof:	So why, who told you to take a picture of it?
Charice:	My grandpa.
Prof:	He told you it was science so take a picture
Charice:	He told me to take a picture of the fan (#1) and of the TV and the VCR (#2).

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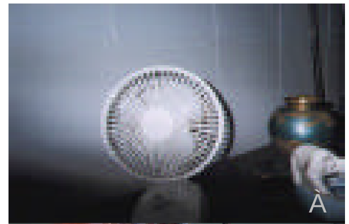
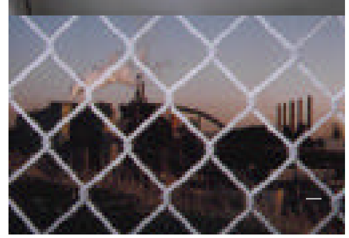
Prof:	You've got a light bulb. Tell me why that's a science picture (#3).
Melissa:	Cause my mom says because it, it's with electricity. She says electricity is science. That's why she told me to take a picture of that.





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Ellen:	Because … I forget … what my grandma said. She said boiling water is part of science because a lot of science people work with boiling water (#4).

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Adam:	That's (#5) a water tap because … it's kind of like … My mom told me, I think she said it's like physics or something. I can't remember.

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Keith:	This is smoke right here (#6). Me and my mom thought that was science.
Prof:	What made you think that was science?
Keith:	I don't know. How it looks?

Related Issues

When Project 2061 speaks of "all Americans" it implies the need for science to address minority and female students (Rutherford & Ahlgren, 1994). Except for research upon mismatches between the communication styles of home and classroom of inner city children (Cazden, 1988), there is precious little guidance about effective ways for teaching science in the urban setting. What expertise might exist is not widely available.

The importance of parents in a child's intellectual development is well documented. Since urban students consistently underperform compared to suburban peers, a common perception is the lack of parental involvement is a major determining factor. At the same time, conventional wisdom about discipline is that parents should be involved as a last resort (Good & Brophy, 1991). Parents of urban students have been regarded as negative and absent parts of the educational milieu.

Contrary to popular belief, at least for the children who participated in this project, their parents were actively involved. When it may seem they interfered with their child's assignment, fault should be placed at the feet of the author. Including "communicating with families" as a key component of professional practice (Danielson, 1996) was driven home as a consequence of this study.

Photographs of the Photographers

Of the fifteen exposures available on the disposable cameras, the first each child was to take was of themselves. Anticipating the difficulty of matching twenty-plus sets of pictures with their rightful owners, the initial photo was a means for matching photographers with their work. An interesting variety of images were generated by this rather simple task.

Nine of the pictures were taken by a family member of the child by himself or herself, usually, but not always, inside their home. Richard (#1) is holding a trophy he won for being “Member of the Year” at the local Boys’ Club. Melissa (#2) is standing in her living room next to a plant she subsequently photographed as an example of science. The children’s pictures were taken by one of their parents.

Seven photographs show the child in close proximity to friends or relatives. Ellen (#3) was one of the students who chose to have their picture taken while holding a young child. Picture #4 is of Donnie, his sister and his brother, who was reportedly too short to fit into the frame. It seems Donnie took this picture himself. In Picture #5, Claire is shown standing in her living room with her sister.

In pictures #4 and #5, the children are trying to cross their middle and ring fingers to create a “W” which suggested some gang signal. After considerable probing of the students who had pictures of people flashing this sign, a couple of children said they were “doing Westside, like in the video.” Apparently rapper Tupac Shakur would strike this pose and the children are imitating.

The last two pictures on this page are perhaps the most personal of all twenty-five dozen that were created. In both, of these, the students stood outside, held the camera at arms’ length and snapped a picture

of themselves. Malik (#6) lives across the street from a school which can be seen in the background. Tavon (#7) discovered in the picture of himself that he included his house, seen over his shoulder.

Related Research

The significance of this subset of the photography project exceeds the scope of this paper as well as the expertise of its author. Psychologists using “autophotography” (i.e., giving camera control to the subjects) have assessed perceptions in a variety of contexts: views of self as related to gender (Clancy & Dollinger, 1993) and students’ views of schooling as related to their race (Damico, 1985).

Ziller and Rorer (1985) compared measures of shyness with the types of photos taken. Perhaps such an analysis could be applied here by someone with better training in personality psychology. If the claim relayed by Rose (1989) that every image, action and utterance is imbued with meaning, then a more careful consideration of self-portraits such as these should be made. Or perhaps these are just evocative snapshots.

Interview Excerpts

Prof:	This (#6) is a great picture, this picture of you.
Malik:	It’s in front of the school across the street from in front of my house.
Prof:	What school is it?
Malik:	Monroe.
Prof:	So you just held up the camera and took your picture.
Malik:	That’s what Tavon (#7) did.

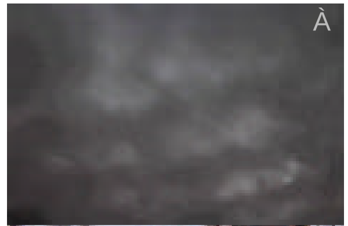
Photographs of the Sky and Weather

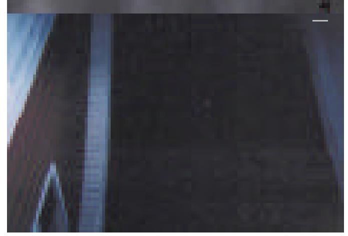
Twenty children took pictures of what they perceived to be science around their homes; six of these young photographers included a picture of meteoro-logical or astronomical events. Included were pictures of the sky as rain approaches (#1 and #5), pictures of puddles (#2 & #3), pictures that attempt to capture the wind (#4), and pictures of a crescent moon (#6).

Even with a widespread effort by the children to photograph the sky, the moon, and the weather, they were generally unable to describe how these were pictures of "science." The sky and weather pictures are evidence that science instruction from previous years had taken root in the minds of these children; such topics were not part of the third grade curriculum. Another possibilities is that the children were using "science" as a synonym for "nature" and that their pictures of the sky represent the interchangeability of these two terms. It is interesting to note that the word "nature" was never uttered during the interviews.

Related Issues

Having nature as the focus of the science curriculum is a rather ancient idea. Pestalozzi and the subsequent Oswego movement advocated "object lessons" in which items from nature served as the touchstones for science learning (DeBoer, 1991). As science became more of an intellectual endeavor and less natural philosophy, educators have largely turned away from nature study approach as the core of elementary science. Occasionally, science educators will suggest redirecting our attention to nature (e.g., Gabel, 1989) but the object lessons of old are viewed as stepping stones to more modern science instruction.





The concern felt about these photos is not with the children's awareness of nature per se; a common criticism of technology is its potential for dulling citizens' awareness of and regard for nature. That these students relate to science beyond the biological aspects of their environment is encouraging. Dwelling in a city has not blinded them to changes in the appearance of the sky and the effects of weather. However, despite my yearlong involvement in these children's science learning, I am troubled that this population seems to perceive science as something to be studied and not something that they themselves do.

Interview Excerpts

Claire: The moon's supposed to be in this picture [not shown].
Prof: So how come this is science?
Claire: Cause it's air filled about the sky. This [#3] is a picture of after a rain and the water on the ground.

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Prof: [reads from record sheet] Oh, this is the "night sky."
Charice: I told you it looked like a little curly fry [see #6].
Prof: What was that, the moon? A little curly fry moon? Oh yeah. So why is that science?
Charice: Because I learned about it last year.
Prof Oh you did? Who taught it to you last year?
Charice: Mrs. Pittmon.
Prof: So what else did you learn last year about science that you remember?
Charice: About clouds, the moon and the sun and everything. And she said the sun is a star, the largest star in the universe.
Prof: Okay.
Charice: And she said the sun is like 10,000 degrees.

Science Represented as Living Things

The student photographers generated 173 pictures they claimed represented science. Of these pictures, forty-two (nearly one-fourth) were of "living things" and this was the exact term they used. Thirty-six of the living things photographed (86%) were plants, most often grass and house plants (pictures #1 and #2) while the non-plant living things photographed included fish, birds, worms, and cats (pictures #3 and #4).

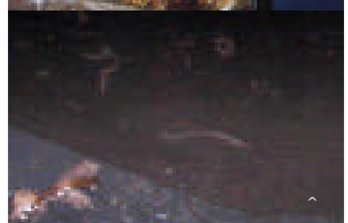
When asked to explain why a plant was "science" the typical response by the child was that they were "living things." In many cases, the child would also state that an organism was science because it could grow or used to grow. Given the district science curriculum, it seems likely that this widely endorsed idea of living things as part and parcel of science is a product of their first and second grade science studies.

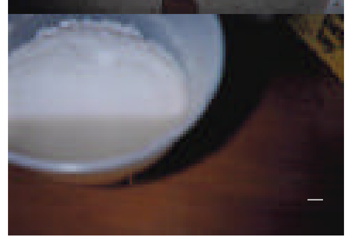
Piaget identified developmental stages for the meaning of "alive" and others have replicated his results (e.g., Lucas, Linke & Sedgwick, 1979). Carey's (1987) interviews of children ages 4-10 led to a scheme which maps closely to that of Piaget. In the most advanced group of her study, children used the characteristic of growth as criteria for classifying an object as living or non-living, a finding supported by Richards and Siegler (1986).

Charice took science pictures of green peppers, oranges and fish because they were all living things. Even though she could not find any living plants to photograph, she knew the oranges once came from a tree, so were associated with "living things." The reader can develop a sense of the photographic moment when one recognizes the refrigerator drawer and the background of the kitchen floor and even Charice's toes in her photograph of the oranges (picture #5).

Henry included a photograph of a car seat hosting a patch of mildew. His assertion was because it grows, the fungus was science. As further evidence of his "growth = science" theory, Henry took a picture of batter his mother was mixing that was allowed to ferment overnight (picture #6). Because it rises up and foams, Henry concluded this was another example of science.





Student achievement results typically show that urban students score significantly lower than their non-urban counterparts, even after accounting for poverty (e.g., National Center for Education Statistics, 1996. The children whose work is shown here had well developed criteria for judging whether objects should be placed in the category of "living things." This suggests that students in city schools do have the capability to grasp scientific concepts and that the commonly implied deficit view of urban schoolchildren is misplaced, inaccurate and flawed.

Interview Excerpts

Prof: (reading from record sheet) "Picture #1: Grass."

Malik: Oh.

Prof: So tell me why this [see #1] is science.

Malik: Because it grows. And it's living.

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Charice: I asked my mother and my father quite a lot of things. My mother and my father and my brother and everybody else. So they told me livings things are [science], but I couldn't find any living things but the tree, right here.

Prof: Uh huh.

Charice: So I took a picture of this and the green pepper and some oranges (picture #5).

Prof: Because these are living things and that's science. And the tree is a living thing so that's science.

Charice: And it's still growing too.

Prof: I'll bet it is.

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Henry: (explaining picture #6) Recipe…cake batter…foam

Prof: Foam? Mom making bread?

Henry: No, it was like cake. It grows. Overnight. When it grows it will rise up.

Pictures of Technology as Science

Outfitted with fifteen exposure single-use cameras, the third graders were to capture ten pictures of science on film. On the twenty sets of pictures, half the children had included some aspect of electricity (devices shown are: television, outlet, light switch, mixer, light pole, refrigerator, and microwave). The types of devices ranged from the sophisticated (computers) to the ordinary (light bulbs) with electronics dominating over appliances.

When asked to explain why such objects represented science, the most common response was simply that electricity was involved. The presence of wires or batteries was used as evidence that science was at hand. The work a device did was sometimes the reason it was considered "science" but electricity was the most pertinent factor.

Related Issues

As indicated in Benchmarks (AAAS, 1993) the U.S. is unique among industrialized countries by the absence of technology education within the elementary curriculum. Perhaps the only American equivalent is the still novel idea of design engineering which contrasts with our common meaning of educational technology (i.e., using computers). Science educators in the U.K. (e.g., Harlen, 1985) labor to clarify the distinctions between science education and technology education. However, this study indicates the problem seems to be ours, not just that of other countries.

Bybee (1998) identifies important distinctions between science and technology in the origins of the respective endeavors and in the processes by which they are undertaken. Science involves the methods of inquiry that begin with questions about the natural world. Technology is a problem-solving activity that starts with the desire to overcome a human challenge regarding the environment. For children to lump scientific inquiry and technological activity as equivalent is a significant problem. This notion that science and technology are identical might explain the perception that science is about finding out the right answers when in fact it is technology that is concerned with finding solutions whereas science is more about developing robust explanations.

Carey et al., (1989) discovered middle school students readily confounded the process of "making something work" with the scientific process of finding causal relationships. To dismiss technology issues as unrelated to engendering "habits of mind" may well backfire. The common public perception that science results in inventions (penicillin, radar) as opposed to knowledge (plate tectonics, photosynthesis) may interfere with efforts to teach children about the nature of science. Neglecting technological education in American classrooms could place our other goals in jeopardy.

Interview Excerpts

Prof: OK. Next one: "Computer." Why is that science?
Melissa: Cause you plug it in. You can use batteries with it. It goes with electricity.
Prof: Is everything that has electricity "science" you think?
Melissa: Yes.

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Malik: This [is] the TV. My mother, she was watching Jerry Springer.
Prof: (laughs) Okay.
Malik: It's science because it got all these wires and electricity in it. The TV, it's like this thing on the back that make it turn on and off. And the volume and the channels.
Prof: Okay.
Malik: And the cable box and the VCR.
Prof: And those have wires too.
Malik: Yes.

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Prof: And here I'm seeing a light switch. Is that in your bedroom or the bathroom?
Richard: My sister's bedroom.
Prof: And why is that science?
Richard: Cause it's something you use to turn on things. Like the light.

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Ellen: And this is a mixer (Picture #4).
Prof: Uh-huh. Why is that science?
Ellen: Because, in the inside is a lot of science things, like wires and electricity. My grandma opened up that part and seemed like a lot of electricity in it. So she told me to take a picture of it.

Photographs at Home of Science Learned at School

The school district policy was for four science units to be taught in each elementary grade, all of which were drawn from NSF's elementary science development projects of the 1990s. Consequently, the third graders spent an entire grading period working on a single unit. The two units most often portrayed in the photographs were the Earth Materials unit (Lawrence Hall of Science, 1994), taught from November through January, and the Sound unit (EDC, 1995), taught from January through March.

Near the end of the geology unit, the students were given the assignment of locating earth materials around their homes. The worksheet listed various earth materials (clay, ore, and limestone) and objects made from these (tile, silverware, and plaster). Claire recalled that assignment by including a picture of drywall (#1). In all, eight children took pictures of rocks (#2) or materials containing rocks (#3).

A similar assignment during the Sound unit was for the children to find objects at home that made sound and explain (using the term 'vibrations') how they were able to hear the object. Although very few of the children were able to illustrate how vibrations were transmitted from an object to their ear, the assignment was not as flawed as we thought at the time.

Jeremy joined the class halfway through the school year. His pictures were all of appliances (e.g., #4). The interviews revealed what he was intending to capture in these photos: all ten of the pictured objects made noise. He never mentioned the electricity involved but provided impersonations of the sounds each object made.

Related Issues

Despite the TIMSS report findings (Schmidt, et al., 1997) that describe the above average number of science topics covered in U.S. textbooks and curriculum guides here, the children benefited by having a relatively focused science program.

Concerned that science might lack cultural relevancy (Ladson-Billings, 1994) for inner city children, attempts to connect the concepts covered in the science units with the home were moderately successful. Many images of science photographed by the children can be traced to the science they were taught this school year.

Interview Excerpts

Prof: What's this (#3) a picture of? I see a hose here.
Rhonda: That's a picture of the ground. Cause cement got little rocks.
Prof: So why is that science?
Rhonda: It have rocks in it!
Prof: Oh, okay. So rocks are science. Okay.

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Prof: And this (#4) is the dryer?
Jeremy: Yeah.
Prof: So why is that science.
Jeremy: Cause it beats like a drum.
Prof: We've got a lot left here. Why are these others science?
Jeremy: Because if I start the car it's like "Vroom, karoom."

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Latisha: I took a picture of the TV (#5) when it was making sound. I turned it up or down.
Prof: So you can changed the volume to make sounds.
Latisha: This one; it was vibrating (picture #6).
Prof: What is that thing?
Latisha: It's a record rack.
Prof: You can make it vibrate to make sound too. Very nice.
Latisha: We put it on the wall and it go "bzzz."

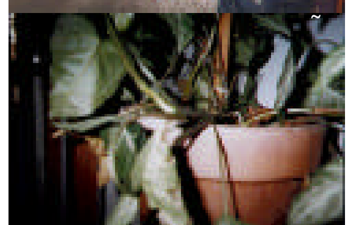
Pictures of Tools and Experiments

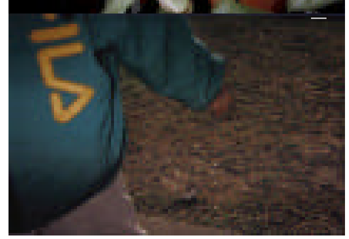
In this author's opinion, and it would seem most state and national standards documents would concur, that elementary school science must strike a balance between science content and scientific processes. To overemphasize terminology would neglect the inquiry. Similarly, to learn science purely through process skills development seeks to decontextualize the activities of scientists from the materials that are literally at hand. Hopefully, children will leave their elementary grades aware that "science" is both a noun (names, formulas, relationships) and a verb (observing, experimenting and inferring). By this measure, the photos from this class show room for improvement.

When asked to photograph science around their homes, most of the third graders were able to take the requested ten pictures. During the interviews, only a handful of children talked about their pictures showing science as a verb. A few children included tools such as a screwdrivers, tool boxes, hammers (pictures #1-#3) explaining these could be used by scientists to break open rocks, such as they did during their Earth Materials unit, or for building things.

During three interviews, scientific activities were described by the children. Jonathan depicted scientists as individuals who enjoy demonstrating their expertise to others. April described scientists as people who take samples of materials such as plant and skin and then conduct tests on them (pictures #5 and #6). She reported this is the type of work her uncle does.

But Jalonda was the only child to show science in action. As she talked about picture #4, she struggled to remember what she was trying to photograph. After a while, she recalled submerging the rocks she had gathered into vinegar to test for the presence of calcite. This activity was one conducted in class several months earlier and had apparently made an impression on her. Among all the students, she was the only child who decided to take a picture of herself actually doing something scientific.





Interview Excerpts

Prof: And you think that [#2] is science too. How come?
Juan: Cause you use tools …
Prof: okay
Juan: …to build stuff…
Prof: Um-hmm
Juan: …and to fix 'em.

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Prof: And you think that's science too (#4). How come?
Jalonda: This right here was some water. I think with some rocks in it.
Prof: So why did you put rocks in water?
Jalonda: I don't know.
Prof: Then why is that science?
Jalonda: [four second pause] Not water, but vinegar!
Prof: Oh, vinegar!!
Jalonda: Yeah.
Prof: Oh!
Jalonda: To see if they was, um to see if they was, had, um, um, um…
Prof: Yeah, you got it.
Jalonda: Um, yeah calcite.
Prof: Yeah! Okay, so that's what you're doing right there. Great!
Jalonda: See, she had, she was holding…
Prof: You found the rocks and she poured the vinegar in there?
Jalonda: Um hmm.
Prof: And that's your picture of that.
Jalonda: They didn't have calcite in them.
Prof: Cause I was trying [to see a reaction]. I don't see any bubbles.

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April: It's just a plant (#5). All plants are science. Because you can do experiments on them. And most living things are science. But not all of them are science. Fish: they are living thing. People, in the pet store, they do experiments on them and everything. And that's why they're science. This is my cousin and his grass (#6). It's science because people still do experiments about it and test it and things. Like they take some tweezers or something and pull some out.

Epilogue

The findings correspond to the study's three research questions. First, the photographs revealed that the students perceived science as encompassing both the physical and biological realms. Their photographs fell into categories of sky and weather, living things, technology, and tools and experiments. The students did not formally study space science during this particular school year so the pictures representing meteorology and astronomy were artifacts of their studies in previous grades. Attributing the process of growth as an indication of living things proved to be a rather sophisticated level of thought although the connections between life forms and science was difficult for the students to articulate. Half of the student photographers included an electronic device as an example of science, often explaining that the presence of electricity was the defining feature.

There were almost no pictures representing science as a process. A few students photographed tools because they are used by scientists by only one child took a picture showing the process of conducting an investigation: this lone photograph showed a handful of stones submerged in vinegar to assess the presence of calcite. In retrospect, the guidelines given for the assignment may have contributed to the paucity of science-in-action photographs. When this assignment was repeated the following year with a fresh group of third graders, they were prompted to include photographs of themselves DOING science. The difference in the kinds of science pictures between these two years was remarkable. Nevertheless, simply teaching science through the extensive use of hands-on materials is not sufficient to engender a clear appreciation of the nature of science; the societal misperception of inventions as by-products of scientific work must be addressed explicitly in the science classroom.

Second, there is some evidence that the science learned within the classroom held significance for the children in their daily lives. Several of the students revealed in their photographs a recognition of science concepts as they occurred in and around their homes. The connection-making included content studied during third grade as well as science studies from preceding school years. The unanticipated involvement of adults in the children's photography confounded efforts to determine the degree to which the science science learning or due to the guidance of their elders. However, the results lend credence to the belief that science can become relevant to students independent of whether they reside in the suburbs or the city.

Third, the cameras were valuable for providing insights into the children's minds. They were quite adept at using the cameras and showed great resourcefulness in translating their ideas into photographs. During the initial examination of the photos, it was apparent that the photographs' connotations were not immediately obvious: the explanations by the photographers were absolutely essential. Unlike a piece of art in which individual interpretation is the expectation, the purpose of these photographs was to communicate ideas, albeit in a unique fashion. The photographs only developed their true meaning when the students explained what it was they intended to represent.

One might wonder whether science photography is necessarily an urban project. It would be perfectly reasonable to imagine conducting similar work in suburban or rural schools. Yet the camera holds potential as an especially powerful tool in settings such as the one in which this study was situated. Urban schools distinguish themselves by marked differences between the teaching staff and the students with whom they work. For example, students of color represent 25% of the students in US schools, while in city schools they represent 77% of the student population (Council of the Great City Schools, 2000). This author recognizes the possibilities of the camera as a tool for transcending subtle yet profound barriers separating populations and individuals.

In their exhibitions, professional photographers Dawoud Bey and Wendy Ewald demonstrate the value in turning control of the camera over to their subjects. When those outside the mainstream population have a role in deciding how they are represented in a photograph, the images become powerful and revealing. Certainly this research account fails to fully test the limits of the camera as a science assessment and communication device. Apologizing for the obvious metaphor, the cameras supplied a unique lens through which the students could represent their thinking while also giving this teacher-researcher a welcomed glimpse into their thought processes.

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