As seen through the lens: Students' encounters and engagement with science during outdoor field trips

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Introduction

Field trips have a long history in modern education (Crawford, 1930; Sharp, 1943; Harvey, 1951; Hollenbeck, 1958; Benz, 1962; Falk, Martin & Balling, 1978; MacKenzie & White, 1982; Griffin & Symington, 1997; DeWitt & Hohenstein, 2010; Gutwill & Allen, 2011). Each year, millions of students and their teachers journey to places such as natural history museums, zoos, aquaria, science centers, and nature preserves (Rennie, 2007), even though these excursions can be cumbersome to facilitate (Orion, 1989; 1993, Kisiel, 2003). These activities are largely observational experiences in which students are placed in environments that provide unique access to specimens, exhibits, or experiences that otherwise would not be available in a typical classroom. Field trips are increasingly being recognized as an important place for children to learn and engage with science and scientific practices in a way that spans both formal (e.g., schools) and informal spaces (e.g., museums, parks) (NRC, 2009).

For the most part, field trip educational research has focused on the evaluation of learning outcomes, rather than on how students engage with the disciplinary activities that are incorporated into a field trip. Thus, research on field trips has been based on data collected before and after the field trip, rather than during the field trip. This means that field trips have essentially been treated as "black boxes." For example, a typical research method employed to measure the effectiveness of a field trip compares one class who took a field trip to another class who learned traditional science at school by hearing a lecture and watching a slideshow about similar concepts. The students are given pre- and post-tests to measure differences in learning, which researchers attribute to features of the

field trip treatment (e.g., Harvey, 1951; Falk & Balling, 1982; Nundy, 1999). This line of evaluative work is often about justifying certain design decisions or proving that field trips increase knowledge, but is not about understanding how students participate in field trip activities or make sense of those activities as pertaining to science.

However, we can now look at records from field trips because of simple to use and portable recording technologies. In this paper, we take seriously the idea that student-generated photographs and digital video can serve as important records of 'scientific' activities during field trips. The capture of digital video and photographic records on field trips have been noted as an activity largely undertaken by adults, such as a classroom teacher who is obtaining documentation of the experience (Kisiel, 2006). However, it is now common to see children on field trips obtaining their own photograph images. In keeping with the theme of the symposium, we are interested in how students encounter scientific ideas and practices and how they are positioned as participants in relation to science field trip experiences.

We draw from data taken from two separate projects that involved students visually documenting their experiences during science field trips. The first project, based out of the Midwest, involved a series of outdoor earth science and biology field trips. These field trips were to both local and distal locations. At these locations students were tasked with making scientific observations using cameras and other tools to support ongoing science classroom learning. The second project, based out of the mountain west, involved students traveling to a National Park in Wyoming where the students documented their experiences on this multiday environmental science field trip using digital cameras. Through examples from these two projects we try to give a sense of the

'encounters with science' students occurred 'naturally' in the context of a field trip. We seek to demonstrate using examples from these two projects that common kinds of unexpected objects are noticed by students. These encounters offer students the opportunity to engage in questioning, speculation, and discussion that are consistent with the practices of science. We also will discuss how by simply providing students with tools to document their experiences, they were able to engage with the objects they were encountering and adopt new roles that supported new ways of reflecting and talking about science content that they had encountered.

Background: Data from two studies

This paper draws upon two independent projects related to science field trips led by the first and second authors in very different parts of the country. For the first project (led by JB), the researcher partnered with one fifth-grade teacher (with three participating classes) and one sixth-grade teacher (with two participating classes) in a major Midwestern metropolitan area who had a combined set of five classes of students. These students were enrolled in either Biology (5^{th} grade) or Earth Science (6^{th} grade) classes with the partnering teachers. In the biology classes, students learned about ecosystems and environments and how organisms survive and thrive. The students in those biology classes participated in two courtyard field trips, once in early spring occurred during early spring and once in mid spring when the campus garden was in full bloom. With a map, a question log, and a digital camera, students found examples of living things and documented with cameras their relationship to the physical environment. During April, following the first field trip, the students began working in pairs to construct PowerPoint

slideshows using observations they made during the first courtyard visit. They continued working on these projects following the second field trip to the courtyard when they noticed changes. In early May, each pair presented their slideshow to the class. Their slides were presented for the whole class as an opportunity to question and comment. All the digital photographs were collected for research purposes, as were their PowerPoint presentations. In June, each class traveled by bus either to a local river or to a nature arboretum for a special event field trip, but these trips happened near the end of the school year after the PowerPoint presentations had been completed.

For the earth sciences classes, the students learned about minerals, rocks, and manmade materials. In late March, the students went to the schoolyard to collect soil samples. Rather than construct PowerPoint presentations using self-generated photographs, as the biology classes had done, the primary task was to sample soil for subsequent classroom analysis. This schoolyard field trip resulted in students gathering many soil specimens, which they studied in the classroom to learn about the physical, chemical, and biological properties. The thrust of the follow-up science activities was to understand how soil is made, where it comes from, and where it goes. They described the color and texture and noted living things such as roots, twigs, and worms. This comparison was intended to help students see various physical and biological properties of soil.

Later, the earth science classes traveled by bus to a river habitat and surrounding woods. Again the students collected soil from a depositional environment. In the days and weeks that followed, the students continued to investigate their soil samples during various hands-on laboratory activities back at school that extended through the middle of

April. These laboratory activities coincided with the book chapters on rocks and soil. In late April, the Earth Science classes went on a field trip to the neighborhood around their school to see examples of natural and manmade materials such as bridges that were physically and chemically weathering and eroding.

Five focal students from each science classes were given Flip Video cameras to record what they saw happening and things they found interesting or important. The focal students also wore continuously recording microaudio recorders. The audio from the microaudio recorders, the audio and video from the researcher video cameras, and the video generated by the focal students are the three main sources of data that were used to reconstruct what happened on these 14 field trips (Boxerman, 2013).

For the second project (led by VL), a researcher partnered partnered with a team-taught fifth-grade class from a public elementary school located in Utah that was scheduled to participate in an annual field trip to Grand Teton National Park (GTNP), a US national park in the Western United States known for mountainous ranges formed by glaciers and a woodland ecosystem populated by animals such as bears, moose, elk, beavers, and bison as well as plant life such as Lodge-pole pines, Douglas firs, aspen, sagebrush, and huckleberry plants. This was a trip that fifth-grade students in the school had taken for over 10 years. It was regularly hosted at Teton Science Schools (TSS)[1], an independently run, nonprofit outdoor education program that emphasized naturalistic scientific inquiry and place-based pedagogy. TSS provides Teton-based educational programming for a number of visiting student and adult groups throughout the year and provides pedagogical training for outdoor educators and K-12 teachers.

[1] http://www.tetonscience.org/

The field trip took place within the first three months of the school year and lasted for four days and three nights. In preparation for the trip, the fifth-grade teachers sequenced their science curriculum so that they covered science content related to weathering, erosion, and native wildlife immediately prior to the trip.

Twenty-seven (27) students were each provided with a point and shoot digital camera and a minimum of a 4-Gigabyte memory card. The students were encouraged to take pictures of things that they saw that "showed science" throughout the duration of the trip. All photographs (4,178 images) were collected and stored as data. One week after the trip, members of the research team individually met with 18 of the students and provided them with a laptop and a slideshow of all of their pictures. In the interview, students were asked to talk about the pictures they had taken and why they took them. The interviewer would interrupt with clarification questions and would periodically remind students of the commentary they were being asked to provide should they cease to offer it after viewing multiple pictures. These interviews each lasted roughly an hour and were each video-recorded and transcribed.

Finally, the team recorded observational notes from the field trip. A member of the project team obtained permission to join the field trip as an additional, non-parent chaperone. Each day, he accompanied a different one of the three field groups when there were activities that the field groups completed separately.

Common Observations from the two projects

Point 1: Common kinds of objects for documentation – precipitating events

Many of the same phenomena were noticed within the field trips and across the various sites. Boxerman (2013) called the discovery of these phenomena or objects in a field trip a 'precipitating event'. Stated simply, a precipitating event is an occasion that lay the foundation for students to engage in further conversations and activities related to the phenomena or objects that were encountered. For example, encountering a Van de Graaf generator at a museum and observing how it affects a visitor's hair upon physical contact could serve as a precipitating event for further conversations and explorations related to electricity that were in some way tied back to the common experience of seeing and using the generator.

In our data sets, we observed these as opportunities for students to begin engaging in practices of questioning and speculation. Certain objects struck students as surprising and tended to generate attention (often from a verbal callout from a student). The objects or phenomena were in some way atypical from what was normally encountered in the classroom and became a locus for conversation. What was striking in Boxerman's data was that, given his study of multiple classrooms, common objects or phenomena were identified by different students as noteworthy – despite involving different students and different groups of students - and thus they became precipitating events.

We present an example from each project below to illustrate.

Example 1: The dead bird

The dead bird event began when Marcy was trying to find something other than 'plain grass.' Then, behind a bush, beside a window, she saw it – a dead bird (see Figure 1). The excitement of Marcy and her partner Manuel was immediately evident, and they

broadcast their excitement loudly to the rest of the class. Manuel yelled, “We found a dead bird! Go. Go. Go. Take it.” Within seconds, eight students were huddled behind the bushes peering at the bird remains with their cameras in hand. “Disgustingly awesome!” said Emogen. The excitement was building. There was quite a bit of yelling, screaming, and running around. Flanna wondered how the bird died and what killed it. Many students hovered over the bird to make closer observations. Other students who wished to keep a safe distance used the zoom features on their cameras.

While half the class squatted beside the bird and talked about it, Calvin screamed at the top of his lungs. He left his group after quickly looking at it and then ran to the other end of the courtyard to alert his classmates, who were in the midst of making plant observations but did not yet know about the bird. He yelled exceptionally loud and for a good length of time, “Dead bird!...We found a dead bird!” JB followed Calvin to the north end of courtyard, while Mr. D, a student teacher, recorded what he saw happening with the group beside the bird. Upon hearing Calvin’s call, Minos signaled to others, “Guys, a dead bird.” Minos and some other students initially had a hard time seeing the dead bird and instead had focused on a rotting orange peel that was nearby. The balance of the class upon experiencing Calvin’s enthusiasm rushed across the distance of the courtyard to see the bird in person. Nagel, struggling to catch his breath, instructed his partner to “Write down the question: How did the bird die?” Nearly the entire class was huddled around the dead bird behind the bushes relishing in their discovery. While standing beside the dead bird, students openly theorized about how it died. Norbert reasoned from prior knowledge that the bird probably crashed into a window. He moved away from the dead bird frenzy and spoke nonchalantly, “It probably crashed into the

window because it happens a lot to our house. I'm gonna go back and get a picture."

A handful of students were not near the bird and were making observations elsewhere in the courtyard. Manuel emphatically shared with Mr. D, "They found a dead bird and you could see its skull, it's really weird." Manuel then informed JB that he "didn't write anything" and then forcefully told his partner Marcy, "We gotta write something."

Meanwhile, the class was still abuzz with excitement. They were in the flow of the activity. A number of students could be heard in the background repeatedly asking, "How did it die?" Other students such as Emogen, Manuel, and Jedidiah were thinking about how it could have died. They gestured while they explained to Mr. D that crashing into the window was entirely plausible. Manuel recalled that owls in Harry Potter crashed into windows trying to deliver letters, and he used this piece of information to justify his explanation. For some time, many students persisted in openly thinking about how the bird died. Nagel wondered, "What is [the] age of [the] tree?" because the age of the shrub the bird was under could have been helpful to him for constraining when the bird died. Nagel announced, "We found a dead bird and our question was how did it die?" Norbert and his partner overlapped talk when they both asked, "Did it die?" JB asked Nagel how they would be able to answer questions about the cause of the bird dying. Nagel was not sure. While Nagel and others theorized about the cause of the bird's demise, Maddy video recorded her peers. She reflected on "how kids react to the dead bird." Maddy critiqued, "Everybody ran over there it was kind of interesting because Louise said she was the only one who had the guts to take the picture. I thought it was gross because the skull was showing."

The dead bird left quite an impression. It even became a focus of attention approximately 30 minutes after the initial discovery. This coda to the precipitating event began when Nagel invited his peers over to the bird. He drew their interest with the promise that he would be courageous and touch the dead bird. So a group of students followed him over to the bird. Beside the carcass, Nagel put on a glove to protect his skin from the bird because, as he said, “I’m not stupid.” The group that gathered around was thrilled to eyewitness this daring feat. Nagel fed off their attention and gleefully touched the rotting fruit peel that lay a foot from the bird. His peers realized the trick and laughed heartily. After they figured out the prank, they insisted and joked he should touch the real thing. Then upon the insistence that he fulfill his promise, he reached out with an arm outstretched and quickly touched the actual bird. They screamed and laughed again. Nagel savored their reaction and the attention he received. He gestured to touch his partner with his gloved hand that touched the bird. His partner screamed and then said while running away, “You touched the dead bird, don’t touch me!” After everyone had left the immediate area Nagel proclaimed how much fun he was having.

(a)

(b)

Figure 1: The dead bird and the group of students huddled around it making videos and photographing it.

Example 2: Bison Remains

During the national park field trip, the class of fifth graders were split into three hiking groups led by a staff member from TSS and accompanied by parents. Each group ventured to a different part of the immediate river area to discuss the surrounding ecosystem and also to look for animal tracks. One group, which VL accompanied, staked claim to one area where the facilitator first had the students turn around and he then proceeded to hide a small stuffed toy in the shape of an alien. The students would then turn around and then proceed to look for it. The point of the exercise was to be carefully observant, avoid disturbing the ground, and examine many different familiar objects (such as bushes, trees, fallen logs) carefully. After completing this a few times and discussing the manner in which observations should be done (carefully, slowly, and methodically), the students were given several minutes to try to find animal tracks. One

student ventured off a ways and called back excitedly about a skeleton he had found. The facilitator, who regularly led groups, was already aware of the presence of the skeleton but allowed the students to congregate and practice their ‘observation’ skills to share what they had noticed about the skeleton. The conversation quickly went to ‘how did it get here’ and ‘how did it die?’. Several students immediately pulled out their cameras to photograph the skeleton.

Following this ‘discovery’, there was a clamor of excitement among these students to find animal remains for the remainder of the trip. It was not at all uncommon to encounter some remains, and thus became a recurring theme for the next several days. The process became one of trying to determine what kind of animal it was (often it was elk, but there were some other bones discovered), what various bones were for, and then discussion of what must have happened to it. The residue for this experience appeared to be tied closely to the ‘discovery’ of bones out in the field. There were many other encounters with bones, such as mounted skulls, bones on display in exhibit spaces but these did not generate comparable enthusiasm and excitement. To illustrate, consider the examples provided in Figure 2.

(a)

And this you can see, it is cracked right there, and you can see the fur, and you can see the hip bone, but there was two rib cages…this one was not entirely broken so we [my friends and I] are guessing that this one had stronger bones, and we are guessing it was a bison, and we are guessing this one is a moose or an elk, and we think a wolf went after these two.

- Student 13

(b)

And this is a picture of an animal, I think it is probably like a… I don't know…but it is bigger than me.

- Student 11

Figure 2: A comparison of animal skeleton photographs and comments provided by students during interviews after the field trip.

As can be seen, the student who was discussing the bison skeleton had a great deal to say. He actually began to recount some of the observations and reported back much of the conversation and thinking that he and his friends had engaged in when the skeleton had been first discovered. In contrast, in an exhibit space on the premises, a mounted deer on the wall of a 'classroom', a skeleton was photographed by a student as showing science, but the conversation around that object was much less animated. During the time that this skeleton was encountered, the students were in the process of looking at, describing to their classmates (who were seated so that they couldn't see the bones), and watching as their classmates drew bones based on their description. The facilitators at TSS treated this as one of many instances of a 'scientific communication' exercise. The students were practicing how to be specific in their descriptions, specifically with respect to observable features such as size, color, and shape. This was not an event photographed by very many students as being 'science'.

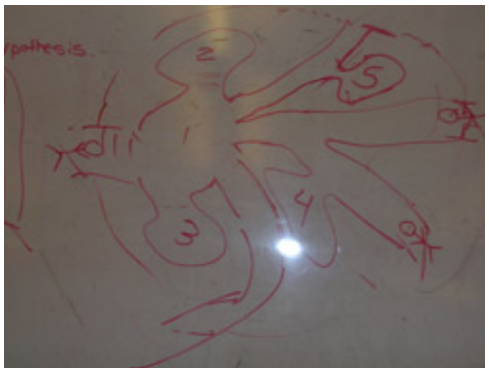
Point 2: Recording devices influence behavior

A second point we wish to discuss relates to how the presence and availability of recording devices influenced behavior. In providing students with cameras, we were largely interested in getting students' perspectives of the field trip experience. However, the sheer presence of recording technologies appeared to establish opportunities for students to position themselves as documenters, innovators, and investigators of science

experiences. We present two examples to illustrate innovations that came about when students were able to play the role of documenters with their digital cameras.

Example 1: The inside of a beaver lodge

(a)



(b)

(c)

Figure 3: A photo taken from the inside of a beaver lodge (a) which was then discussed and used to help figure out the internal structure of the beaver lodge (b) and subsequently was presented to the rest of the class (c)

As part of the Grand Teton trip, groups of students were responsible for conducting an investigation of their own choosing and creation and for presenting it subsequently to the rest of the class that evening. One of the groups had originally planned to do some comparison of different areas where animals could live, but the idea came about to visit an area that happened to have an intact, but abandoned beaver lodge. (A beaver lodge is the primary habitat that beavers create. The lodges are made of a combination of sticks and mud near a river and a dam that they assemble. A beaver lodge houses up to roughly a dozen beavers from the same family for a season.)

Upon discovering the lodge, one adventuresome boy decided to crawl inside the lodge. Beavers build the lodges such that larger, more dangerous animals (such as a fifth grade boy) are not able to reach the inner partitions of the shelter. This was discovered quickly by the boy, but he decided to extend his camera further beyond where he could fit to get photographs that he could share with his group. Given the viewfinder on the camera, this was entirely possible and thus enabled the students to find out about the rooms inside of the lodge.

Upon returning after taking the pictures, the entire field group worked to reconstruct the internal structure of the beaver lodge. The boy who had taken the original pictures was so enthusiastic about the photographs he had taken that he pleaded with the TSS field guide and one of his regular classroom teachers to let him show the photographs on an overhead projector during the investigation presentations[2]. When they returned to TSS, and after much searching, they found a USB cable to connect the camera

[2] The cameras were intended to be available for students to document their experiences but were not meant to be integrated into any of their investigations. This initial plan was discussed and agreed upon among all the TSS staff members involved with the trip shortly after arrival.

to one of the TSS computers and transferred the images so that he could show these to the entire class.

This presentation about the beaver lodge generated so much interest that the teachers made arrangements with the bus driver to take the entire class to the location of the beaver lodge on the return bus ride so that the entire class could see it. After reaching that location, rather than admiring it from afar or from the outside, over half of the class then proceeded to climb (through the mud) inside of the beaver lodge so they too could get pictures of the interior. While this was not intended, the presence of the camera ultimately served two roles. First, it allowed the first boy to get a view of a space that he (and his classmates) could not access. Second, the public presentation of the picture of the beaver lodge enabled the entire class to see something unexpected and unique and motivated many of the students to 'get their hands dirty' (as well as the rest of their bodies) by emulating him so they could get their own photographs of the inside of the beaver lodge as well. According to the classroom teachers, the intact beaver lodge was a sight never before encountered on any trips to TSS. It subsequently became a topic of discussion and part of a showcase involving parents a few weeks after the students returned to Utah.

Example 2: The purple crocus

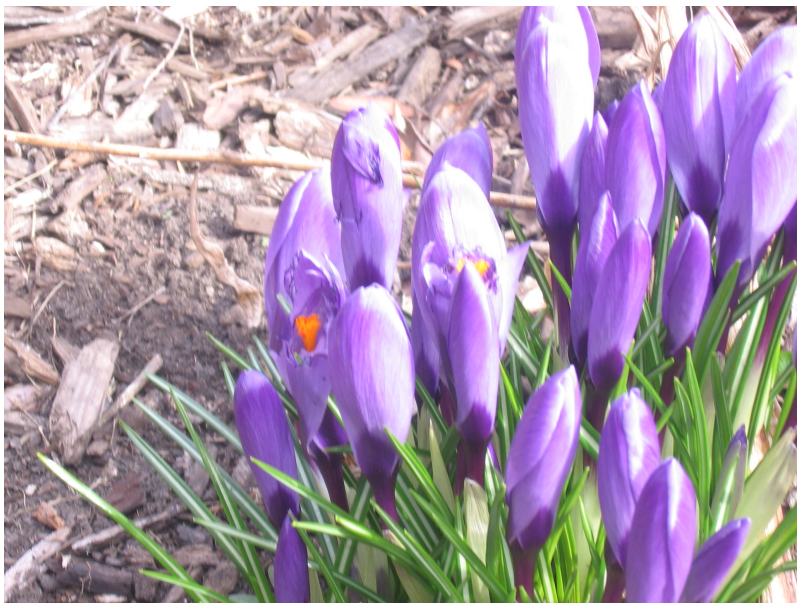


Figure 4. Student photograph of purple crocus flowers.

In JB's project, students often also used the cameras as intended, naturalistically, as tools to capture talk and action in the flow of the science activity. Like the Teton kids, it also appeared that the cameras could play another role; for some parts of the field trip experiences, the cameras appeared to mediate students' sensemaking. One way students did this with the Flip Video cameras was by routinely "event casting". This involved students recording audio commentary while they filmed, a metacognitive practice suggesting they were being thoughtful about what they saw happening.

For example, partway through the dead bird event, a handful of students left the bird to observe a patch of purple flowers (see Figure 4). Unlike the dead bird, the flowers did not cause a big excitement and only involved one small group of students. Like the dead bird event, this event precipitated a good amount of residue. The purple crocus event initiated when Manuel spotted a couple of his peers across the courtyard beside the

purple flower patch. He turned to his partner, Marcy, and insisted that she make a video with him talking about these flowers. She agreed. The two of them walked over to the flower patch to event cast it. They started filming a movie about the flowers. The petals of some of the flowers appeared wilted and ripped. “Look at these purple flowers, I bet something ate it,” Marcy questioned. “Why are they eaten?” Calvin argued that he thought the flowers were “too bloomed” and had “bloomed out.” The act of filming a movie about the wilted purple flowers motivated this group of students to take a closer look, to notice details about the flowers, and to speculate about what caused the petals to change.

The handheld video cameras were provided for capturing the students’ perspective of what happens on field trips. Interestingly, even though the cameras were provided with a fairly specific research purpose, when given the freedom to capture what they see happening, students were motivated to appropriate the technology in innovative ways and interact with the objects they were originally casually documenting in more substantive, engaged ways. For example, one pair of students decided to use the tool creatively, making a movie about the science content, playing roles of director, producer, and assistant director.

Discussion

One of the focal concerns of the symposium of which this paper is a part is the ways in which both learners and ‘science’ as a practice are positioned with respect to one another in a range of contexts. In this paper, we focused on field trips. Drawing from two separate and independently run projects, we observed a number of similarities despite

different populations, sites, and research designs. Specifically, we observed the appearance of 'precipitating events' in field trips where new or novel objects prompted ways of engaging with science content and science practices. This is one way in which we believe field trips can be a boon for supporting science learning. Exposure to sites that offer objects that deviate from the norm, whether it is a dead bird or a mysterious skeleton, appeared to invite valid questions and speculation about how the object came to be where it is. For field trips that truly involve excursions into 'the field', it may be that having opportunities to examine natural objects as they came to their present state and location means that students will not default to an assumption that the object was 'staged'. It is unlikely that anyone deliberately killed a bird or bison and placed it somewhere for students to discover and use in their science class. Given that, there are legitimate questions and also a set of legitimate answers drawing from everyday experience and diverse knowledge related to the object of inquiry and the setting being explored. This is a marked contrast, for instance, from a typical classroom lab activity in which an 'experiment' is done for the purposes of verification and the desired result is known beforehand. Thus, one point we offer about positioning is that by providing opportunities for students to engage with real, messy settings such as those that are abundant 'in the field', authentic questions can emerge and real occasions for wondering and interpretation can take place.

A second observation we made from the two projects is that by providing students with familiar yet expressive tools can also enable the adoption of new roles that position students in productive ways. This idea of documentation tools leading to shifts in roles has been documented elsewhere. For example, Ching, Wang, Shih, & Kedem (2006)

documented how students in a K-1 classroom appropriated and used a digital camera to record and document their everyday classroom experiences. One case they reported on involved a student who, upon possessing a digital camera, positioned himself differently in the class and ‘snuck up’ and approached certain people and objects in ways very different from what was typical for him in the interests of documenting something with the camera. We believe something similar is happening here, but it is in the context of engaging with the content and practices in science. We reported on occasions from each project where having the camera allowed students access to places and roles that they might not have had otherwise. Our second point is that by providing learners with technology to document experiences, we are subtly shifting their roles with respect to the activity that they are assigned to ‘record’. In the context of a trip or outdoor excursion that is framed as being ‘about science’, this could lead to new and productive ways of relating to the activity.

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