Changing perceptions about science for underrepresented students through an authentic inquiry-based investigation

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Abstract

This study investigates how the context of authentic investigation may alter and shape underrepresented students' views about science. This research follows the implementation of the Fossil Finders project in an urban middle school classroom serving English language learning (ELL) students from Latino backgrounds. Following participation in an authentic investigation coupled with explicit instruction in nature of science (NOS) and interaction with a scientist, students demonstrated learning gains in science and altered views about science inclusive of science as 1) more than just a subject at school, 2) different than media-based examples of "mad scientists" in white lab-coats, and 3) more specific to the discipline of geology. Students also demonstrated self-identifying as scientists to a greater extent and greater interest in pursuing scientific careers. The changes in student perspectives coming out of the intersection between students' school-worlds of science and the practices of actual science illustrate the need to bridge between these disparate spaces and to create learning opportunities that facilitate students in doing so. The instructional approach used by the Fossil Finders poises initiatives that seek to draw together school, science, and students' everyday understandings as promising for engaging underrepresented students in science.

Introduction

As long as there are groups labeled "underrepresented" in the sciences, science education remains unsuccessful in reaching all students. Despite educational reforms (Rutherford & Alghren, 1990), in most school science settings and urban schools serving underrepresented students from Latino and African American backgrounds in particular, students are not introduced to science and scientific activities, but rather, to the activities of schooling (Settlage & Meadows, 2004). Researchers suggest that learning science, rather than learning about science, may occur provided guidance, authentic activities, and contextualized investigation (Driver et al., 1994; Chinn & Malhotra, 2002; Schwartz et al., 2004). Reform efforts toward inquiry or engaging students in the activities of science (National Research Council [NRC], 2000), meet this demand by providing opportunities for engaging diverse students, including students from underrepresented groups in science learning. Involving diverse students in inquiry, through the context of an authentic investigation in collaboration with scientists, may allow for students to interact with and experience the scientific community of practice (Lave & Wenger, 1991). Consequently, these students' views about science and the work of scientists may alter.

This study investigates student science learning and views about science through the context of the Fossil Finders project, a collaborative initiative between educational researchers, scientists, and science teachers centered in geologic instruction. The Fossil Finders project involves students in an authentic geological investigation of the past environment using fossil samples provided by paleontologists. Classroom implementation of this project includes teaching lessons from a curriculum that combines inquiry and explicit instruction in nature of science (NOS), as well as instruction in geological concepts, vocabulary, and the measurement and fossil identification skills. This paper focuses on the implementation of the Fossil Finders curriculum in an urban middle school classroom serving English language learning (ELL) students from backgrounds underrepresented in the sciences. This paper addresses the following overarching research question: *In what ways, if any, may student perceptions about science and the work of scientists change as a result of being involved in an authentic investigation and learning about NOS?*

Theoretical Background and Context of Investigation

The Fossil Finders project involves the confluence of three communities in the context of authentic scientific investigation: students, schools, and scientists. An overlap between theories of communities of practice (CoP)(Lave & Wenger, 1991) and situated cognition (Brown, Collins, & Duguid, 1989) frame the lens through which the intersection of these communities is viewed, with respect to scientific knowledge and practice. These theories guide the design of the Fossil Finder project and data analyses in regards to the interrelations, activities, and learning opportunities it may provide. While CoP perspectives afford possibilities to consider exchange between the three communities, notions of situated cognition frame science learning as a product of participating in the activities, context, and culture of science. Together, these components frame the Fossil Finders project, where the project involved students in inquiry, collaboration with scientists, and learning about the nature and practice of science.

With respect to situated ways of knowing, the Fossil Finders project can be seen as modeling the activity component of science in school settings through inquiry. In an inquiry-based science classroom, a learner: engages in scientifically oriented questions, gives priority to evidence in responding to questions, formulates explanations from evidence, connects explanations to scientific knowledge, and communicates and justifies findings (NRC, 2000, p. 29). The Fossil Finders curriculum provides opportunities for inquiry, guided by questions in relation to the geologic past and data-based evidence for constructing explanations using fossils. Moreover, the authentic investigation of the Fossil Finders project involves students in the context of science, which frames content-matter learning. Teacher collaboration with scientists toward pursuing authentic research experiences with students bridges school-based science with the scientific community. The curriculum further strives to expose students to the culture of science, through participation in inquiry, interaction with scientists, and explicit instruction in NOS (Lederman, 2004). Explicit instruction in NOS may specifically help deconstruct science by better framing the assumptions upon which scientific knowledge is based (Meyer & Crawford, 2008). Student engagement in this scientific investigation and related content-matter learning is thus viewed as a part of participating in the activities of the project.

The intersection of differing CoPs is brought about through the Fossil Finders project by involving students in the authentic research of scientists. To this end, geologists, together with educational researchers, helped shape the curriculum at the center of the Fossil Finders project. Moreover, geologists also guided teachers in developing background understandings of geology-based content and research practices through professional development. Teachers involved in this project were able to interact with these scientists for additional support while implementing the investigation in their classrooms. Moreover, there was opportunity for students to interact with geologists by means of an online forum. By involving students in authentic research and collaboration with scientists, the Fossil Finders project makes a significant point of departure from traditional school-based science instruction. Students involved in the project also brought varying degrees of scientific knowledge and understandings that shaped project implementation across school settings. The implementation of the Fossil Finders project in an urban middle school serving ELL students from backgrounds underrepresented in the sciences provided the opportunity to investigate how a classroom involved in an authentic investigation and explicit instruction in NOS may shift student perceptions about science and the work of scientists.

Intercommunication between scientists and this group of students was initially fostered through the online "Student Scientist" portal and "Ask a Scientist" section of the project website. However, student requests to meet a scientist materialized into a geologist's visit to this classroom. During this visit, the scientist answered student questions about paleontology and being a scientist, as well as assisted students in handling and identifying fossils. Though this classroom visit extended the original project design, it was in part made possible through the interrelationships formed by the teachers, scientists, and educational researchers during the summer prior to the classroom implementation of the project. Students in this classroom, specifically, thus experienced greater interaction with the scientific CoP than some of the other classrooms involved in the project. These learning experiences and others provided for by the Fossil Finders project and instructional approach, established a setting in which to observe student engagement in science and science learning through the context of an investigation.

Methods

This study used a participatory observation approach in collaboration with the teacher (Merriam, 1988) to address the research question. The first author observed the enactment of the Fossil Finders curriculum in one teacher's dual-language urban 5th grade classroom. This teacher, Monica, aimed to integrate inquiry into her instruction, although she may not have been expert in this approach prior to the project. As evidenced in the observations, she also practiced culturally relevant strategies in her teaching to reach her ELL student population. Monica enacted the Fossil Finders curriculum over 19 instructional days, in block periods of time spanning between 30 and 90 minutes. During this time, Monica introduced the background Fossil Finders instructional materials focused on nature of science and geology, extended these materials into literacy-building activities, and initiated the investigation. Moreover, a scientists' visit to the classroom established a setting in which students were able to interview and interact with the scientist.

Students in this classroom were pre-post tested using the elementary-school version of the Views on Nature of Science (VNOS-E) (Lederman & Lederman, 2005), prior to the implementation of the Fossil Finders investigation and upon its completion. The VNOS-E aims to assess students about their understandings about NOS. This includes understanding these aspects of NOS: science as tentative, empirically-based, subjective, involving human inference, and socially and culturally embedded. Analyses of the pre-post test and post-post test measures for five focus students indicate a shift from naïve views about science and NOS to emerging or partially informed understandings about science and NOS. These more developed views map on to what is a continuum of understandings related to NOS, from uninformed to emerging to informed.

Interviews were conducted with five focus students between the first and second iterations of the pre-post measure, where students were asked questions about science using the VNOS-E instrument as a guide. Focus students were selected for interviews to represent students at higher and lower levels of English language proficiency in the classroom. In these interviews, focus students had opportunities to elaborate on how their views on what scientists do and NOS were influenced by their learning experience in the classroom. In this way, interview responses serve to triangulate the VNOS measure and also reveal greater details about students' perspectives about science. Further, these interviews extended beyond the VNOS measure to gather more information about students' everyday and cultural understandings about science. Follow-up interviews were conducted with after engaging in the initial portion of the Fossil Finders investigation and interacting with the visiting scientist the previous day. These interviews followed a narrower script that focused more on what students thought about science in relation to their experience with the investigation and the scientist's visit. Analysis of these interviews revealed the focus students' changing views on what science is and how it is practiced. Together, student responses on the VNOS-E measure and student interviews describe how views about science changed with respect to their experiences of being involved in a scientific investigation in collaboration with scientists.

Findings and Discussion

Research findings suggest that an instructional approach involving students in authentic investigation and providing opportunities for students to interact with practicing scientists influenced students' views about science. In this section, evidence of enhanced perceptions about NOS, science as a field of practice, understandings about what scientists do are shared. This section also shares findings about increased student interest in pursuing scientific careers.

Enhanced Understandings about NOS

Focus student interviews and results on a pre-post measure indicate emerging understandings about NOS. Analyses of the pre-post test and post-post test measures for five focus students indicate a shift from naïve views about science and NOS to emerging or partially informed understandings about science and NOS. These more developed views map on to what is a continuum of understandings related to NOS, from uninformed to emerging to informed. The following student responses to questions on the VNOS-E represent changes in content-matter and in understandings about science.

The first question of the VNOS-E asked, *what is science?* Focus students in Monica's classroom responded to this question on the pre-test along the lines of viewing science as subject-matter in school, science as a way to find out about things, science as making progress, and science as reading a book (Table 1).

Table 1. Focus Student Responses to VNOS-E Question 1: What is science?

	Pre-test	Post-test	Post-post Retention Test
Alyssa	Science to me is a fun subject because you can learn and do a lot of projects.	Science is when you study about the earth and do expirimets, try to figer out things, to observe, to anylise and to infer	Science is went you study about the earth and pre-historyc time and when you observe and inference
Bianca	Science is like things that would help you find out about the solar system, gravity, you can find out about the moon, the milky way and lots of cool projects.	Science is about observing, making inferences, figuring out expiraments, and things that lived millions of years ago (dinosaurs)	Science is about studying the earth, fossils, archiology, and paleontology. It is about making inferences, observations, and learning about prehistoric times. Also you learn about the climates there was and then NYS was underwater with the trilobite and brachiopod
Raul	Making progess read about science book and lear what science is	I think that science is somein when some boday findes fossil and leardes abouet them and loveing wahat you do	science is a very cool thiing I like looking a fossel reiting down what you read what you looked at

Alyssa initially described science as “a fun subject” and Bianca described science as “things that help you find out about” a variety of natural phenomena. Raul, on the other hand described science expansively as “progress” and also very narrowly as something that you “learn from a book.” Post-test responses show enhanced understandings of the processes of science and of the active role of the scientist in observing, analyzing, and making inferences. For Alyssa, her initial response shifted from describing science as subject to considering scientific processes, such as when you “try to figer out things, to observe, to anylise and to infer” [sic]. She also connected the study of science with the discipline of earth science. Bianca elaborated on her understandings of scientific processes and also extended science to studying about dinosaurs. Raul wrote that science has to do with an interest in learning more about something. The retention-test responses indicated that students mostly held onto these views four months after completing the project. For example, Alyssa wrote that science is “when you observe and inference” and included her previous reference to studying the earth. Bianca wrote, “it is about making inferences, observations,” specifically. Raul’s response had to do with the empirical nature and processes of gathering data.

It is important to note that all three students moved from demonstrating having broad views about science to context-dependant views on science. For example, though the pre-test responses have nothing to do with geology or fossils, the post-test responses of all three focus students made reference to science as studying about the earth, dinosaurs, or fossils. The retention test responses were yet further contextualized by the project. For example, both Alyssa and Bianca referenced pre-historic times, while Raul wrote about observing fossils. In this way, these responses indicate that participation in an authentic investigation shaped student views about science.

The second question probed student understandings about the use of evidence in science and asked, *how do scientists know that dinosaurs once lived on the earth*? Several students provided examples illustrative of developing understandings about NOS. In her pre-test response, Alyssa wrote “Because they study a lot to know these things.” She thus attributed scientific knowledge to studying rather than knowledge production through scientific investigation. Her retention-test response to the same question, however, indicated the use of empirical evidence to construct explanations in science. She wrote “because they can see the tracks and in the rock you have prove that there were dinosaurs and they can see the prints." Though her notion of evidence in science is naïve, the difference between her responses demonstrates a more informed understanding about how science is practiced and the role of scientists in constructing scientific knowledge.

The third question probed student understandings of the subjectivity of science and asked, *how sure are scientists about the way the dinosaurs looked?* Two of the focus students' responses are illustrative of student growth in understandings about the subjectivity of science and the potential for error (see Table 2). In her pre-test response, Alyssa made reference to scientists possibly having seen the dinosaurs. However, her post-test response made use of evidence, such as fossils, as rationale for scientists being certain about how dinosaurs looked. Further, her retention test indicates content-matter understanding and hints at the subjectivity of science. Here she wrote about scientists being certain about the bone structures but not the skin. It can be inferred that her response relates to instruction about scientists not being certain about what dinosaur the skin actually looked like, despite widespread book illustrations and other images of dinosaurs. Brandon, however, maintained his responses in reference to dinosaur bones and fossils to describe the certainty of scientists with respect to the same question. Brandon also included a caveat to illustrative the human nature of science, "but everyone makes mistakes." In this, Brandon's response was indicative of his understandings about the possibility for human error in science.

Table 2. Focus Student Responses to VNOS-E Question 3: How sure are scientists about the way the dinosaurs looked?

	Pre-test	**Post-test**	**Retention Test**
Alyssa	Maybe some scientists swall they dinosaurs	Very sure because they have seen the Fossil and they are sure because they now when the study about back then.	I think there are very sure because if they put the bones together you can see how they looked but with out the skin
Brandon	cuse scientists studied on the bones and the found the now what dinosaur looked like	scientists know about the way dinisaur look. The research is to help them figure out what dinosaur it is. When the scientst found all the bones and put them all toghether. Then they now what dinosaur it is.	Very shure. The way that they now is by connecting the right fossils together. But everyone makes mistakes.

Another VNOS-E question probing for student understandings about the subjectivity of science included: *A long time ago all the dinosaurs died. Scientists have different ideas about why and how they died. If scientists have all the same facts about dinosaurs, then why do you think they disagree about this?* Alyssa responded with the answer "Because some scientists know different things." This response had to do with scientists' disagreement with one another based on what they may know. However, Alyssa's post-test and retention-test responses were "They may have different opionoin because they saw diferent thing" [sic] and "I think that they disagree because they may know something diferent of they may have different opinion" [sic]. In these responses, Alyssa indicated that scientists may hold differing opinions, rather than more or less knowledge with respect to the topic at hand. These statements are show Alyssa coming to understand the subjective nature of science and that the opinions of scientists may drive some of the conclusions that they make.

A VNOS-E question directed toward student understandings about the creativity and inference-making used by scientists in constructing explanations asked: *Do scientists use their imaginations when they do their work?* In response, Bianca first wrote, "I think they don't [use their imaginations] because scientists really do dig up things like dinosaur bones, reptiles, mamoths, and lot of others" [sic]. This response illustrates Bianca's understanding of science as strictly data-based, without an interpretive component. Bianca's post-test response stated, "I think they use their imagination when they find new animals and they imagine what they would look like." It is clear that Bianca made reference to the interpretive aspects of science, including the use of imagination, in her post-test response. In her retention test response, "I think they use their imaginations when they learn about prehistoric time and when they study fossils," Bianca retained her post-test view point and contextualized it in the realm of paleontological work.

Bianca also demonstrated enhanced understandings about NOS in response to the question: *scientists are always trying to learn more about our world. Do you think what scientists know will change in the future?* In her pre-test response, Bianca wrote: "Yes, because in our invironment we now have different animals and some might extinct in the ground" [sic]. This response has to do with how current understandings about the world around us may shape future knowledge. However, her post-test response stated, "Yes, because might not have been able to find full fossils with brachiopods and in the future the probably will." This answer pointed to the tentativeness of science through the type of data that is available. In this response, Bianca demonstrated more developed views about NOS in that she considered the empirical nature of science and the tentativeness of scientific knowledge.

These shifting responses across the VNOS-E measure indicate student development towards more informed views about NOS through their involvement in an authentic investigation and interaction with a practicing scientist. Though student responses may not include entirely robust understandings about NOS, they reveal that students are poised for future learning with respect to understandings about NOS. It can be assumed that an understanding that science is subjective may later prepare students to understand the cultural differences of science across the places where it is practiced.

Developing Views about Science: More than just a School Subject

Student interviews indicate developing understandings about science as being more than solely subject-matter following participation in an authentic investigation. For example, in her first interview, Paula stated, “science is about learning most of the stuff your teacher says.” But she also commented on the differences between “regular science” and the investigation she was participating in. “Fossil Finders is different from regular science because in Fossil Finders you have real fossils but regular science you learn from book.” Thus, Paula differentiates regular classroom instruction in her experience, with participation in an authentic investigation. Alyssa commented on her changed views about science following participation in inquiry-based work along a similar vein. “Before we started working on fossils, I thought science was reading out of a book.” These responses suggest that for these students, regular school science is not reflective of actual scientific activities.

Students also indicated enhanced views about the nature of scientific practice through interview responses, a further point of departure from standard school science instruction. In response to the question, “do all scientists do science the same way?,” all five focus students indicated that scientists did different kinds of work. For example, Bianca responded “sometimes a scientist might do experiments and sometimes a scientist might do fossils,” illustrating an understanding that not all science is experimental. Brendan commented on learning that scientists did other things than “experiment with chemicals.” Raul acknowledged that some "scientists learn from past and figure out fossils" but others "might be learning about something else." Meanwhile, Paula commented "scientists have different stuff to do" and explained that scientists discover new things and have different pieces of data to support their discoveries. These responses demonstrate emerging views about the diverse practices and fields of study that scientists may engage in and science as a dynamic practice, rather than information in a book.

In response to further questions, "do all scientists agree?" and "do all people agree with scientists?" student replies suggested differing, yet emerging understandings about the tentativeness and subjectivity of science. For example, Brendan stated, "scientists have imaginations and disagree sometimes." This response considers scientists as active agents of constructing explanations based on their subjective perspectives. Paula also explained that sometimes scientists agree and sometimes they do not. This is because "scientists aren't the same." Together, these interview responses indicate students learning about science as a field with active participants, rather than a passive school-based subject. Part of this may be related to contextualizing scientific content-matter learning within scientific activities.

Changing Perceptions about What Scientists Do

Focus students demonstrated changes in their views about science, NOS, and what scientists do following inquiry-based learning experiences and a scientist's classroom visit.

In her first interview, Alyssa mentioned liking science and wanting to become a doctor for babies. However, in the second interview upon completing data collection and analysis, she commented on the fact that fossils are fun and that she used to think that science was learning out of a book. Though Alyssa had an affinity toward science prior to her participation in the in the investigation, her views on what science were based on her classroom learning experiences and served to misrepresent the nature of scientific work. Bianca first mentioned that she wanted to become a veterinarian and acknowledged that there's "a lot of stuff that's involved that has to do with science" within the field. After being involved in a fossil-related investigation, Bianca acknowledged that fossils can teach you about which animals were around a long time ago and changed her mind to wanting to become a paleontologist. Her views on science also shifted. In her follow-up interview, she stated that she "thought science was about experiments and gadgets."

Brendan's second interview indicated a shift in his understanding what scientists do. "I thought scientists used chemicals and [laboratory] experiments, but they do more than that." Clearly, Brendan's perceptions about the broad range of work that scientists can be involved in shifted as a result of his interaction with scientists and participation in the research-based aspects of the investigation. Raul, as well enhanced his understandings about the work of scientists. He moved from a perspective that science is all about being "hands-on" to deeper set notions about science. Raul further claimed that there were different types of scientists, altogether. For example, while "scientists learn from past and figure out fossils, some [other] scientists might be learning about something else." Brandon also indicated growth in his understandings about science. In his first interview, he shared "scientists do experiments with chemicals, invent." However, second interview indicates reflection on his prior stance. "I thought scientists used chemicals and experiments, but they do more than that."

These student comments indicate a shift in perspectives about science and what scientists do upon engaging in an authentic investigation and interacting with a practicing scientist. The changes in student perspectives coming out of the intersection between students' school-worlds of science and the practices of actual science are illustrative of the potential for engaging underrepresented students in science learning through this instructional approach.

Beyond NOS: Learning How to Become *a Scientist*

The introduction of a scientist, Trina, impacted the students' views on science and interests in pursing scientific careers. Trina came into the classroom in casual clothing (i.e. no white lab coat) and had a friendly demeanor. Many students had never interacted with a scientist and they were able to ask Trina questions about science content and practice. Many of these questions focused on the process of becoming a scientist, rather than the traditionally recognized aspects of NOS and inquiry. For example, in the transcription below Anamaria asked the scientist how long she needed to study to become a paleontologist (December 10th, 2008, Lines 30-34):

Anamaria:	How long have you studied to become a paleontologist?
Scientist (Trina):	High school, did the math stuff, the science stuff that everyone else did, paid attention, did four years at a college. I had to go to school for another two years, but I did a bunch of other stuff so it

wasn't all science all the time.

Students asked the visiting scientist a number of other questions along the lines of how does one become a scientist. Figure 1 illustrates a list of questions that a focus student, Paula, prepared to ask the visiting scientist. These questions demonstrated that Paula was interested in learning how the paleontologist conducts science: what tools do you use, how do you study, and how long do you study for? Though these questions uncover the processes of entering the scientific community of practice and being within it, rather than NOS, they also serve to deconstruct the structural constraints of science. Students for example, may or may not be certain about the amount of time it takes to conduct research.

Focus students reflected an increased interest in science and pursuing careers in science following the Fossil Finders instructional unit and scientists' visit. For example, Alyssa, whose family had recently immigrated to the United States from Puerto Rico, shared that she had always wanted to meet a scientist. She wanted to learn what scientists did and how they felt (Alyssa Interview, December 15th, 2008). As stated above, this and other students' views about science and scientific research changed after participating in activities related to the Fossil Finders investigation.

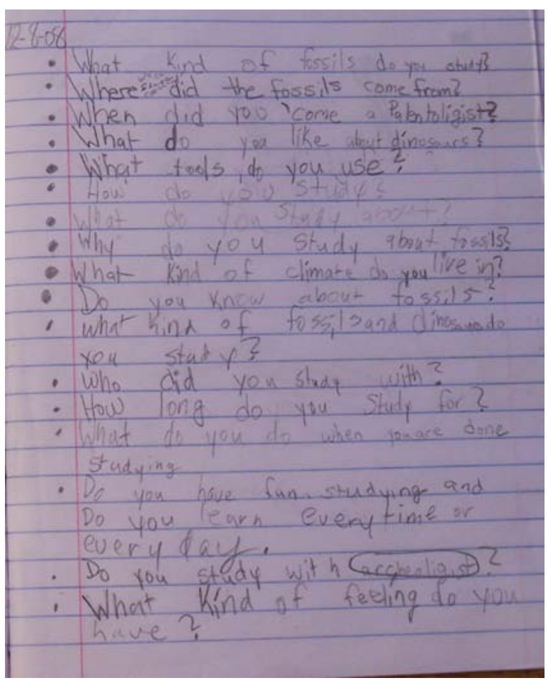

Figure 1. Questions for Scientist from Paula's Notebook; December 8th, 2008

Students also identified with also becoming and being scientists upon participating in the investigation when asked “would you describe yourself as a scientist?” However, reasons for describing themselves as scientists differed across students. Brendan, for example, self identified as a scientist because he “has a notebook like a scientist” and took notes. Raul, however, provided rationale for describing himself and the rest of the classroom as scientists for the reason that they were all involved in an investigation. “We’re basically doing the same thing” as scientists, he stated. Though in her first interview, Bianca honestly stated that she was not a scientist because she was “not that good at science,” in her reflective interview she identified with wanting to become a paleontologist, as described above. Like Raul, Paula also felt that she was a scientist; however, there were inconsistencies in what she thought scientists did and what she did to solve problems. For example, while she thought scientists “discover new stuff,” she explained that when she tries to figure out a problem, she does so by “using internet or an encyclopedia.” Her response does not entail the production of new knowledge; rather, it relies on sources of information for already determined facts. Though all focus students identified with being like a scientist, interview responses also indicated that the work of scientists remained largely obscure to them, as in Paula’s case above. This suggests that interacting with scientists increased student interest in science; however, greater opportunities for students to engage in authentic scientific activities may provide students with more informed understandings related to what the work of scientists entails.

Conclusion

In summary, following participation in an authentic investigation and interaction with a scientist, students demonstrated views about science as 1) more than just a subject at school, 2) different than media-based examples of “mad scientists” in white lab-coats, and 3) more specific to the discipline of geology. Students also demonstrated self-identifying as scientists to a greater extent and greater interest in pursuing scientific careers. The changes in student perspectives about science, resulting from student involvement in authentic scientific activities, illustrate the need to bridge between the disparate spaces of school and science and create learning opportunities that facilitate students in doing so.

Students' initial lack of interconnectedness between their views about school science learning and the scientific enterprise may be indicative of infrequent instructional links between the two. However, involving students in an authentic scientific investigation provided them with a context for situating scientific activities and practices, as well as the content that they learned. Along the lines of situative learning theory, inquiry became a vehicle for bringing scientific activities into the classroom setting, and thereby aspects of scientific culture. Explicit instruction in NOS served to guide students in making connections between what they were doing and how it related to science as a field. The interweaving of the activities, context, and culture of science thus provide a framework to situate geology content into a larger framework, science. Consequently, students demonstrated not only geology content-matter learning, but also more informed understandings about scientific activities.

Student involvement in authentic scientific activities was validated and reinforced through the classroom presence of a geologist. Students had the opportunity to ask the scientist questions about scientific content and practice, as well as learn about other aspects of science that they may have not considered. The scientist thus introduced opportunities for students to access the scientific community of practice, and for the scientist, as a representative of scientific community, to have an influence on the classroom. Through this experience, students also gained better understandings about the nature of scientific work. However, it is evident that students notions of what scientists did were limited to their classroom experiences of observing and identifying fossils. This indicates that varied inquiry-based learning experiences are necessary for students to have broader and more informed understandings about science.

Focus students also indicated that they had more interest in science and pursuing science-related careers following involvement in the investigation. Greater access to authentic scientific practices and interacting with a scientist provided students with the opportunity to view themselves as scientists and as contributors to scientific work. Nonetheless, it is important to note that while students self-identified themselves as scientists while participating in the project, their views of what scientists actually did were ultimately shaped by their classroom experiences. For example, many students were able to describe the processes of data collection, however, were not able to describe how scientists made use of data. This however, suggests that taking on a scientific identity is itself situative, and thus provides a strong argument for providing students from underrepresented backgrounds in science with learning opportunities that involve authentic investigation and communication with practicing scientists. Through the authentic nature of investigative instruction, students are able to experience some of the aspects of what it is like to be a scientist. These aspects of learning about science are unfortunately absent from settings that are limited to traditional instruction in science.

Further, through student questions, we learned that students were not aware about the process through which one may become a scientist. In other words, the pathway to becoming scientists was not explicit to students. Though bodies of work consider the accessibility of science for underrepresented and ELL students, questions related to what it takes to become a scientist remain obscure. We thus propose including "how to become a scientist" as a complementary aspect of NOS. It is clear that the instructional approach used by the Fossil Finders, which seeks to draw together school, science, and students' everyday understandings, poises promise for engaging underrepresented students in science. Further research is needed to evaluate its longer-term impacts on student learning and views on science.

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