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Echoes from the field: An ethnographic investigation of outdoor science field trips

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Abstract

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As popular as field trips are, one might think they have been well-studied. Nonetheless, field trips have not been heavily studied, and little research has mapped what actually transpires during field trips. Accordingly, to address this research gap, I asked two related research questions. The first question is a descriptive one: What happens on field trips? The second question is explanatory: What field trip events are memorable and why? I employed design research and ethnographic methodologies to study learning in naturally occurring contexts. I collaborated with middle-school science teachers to design and implement more than a dozen field trips. The field trips were nested in particular biology and earth sciences focal units. Students were tasked with making scientific observations in the field and then analyzing this data during classroom activities. Audio and video recording devices captured what happened during the field trips, classroom activities and discussions, and the interviews. I conducted comparative microanalysis of videotaped interactions. I observed dozens of events during the field trips that

reverberated across time and place. I characterize the features of these events and the objects that drew interest. Then, I trace the residue across contexts. This study suggests that field trips could be more than one-off experiences and have the potential to be resources to seed and enrich learning and to augment interest in the practice of science.

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Preface

The very word excursion carries with it a certain suggestiveness of pleasurable excitement...to feel the heightened sense of living, which accompanies the exploration of new fields.

(Atyeo, 1939)

It seems to me that the natural world is the greatest source of excitement; the greatest source of visual beauty; the greatest source of intellectual interest. It is the greatest source of so much in life that makes life worth living. -David Attenborough

To me school is more than book learning. It is about life lessons and experiential learning. My motivation for this study arose from a curiosity about learning in the natural world—in the actual settings in which phenomena exist.

Several years ago I was hiking in Anza Borrego State Park. I stopped at the visitor center. In the park newsletter was a lead article that began with the statement “the best classrooms are the ones without walls.” This statement piqued my interest. I was not interested in proving the validity of this claim, but I was interested in understanding how learning happens in outdoor spaces (Orr, 1994; Sobel, 2004; Louv, 2006). What happens learning is situated in these places? I was curious to see what happens when learners explore new fields. I had a hunch that I might see learners identify and connect with newfound places, but what I discovered was something much more powerful than field trips connecting learners to places. I found that people connect places through memories of events, and they do so in social and emotional ways.

John Dewey (1922) wrote, “In every waking moment, the complete balance of the organism and its environment is constantly interfered with and as constantly restored. Hence the 'stream of consciousness' in general, and in particular that phase of it celebrated by Williams James as alternation of flights and perchings. Life is interruptions and recoveries" (p 178-179). Dewey means that we seek to make sense of the world through a process of finding stability, encountering interruptions and restoring order. The act of organizing our world is about holding life in balance. For this dissertation, I built theories about children on field trips, what happens when order is disrupted, and how recoveries emerge.

The outdoors is a powerful setting where learners may direct their own learning. It creates space for interest driven discovery. When I investigated outdoor science field trips, I found that unplanned moments of discovery were memorable. I looked to see what happened during these experiences. This thesis examines those moments that precipitated memories and then follows their traces across time and place.

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Chapter One: Research Problem and Questions

The purpose of my dissertation was to investigate how learning happens through outdoor science field trips. In this chapter, I discuss why field trips are important to study. Then, I unpack the research questions. This introductory chapter concludes with a thesis overview and a summary of what follows in the subsequent chapters of this dissertation.

Field Trips

A field trip is "any journey taken under the auspices of the school for educational purposes" (Sorrentino & Bell, 1970, p. 233). For this dissertation, a "field trip" is an observational, student-centered science activity that happens beyond the classroom. I am studying outdoor field trips in particular. On these trips, groups of self-directed kids engaged in observational activities were tasked with generating data for subsequent classroom analysis. I am not looking at field trips to science and nature museums where students see exhibits and objects behind glass. I also rule out other kinds of popular excursions including graduation field trips, field trips to theatres, and field trips to other cultural institutions that do not directly relate to ongoing science learning. I am studying what happens on outdoor field trips where phenomena are embedded in the real world systems in which they naturally exist.

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).

Indeed, field trips have been found to spark interest and motivate learning, inspire perspective taking, allow for the verification or illustration of information learned in the classroom or in other settings, introduce new concepts, and provide exposure to new experiences (Rennie & McClafferty, 1995). Anderson, Kisiel, & Storkskieck (2006) found that field trips are popular with teachers because they believe field trips are powerful and valuable learning experiences affording authentic hands-on, multi-sensory learning opportunities.

Despite their popularity, some people argue that field trips are “missed educational opportunities” (Tunnicliffe, Lucas, & Osborne, 1997) because while learning happens, it is not always the targeted content that teachers intend that is learned. Field trips appear to have the capacity to offer many rich opportunities for science learning, but for many reasons fail to capitalize on them. This challenge, of field trips being one-off experiences for which we see only the slightest educational impact, has been labeled the “field trip problem” (Stevens & Toro-Martell, 2003, p. 17). This dissertation aims to understand this challenge, which has not yet been studied for a variety of reasons. The following illuminates some of those reasons.

For the most part, field trip educational research has focused on the evaluation of learning outcomes, rather than on learning processes. 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.”

Field trip data is typically collected outside of the actual event and sometimes only after the event has transpired. 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, 1981; 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 about studying their learning processes.

Studying what happens on field trips poses some particular challenges. The methods typically used to study field trip learning fail to capture all the layers of activities present. A related challenge has to do with the space in which the activities happen. In classrooms, students are generally seated at desks, whereas on a field trip, students roam around large spaces individually or in groups, sharing ideas with their peers and teachers. This complicates data collection efforts because it is very difficult to see and hear what most students experience when everyone is dispersed geographically and engaged in parallel field-trip activities. The logistical challenge of conducting field trip research is an important reason for why field trips are poorly studied. New ways of capturing multiple, nested layers of activities that go on during field trips have materialized. Video technologies that capture rich detail of student talk and action in everyday situations have only recently become readily affordable, portable, and with good enough sound quality to work in noisy open spaces (Derry, Pea, Barron, et al., 2010).

In practice, field trip research is a time-consuming, expensive, and complicated process. For example, gaining access to classrooms to conduct thorough educational research with school children, especially for activities to take place off school property can take months of planning and preparation and requires significant coordination and networking with a variety of stakeholders (e.g., IRB boards, principals, teachers, parents, students, research assistants, chaperones, science center staff, etc.). Even if the logistical concerns surrounding access and preparation are addressed, it is difficult to conduct field trip research because of the significant challenge of scheduling.

Researchers tend to construe the types of outcomes they are interested in relatively narrowly, which is a third reason field trip research comes up short. They focus very narrowly on content and affect, but there are other kinds of outcomes besides changes in interest, attitudes, and the accumulation of facts. For example, changes in the kinds of talk can be thought of as an outcome. In order to know what types of additional outcomes to look for, however, one must first see what actually transpires on the field trip.

There are now increasing calls to research learning everywhere it happens (NRC, 2009) such as at home playing video games (Stevens, et al., 2007), in a carpool (Ochs, et al., 1992), or at a museum with family (Ash, 2003). These everyday contexts have only just begun to receive attention from educational researchers.

In addition to being worthy of study in their own right, field trips provide the opportunity to study teaching and learning in a way that might have broader impact. It might be the case that people learn in different ways across various settings. If this is true, then it is important to know how people think and learn outside of classrooms to build stronger educational theories that improve teaching and learning in and out of the classroom (Hofstein & Rosenfeld, 1996) and across the life span (NRC, 2000). This shift in where educational research takes place is necessary if we hope to build more robust theories about how people learn and develop

(Bronfenbrenner, 1977; Cole, et al., 1978; Schoenfeld, 1999, 2006; Bransford, et al., 2006; Lee, 2008).

Research Questions

For this research study, I seek to answer three interrelated research questions:

1) What Happens on Field Trips?

Basic research questions remain unanswered. How much time do students spend doing academic tasks relative to other sorts of activities such as riding the bus, taking role, eating, and transitioning? How is knowledge shared? How do groups form and reform? What draws interest? What resources for making observations are used, when, and how? What field trip materials are not used or discarded? I believe that answering these basic questions concerning what transpires during a field trip is an important prerequisite to identifying and measuring outcomes. Furthermore, if we know what transpires on the field trip specifically related to how salient experiences in the field become memorable, then we can begin to unpack the second research question about why some field trips are memorable.

2) What Field Trips Events Are Memorable and Why?

I am interested in knowing what knowledge or memories students take away from field trips. This question is about understanding what types of events are particularly memorable. I make a comparison of memories that students draw from in and across learning environments because I believe doing so could lead to improved models for explaining learning processes. I focus on field trips to outdoor settings because it is in these places where “real” events, objects, and processes can be seen and experienced in the systems in which they naturally exist.

3) How Can Field Trip Experiences Be Productively Integrated with Classroom Learning?

This final question is concerned with the design of more effective instructional sequences that incorporate field trips. The focus of my research was the field trips rather than the surrounding classroom instruction. Consequently, I have limited data to help me answer this third research about classroom learning. My thinking about design is driven by a belief that a careful integration of field trips and classroom learning will lead to more productive learning. At one level, this question means knowing how to weave together field and classroom learning environments. At another level, answering this question means understanding how to support students during field trips and in classrooms. If there is some residual effect, such that experiences carry over from the classroom, to the field, and back to the classroom, then I want to understand how this process happens.

Thesis Overview

The following section is an overview of the thesis. In this synopsis, I give an overview of the timeline of the research because it makes clear the main argument I am making, which is that field trips are memorable because they are social and emotional events. I argue that examining how field trips and classrooms are connected through memories of specific field trip events is a productive and constructive place to get traction on understanding the field trip problem.

I reviewed a wealth of field trip literature to flesh out what works and doesn't work about field trips. The findings I reviewed suggest that part of what makes field trips memorable and positive is the social and emotional nature of them. Another thing that makes them memorable are the problems. For example, Mackenzie & White (1982) suggested that long-term memories of field trips are about colorful, meaning making "key episodes." They postulated that colorful memories of discrepant events (both good and bad) that happened on field trips link up to conceptual structures connected to long-term memory. The authors suspected this process happens when students are socially active and emotionally engaged in processing new material. Nundy (1999) also found that students readily recalled discrepant events. These “novel events,” which occurred during the field trips were specific social and emotional episodes. It is a striking feature of field trips that memories of them are colored with socioemotional experiences about discrepant events (Falk and Dierking, 1997).

Once I had a handle on framing the problem with field trips, I designed and observed a variety of field trips to outdoor places. These field trips were accessible by either bus or foot. On the outdoor field trips, the students were tasked with making observations and generating data to work with in the classroom.

Then, I looked systematically at data collected after the field trip. I looked for evidence of field trips that could help me understand how field trips and classrooms are connected.

As I examined the corpus of data I began to see remnants of a particularly interesting event, one that I will later refer to as the “dead bird event.” There was plenty of evidence or traces of this particular field trip event, when a bird carcass was discovered under some bushes and many students enthusiastically rushed over to it, shared ideas about what they were seeing, and brainstormed reasons it died. Memories of this particular event filled the data, so I began to catalog instances when I saw this socially engaging and emotional charged field trip event come up in conversation after the field trip. As I looked further for additional sources of data, that is other events that like the dead bird event I could trace from the field to the classroom, I found a wealth of similar looking events that also left a strong trace.

As I expanded the analysis to the full corpus, I traced field trip memories across contexts. I saw students talking about field trip experiences. These mentions are evidence that the experience was remembered. I saw evidence of experiences being remembered during classroom activities and discussions, during clinical interviews, and even on subsequent field trips. I called these memorable experiences “reverberations.” A reverberation consists of two parts. The first part is the “precipitating event,” the original field trip experience that generated ideas that were later recalled. I analytically decompose a precipitating event into five component processes: noticing, signaling, congregating, sharing, and theorizing. The second part is the “residue,” or recalled memories stemming from a precipitating event that echoed across contexts. A “residual event” is the subsequent conversation, that is, when the precipitating event is remembered.

Once I had a handle on the reverberation phenomenon, I focused my analysis on field trip events. I looked for the moments in the field trip data that led to the residue that I was seeing. These precipitating events occurred during the larger field trip activities.

Initially, I saw moments of heightened engagement. This was when a large number of students would enthusiastically come together like a flash mob to make observations and theorize about what they were seeing and experiencing. I also saw quite a bit of group mixing, when assigned groups would dissolve and students would work with their peers across groups. During these moments of heightened engagement, I saw students sharing ideas, drawing on prior experiences, and using a variety of resources to reason about what they were seeing. Although sometimes these events would involve a good deal of unconstrained theorizing, they would also generate new ideas. These events precipitated the memories I saw carry forward to other contexts.

I transcribed and analyzed the field trips and any classroom and interview activities specifically related to the field trips, with the aim of reconstructing the field trips from the data record. In the process of reconstructing the field trips and related classroom activities, I constructed timelines of how time was spent. I also cataloged any occurrence of a field trip event that I saw reverberate. Through a microanalysis of talk and action across settings, I documented 82 precipitating events that reverberated 242 times. The idea is if we know what is memorable, that is, if we know what experiences connect field trips and classrooms, then we can begin to get a handle on understanding the scope of the problem with field trips making only a minimal educational impact.

The kinds of memories that I saw reverberate were fairly unsurprising. What students remembered reflected the situation in which the memories were cued. For example, some of the classrooms learned about soil and weathering on the field trips, so one would predict that field trip memories would be recalled about dirt and rock. However, while the kinds of memories were somewhat predictable, the specific memories that I saw reverberate were generally serendipitous. The field trips were "in the wild," so the specific things that were possible to see and experience at the site were largely unplanned. Despite the seemingly unpredictable nature of specifically what could be seen and experienced, there were patterns in the kinds of things that were noticed in the field and later recalled. For example, gross things such as decomposing organisms were especially memorable as were other sorts of physical objects such as plants, animals, and water.

The focus on how time was spent on the field trip helps to answer the first research question about what happens on field trips. The focus on residue helps to answer the second question about how field trips events are memorable and why. This analysis gives me a way to begin to answer pressing questions about field trips. How to best integrate field trips and classrooms? What makes them so memorable while, at the same time not very useful in classes? How can we fix that?

Precipitating events should be flagged in the field because they create common ground, a shared space for collaboration. Residue, especially residue related to the science content, could have profound implications for how we think about the design of learning environments including museum exhibits and classroom demonstrations of phenomena.

Thesis Outline

In Chapter Two, I review the literature on field trips. This up-to-date snapshot on research about field trips paints a picture of what we know about field trips and what research gaps my dissertation fills.

In Chapter Three, I describe the methods and research design for this dissertation, and I explain how design research and ethnographic methodologies are useful for this particular research endeavor. In Chapter Three I also describe the research contexts, including the places, tools, and learning activities, the students and teachers who participated in this study, and the resources that supported research and learning activities such as the curricula, the digital technology, the survey instruments, as well as other materials that were used for research or learning purposes.

In Chapters Four and Five, I present the results of my data analysis. In Chapter Four, I give an overview of what happened during nine of the field trips and present one detailed case to illustrate what happens during field trips. I first summarize how time was spent doing various activities across all the field trips I analyzed for this thesis. Then I show in “thick detail” what happened on one of the field trips. Along the way, I pay particular attention to episodes that played an important role in later activities. In the discussion about what happens on field trips, I discuss two themes about curiosity and collaboration.

The second of the two data chapters, Chapter Five, analyzes precipitating events and the residue they left. In Chapter Five, I take a microscope to events that reverberated across time and place. First, I discuss precipitating events, that is, moments in the field that are specifically related to ones that I saw come up later on in the classroom, on subsequent field trips, or in the clinical interviews. Then I present a model that describes the choreography of social interactions during a precipitating event. Next, I describe the range of the residue; I show examples of three different kinds of reverberating events, and then generalize to the larger set of episodes that I saw field trip residue. I discuss how these events precipitated, when and why they reverberated, and show how classrooms and field trips are related through residue.

In Chapter Six, I conclude the thesis with a summary discussion of limitations, recommendations on how to best integrate field trips and classrooms, suggestions for future work, and implications for the field. I close with a discussion about what the findings mean for how we think about the design of schools and informal learning environments.

Chapter Two: Literature Review

In this chapter, I present a review of prior field trip research. In this review I focused on literature with a substantial empirical component. In total, I sourced for review 42 peer-reviewed journal articles, five dissertations, and seven reviews of field trip research.

For the most part, the literature I unearthed involved data collection efforts *after* the field trip (26 articles, 2 dissertations) and sometimes before the field trip as well, but usually not during the actual field trip. This body of work is primarily about measuring affective and cognitive outcomes, and evaluating the effectiveness of different field trip "treatments." Occasionally, observations are made exclusively during the field trip (8 articles), for example, by observing conversations *during* a school visit to a museum (Tunnicliffe, et al., 1997). Sometimes people gather data *before, during, and after* the field trip (8 articles; 2 dissertations). Based on how people approach field trip research, I organized the literature review into three general areas: (a) outcomes, or products of field trip experiences; (b) processes, or research on field trips processes; and (c) research on designing optimal field trips.

Field Trip Outcomes

People study a variety of outcomes for field trips, including traditional cognitive outcomes such as fact learning (Benz, 1962; Falk & Balling, 1982; Falk, 1983; Orion & Hofstein, 1994; Eaton, 1998; Bamberger and Tal, 2008). But what is really unique to field trips is the amount of research on affective outcomes (Falk & Balling, 1982; Orion & Hofstein, 1991; 1994; Hattie, Marsh, Neill, et al., 1997; Tunnicliffe et al., 1997; Eaton, 1998; Bixler & Floyd, 1999; Nundy, 1999). This is the case because people believe that the real unique benefits of field trips have to do with their affective impact. I believe that research on field trips has focused more on affective outcomes than research on classrooms generally does. This does not mean that field trips are necessarily more emotional than classroom learning situations. However, it could be the case that field trips are distinguished from classrooms because field trips have unique affective qualities. In this section, I will first focus on affective outcomes since that is where most field trip research happens. Then I will discuss cognitive outcomes and links between cognitive and affective outcomes.

Affective Outcomes

Affect covers a vast territory of human development involving thinking and feeling; affect pertains to the subconscious processes that transpire in the moment and involves consideration about what aspects of the physical environment feel stressful, safe, friendly, bad, etc. The emotional system is a subsystem of the affective system; it involves conscious feelings and regulates decision-making. On a field trip, emotions could help a student judge whether something is interesting or memorable depending on how it feels. Since studies of affect related to field trips are typically conducted sometime after the field trip has ended, this line of work is more of an emotional readout than an affective account of what occurred in the moment on a field trip.

In this section I review four affective dimensions of field trip outcomes that have received considerable attention: interest, attitude, emotion, and self-concept.

Field trips spark interest

Interest is a powerful and complex motivator for learning; it can cause a person to "engage…or reengage with particular classes of objects, events, or ideas over time" (Hidi & Harackiewicz, 2000). People have found through post-visit surveys and retrospective recall events that interesting field trip experiences motivate students to engage in inquiry practices (e.g., Harvey, 1951; Gottfried, 1980; Jarvis & Pell, 2005).

On field trips, animals are of special interest to students (e.g., living ones, stuffed ones, animal behavior, fossils and bones, parts of animals, etc.) and appear to be a powerful motivator for drawing out knowledge through questioning (Margulis, Reiser, Dombeck, et al., 2001), for comparing observations (Harvey, 1951; Bixler, Carlisle, Hammitt, et al., 1994; Bixler & Floyd, 1999), and for motivating further inquiry into scientific ideas (e.g., Gottfried, 1980[1]; Bamberger & Tal, 2008).

Sometimes just being in ecologically rich places such as national parks can do much of the work for sparking interest in reasoning about the natural world (Orion, Hofstein, Tamir, et al., 1997). However, field trips may fail to engage learners when they happen in uninteresting places (Birnbaum, 2004). In urban areas, for example, such as parking lots, schoolyards, city parks, or industrial sites, the observable phenomena may not be as intrinsically interesting for

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[1] The evidence Gottfried (1979) presented suggests a "systematic study of school field trips." He looked carefully at what happened on a museum visit for a handful of focal students. Students were closely observed in a room full of specimens at a museum. A week later he followed up the experience with a classroom survey asking them to draw maps of the room and the things in it and to answer questions abut what they remembered. Even though he made observations on the bus, for instance, he did not report that data, so the particular field trip activity he studied was for the most part bounded by the museum.

thinking about scientific ideas. Or, it could be the case that the learners are disengaged when the effects of a dynamic process are noticeable, yet the process is largely invisible to human eyes (e.g., fossilization). Consequently, not every field trip may yield a bounty of phenomena to interest learners in thoughtful activities or to connect to them personally; therefore, activities in these places may need extra support to spark curiosity and guide productive engagement with scientific ideas (Orion et al., 1997; Birnbaum, 2004).

Field trips affect attitudes

Prior research about field trip attitudes suggests that field trips have a positive effect on students' and teachers' inclinations and positions toward learning (Harvey, 1951; Kern and Carpenter, 1986; Orion & Hofstein, 1991; 1994; Orion, Hofstein, Tamir, et al., 1997; Price & Hein, 1991; Jarvis & Pell, 2007).

Kern & Carpenter (1984) conducted an experiment aimed at measuring the effect of fieldwork on attitudes toward earth science. Compared to a "more traditional laboratory approach," positive attitudes toward the content "increased dramatically" when learning through a field-oriented approach. The authors discovered a "carry-over" effect to laboratory activities after the field trip. They attempted to explain why students liked learning the subject matter more after having been in the field compared to students who learned in a more traditional laboratory approach. The authors postulated, "The positive effect of outside activities on affective responses might be at least partially a result of student perceptions of such activities as being more 'realistic' (p. 302). The authors noted that this was a marked change from what the authors had experienced for many years prior to this study while teaching undergraduate earth science the traditional way. "Many of the students perceived classroom laboratory activities dealing with rocks, soil, weather, space, etc., as unrealistic—not true earth science, not activities ‘real’ earth scientists would engage in. Students have repeatedly asked the question, ‘Since this is earth science, how come we aren’t out there (pointing out the window)?’” (p. 299). Although the authors suggest learning activities in real-world settings were perceived positively precisely because they were more realistic, they do not say why learning outside and working with realistic rather than unrealistic materials would have any effect on affect.

To better understand the relationship between attitudes toward field trips and learning outcomes, Orion & Hofstein (1991) built a survey tool consisting of five unique “aspects,” or categories of survey items related to the field trip experience: the (1) social, (2) adventure, and (3) environmental aspects, (4) the degree of individualized learning, and (5) the extent to which the field trip is perceived to be an activity for learning. An example of a “learning aspect” item is “the field trip is important since it demonstrates and illustrates concepts learned in class.” Another example item, this one regarding the “environmental aspect” is: “I like to go on field trips, since it is important for me to understand the environment in which I live.” Through further research, Orion and Hofstein (1994) discovered that students with positive attitudes towards the field trip learned more *after* the field trip than those with less positive attitudes. Furthermore, these same students also learned more than those who learned the traditional way, when instruction was delivered “as a summary event” (p. 1111). This line of research suggests there is a link between attitudes toward field trips and buy-in to subsequent learning activities. There is no control group or surveys administered about attitudes toward learning in general, so we do not know from this study whether these same students would be engaged in activities independent of the field trip. The authors do not report on the students with less positive attitudes who do not learn as much after the field trip.

Field trips are emotional experiences

Following field trips, emotional responses are measured through post-visit interviews or surveys (Falk, Martin, & Balling, 1978; Bixler & Carlisle, 1994; Bixler, et al., 1999; Margulis et al., 2001; Bamberger & Tal, 2008). Some of the phenomena that stand out to students are the ones that cause anxiety. Researchers have found that live animals, plants, and habitats engaged students emotionally and provoked surprise, fear, disgust, and dislike—four common emotional responses students report feeling on field trips (Bamberger & Tal, 2008; Gottfried, 1979; Bixler et al., 1999). Anxious emotions students feel on field trips could influence how they engage in learning activities. For example the meta-analysis conducted by Hattie et al., (1997) revealed that students with especially low or high levels of anxiety could not cope well with the field experiences and this caused undue distraction that disrupted the learning process. Those students with moderate levels of anxiety were able to better understand the content. Other researchers have also found that intense anxiety on field trips can inhibit learning. In one study specifically about the emotions students experience on field trips to a nature center, Bixler & Carlisle (1994) asked 48 nature center interpreters to list features of the environment that produced emotions expressed by the students visiting nature preserves. The nature interpreters listed non-native animals, snakes, plants, insects, the fear of getting lost, and the disgust toward natural things as fear-inducing objects. The main finding of this study was that students preferred activities that did not require them to touch organic matter. The authors concluded that pre-visit preparation for reducing fears is necessary to create a more comfortable learning environment in the field sufficient for engaging learners in inquiry activities. This line of research on anxiety and engagement suggests there may be an optimal level of anxiety to engage students in a productive and conformable zone of inquiry. With preparation to reduce students' fears for unknown objects, anxiety might be reduced to a level that promotes closer interactions with nature, peers, and the setting.

Field trips boost self-concept

The power of field-based learning, particularly for longer more immersive experiences, may be in its ability to change the way people see themselves in relation to one another and to the physical environment. Researchers who have found changes in self-concept typically conduct their research on programs that are longer than a single day, such as adventure-based field programs (e.g., Stokes & Boyle, 2009; Kitts, Perry, Jr., Leal-Bautista, et al., 2009). Much of the research on adventure-type field trips points to the value of experiences that ask students to take risks in situations that create a need for survival. Adventure-type field trips are found to have a strong effect on outcomes relating to identity, self-concept and motivational orientation, and tend to have a pronounced effect over time (Hattie et al., 1997). The unpredictable nature of what is possible to see on field trips helps students take possession of their own learning processes, which in turn encourages independence and reinforces confidence for solving problems.

Changes in how students perceive themselves have received considerable attention. Nundy (1999) conducted an experiment where some classrooms learned by working in the field while others learned at school from textbooks and slideshows. In terms of self-concept, students in the experimental condition had significantly boosted self-conceptions when compared to the control group. Most of the gains related to self-concept were captured by items relating to the academic construct on the affect questionnaire the students filled out. The researchers found that confidence contributed to gains in learning outcomes. They attributed changes in student autonomy to teachers on field trips offering fewer evaluative statements, and students collaborating and discussing more often compared to classroom interactions.

In a similar study about self concept, Bamberger and Tal (2008) discovered that a majority of the students had meaningful experiences on the field trips to natural history museums. The surveyed students reported a willingness to visit the museums again. The students expressed a deeper sense of personal relevance after a field trip because they were "connecting the visit to the student's world and experiences" (p. 274).

Field trips help learners construct personally relevant experiences because they create collaborative, confidence-building learning environments. Such environments allow learners to take ownership over their own learning.

Cognitive Outcomes

Cognitive outcomes comprise a substantial fraction of field trip research. Like affective outcomes, this data is typically gathered through surveys and tests that measure changes due to a field trip activity (Benz, 1962; Mason, 1980; Falk & Balling, 1982; Falk, 1983; Bitgood, 1989; Orion & Hofstein, 1994; Eaton, 1998). A variety of additional methods are also employed such as interviews with students (Falk & Dierking, 1997) and teachers (Anderson et al., 2006) or a mix of participant observations, questionnaires, interviews, and analysis of the work products made by students on the field trip (Anderson, Lucas, Ginns, & Dierking, 2000; Cox-Petersen, Marsh, Kisiel, et al., 2003). Although much of this research is positive and students do often acquire facts and skills, not all field trips lead to productive learning or to positive changes in knowledge and skills. Consequently, not all researchers who report on field trip studies that measure knowledge before and after a field trip find that changes in knowledge are necessarily productive. In one study, Cox-Petersen, (2003) interviewed students after a museum-based field trip. The students were able to articulate what they learned on field trips, yet only a handful of students talked about relationships among facts they heard. They attributed this finding in part to the style of the docent led tours, in which the docent lectures provided “minimal connections between the content of exhibit halls and the lives and prior knowledge of the students” (p. 207).

Orion and Hofstein (1994) determined the extent to which knowledge changed following a geology field trip to an outdoor learning environment. Their study looked at knowledge gained due to the effect of different kinds of preparation and employed validated pre- and post-visit achievement tests to measure what knowledge changed. The instructional activities centered on earth systems science. They reported gains in knowledge of science content (e.g., the formation of rocks) and practices (e.g., rock identification skills). They attributed these gains in large part to pointed preparation provided prior to the trip.

In a study of students understanding of magnetism and electricity, Anderson et al., (2000) looked for changes in conceptual understanding before and after a field trip to a science museum. The authors considered the nuanced ways in which knowledge changes by closely examining the personal theories 12 students used for explaining physical processes. At the museum, the students roamed freely for about 40 minutes at exhibits about sound and mechanics; then for 30 minutes in a gallery about electricity and magnetism; and next for about 30 minutes in a gallery about light and color. At the end of the visit, the museum staff led a 30-minute presentation for the students. The extensive set of data from which they based the claims included audio logs from fitting selected students with microphones, concept maps, worksheets, interviews, and field notes. Through a cognitive analysis of student work products and interview transcripts, they found that students' knowledge changed in subtle ways because of their experiences from having visited the science center. They found students "developed coherent, abstract personal theories that enabled them to explain a number of phenomena, although not in accord with canonical science, the personal theories developed…are important steps in [the] construction of science concepts used for explaining phenomena and scientific concepts" (p. 677). The changes happened because of an "integrated series of post-visit activities [which] resulted in students constructing and reconstructing their personal knowledge of science concepts and principles represented in the science museum exhibits" (p. 658). Furthermore, the knowledge students drew from in the interviews showed a close interrelationship among their school, home, and the informal learning center, which the authors understood to illustrate "the power of past experience on subsequent knowledge construction" (p. 678). Importantly, the field trip and post-visit activities did not always have the intended consequence, as some students constructed alternative conceptions at odds with accepted views of science. The authors concluded by stressing the importance of post-visit knowledge integration activities. Such activities they found attended to "alternative conceptions," which were generated or became reinforced through a field trip.

Links between Affect and Cognitive Outcomes

People have suggested that field trips are memorable because they create links between affect and cognition (Kern & Carpenter 1984, 1986; Orion et al., 1997; Eaton, 1998; Nundy, 1999; Stokes & Boyle, 2009; DeWitt & Hohenstein, 2010). Since field trips arouse interest and emotion, we are more likely to remember the field trip. This is a significant aspect of the field trip. Field trips can be an indelible experience, etching salient memories into students' minds months and even years after an event (Mackenzie & White, 1982; Falk & Dierking, 1997; Nundy, 1999).

Mackenzie & White (1982), through their work on how field trips affect memory structures, emphasized the importance of "key episodes," colorful memories of events that happened on field trips that link up to conceptual structures connected to long-term memory. The study they conducted involved three days of classroom work and three days of fieldwork. They set up the study so there were three "treatments" for the eighth and ninth graders: one group got a passive excursion, one group got an active one, and one group did not go on any field trips. The active group held frequent group discussions and "students were continually required to do things: observe, sketch, record, answer questions. Several unusual events were arranged, such as walking through the mud of the mangrove shore, tasting foliage for salinity, scrambling over cliff platforms, wading in the sea" (p. 627). In contrast, the passive group experienced no unusual events and were "recipients of information, not finders" (p. 626). In terms of the effect of learning and retention of geographic facts and skills, the students who had the field trips remembered more than the students who did not, and in particular, the students who had the active field trip retained the most subject matter knowledge. The authors suggested that for students to generate meaning, they must be able to relate it to prior knowledge. They suspect this process happens when students are active in processing new material.

Falk and Dierking (1997) surveyed 128 adults and kids (cohorts aged 9, 14, and 20 years). They found that nearly everyone who responded to the survey could recall specific school field trips taken early in primary school. An overwhelming majority of the subjects could write down specific details about the trip including content that they remembered learning and details about the people they were with. What is interesting about this research is "the vast majority of recollections were embedded within descriptions of the physical and social setting, often in relationship to some statement of feeling or attitude" (p. 217). It is a striking feature of field trips that memories of them are colored with socioemotional experiences.

Nundy (1999) also found that students readily recalled discrepant events, "novel events," that occurred during the field trips. These memories were often emotionally charged specific episodes that happened on a field trip (e.g., "getting muddy" and "getting wet"). For his dissertation work, Nundy compared four sixth-grade classes learning the same science subject matter. In one condition two classes embarked on a week of fieldwork to learn about the same material as their peers who could not benefit from being on the field trip. The other two classes learned in the classroom. In comparing the classroom and field situations, Nundy found that the students who remained at school because their class did not go on any field trips that week only weakly recalled memorable episodes as little more than routine social interactions such as "peer interplay" (p. 195). He argued that novel events become imprinted in the memory of students who went on the field trip and become conceptual structures used for indexing and subsequently generating additional information and imagery. In other words, novel experiences may be more likely to be remembered. Nundy (1999) wrote, "Positive changes in affective learning appear to lead to positive changes in cognitive learning and that this is enhanced within a residential fieldwork setting" (p. 193). He postulated that students who went on the field trip gained more knowledge than their peers who did not have the supplementary field trips. Though he provided no mechanism that could help explain how thoughts and feelings are linked or what might affect degrees of change, Nundy concluded by claiming that students who went on field trips learned more facts about science and elevated their self-concept than did their peers who learned about the material only in a classroom. His work looked at the positive effect and the null effect of field trips on learning, but the question remains about what is the negative effect of field trips on learning. Clearly, on field trips, novel and positive things are memorable.

Research during Field Trips

Even though most field trip research is about affective and cognitive outcomes with data collection happening after the field trip, some researchers do collect data during the field trip event itself. The range of research that looks at what goes on during field trips sometimes involves observing participants' social interactions with audio recorders (Gottfried, 1979; Tunnicliffe, et al., 1997; DeWitt & Hohenstein, 2010), video cameras (Orion & Hofstein, 1994[2]; Tal & Morag, 2007), still cameras (Cohen, 1968; Gottfried, 1979), and learning and data collection technologies physically embedded in the field site (Rogers, Price, Fitzpatrick, et al, 2004; Kuhn, Cahill, Schmoll, et al., 2010). In other cases, data is collected through field notes using a pen and paper (Orion & Hofstein, 1991; 1994; Anderson et al., 2002; Cox-Peterson et al., 2003; Endreny, 2008). Collecting field notes is challenging on field trips, for the same reasons as other sorts of data collection methods. This is somewhat problematic because field trips are particularly interactive and busy situations with many parallel activities happening. A high-quality camera and microphones can attend to multiple interactions at once and capture precisely what is said and done. For example, an activity could be happening in the foreground while

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[2] The authors note that they made videotapes on the field trip and "later analyzed" that data to help build the field trip questionnaire. The video data is not presented.

another activity involving a different group of people could be happening in the background. A camera and distributed microphones would pick up all the talk and action, but even the best-trained ethnographer may only selectively attend to one interaction at a time. In general, the methods used to capture the field trips do not capture all the layers of activities that are present.

In addition to audio-video technology and field notes, field trip researchers often use worksheets to structure their field trip research tasks about learning (Harvey, 1951; Cohen, 1968; Gottfried, 1979; Mackenzie & White, 1982; Falk et al., 1982; Jarvis & Pell, 2005). One reason researchers use worksheets to support data collection is the worksheet can focus students' attention onto specific ideas and objects that a researcher may deem relevant or important. Another reason researchers focus on worksheets as a data collection tool on field trips is probably because they create a written account of student thinking that can be looked at later on. They are also popular because, like the teacher in the classroom, a researcher on a field trip is really only in one place at a time. The worksheet is in some ways a surrogate teacher or researcher, a resource that can solicit ideas and generate data even without an adult present.

In reviewing the literature on what researchers found happening during field trips, two themes emerged: forms of talk and collaborative inquiry.

Students Socialize on Field Trips

One form of talk, sometimes labeled "socializing," the phenomenon where students mingle and talk on field trips, is an issue for some educators because it could be a source of interference that blocks content learning (e.g., Orion & Hofstein, 1991). The idea behind this perspective is that students who socialize are not participating in the activity and are therefore "off-task." In fact, Orion & Hofstein (1994) suggested, "the social aspect of a field trip is at the expense of the learning aspect" (p. 515). In practice, it probably comes down to the specifics of the socializing. For instance, storytelling on field trips yields mixed results: either by not noticeably "enhancing learning or personal meaning-making at phenomenon-based exhibits" (Allen, 2004, p. s31) or by fostering connections when "a child tells a story about his summer vacation" (Gottfried, 1979, p. 21). With respect to socializing, there very well may be learning happening, but perhaps it is not always the one intended by the instructor (Becker, 1972).

Field Trips Don't Always Invite Knowledge Sharing

Some researchers who have looked at forms of participation during field trips have not found field trip situations to be productive for sharing knowledge. For example, Tunnicliffe, et al., (1997) observed school groups at an exhibit in the zoo. The authors examined nearly 1,200 conversational units from transcriptions of audiotaped conversations. They found that the experiences of the school groups at the zoo exhibit were highly affective, replete with emotive comments. Though the students could name the animals, identify attributes and body parts, draw comparisons to humans, make observations about them, and interpret them from prior experiences, the authors found little evidence of "talking science." Similarly, Cox-Peterson et al. (2003) focused on docent led tours for student groups at a natural history museum. These tours were one-hour in duration and were observed by non-participant observers who collected field notes and conducted post-tour interviews. The tour guides told stories and presented facts, but the data revealed little evidence of sharing big ideas or concepts. The scientific jargon they regularly used appeared (to the observers) to be too sophisticated to understand. The closed-ended, fact-based questions typical of the guides did not require much deep thinking, and the tours afforded minimal interaction. Thus, during post-visit interviews, it was not too surprising that the students could articulate unrelated facts and descriptions and say what they learned, but according to the authors, the students did not talk about big ideas or concepts. They conclude that the museum experience was merely “satisfactory” to the teachers and students; however, because the field trip museum tour amounted to a disconnected learning experience, what transpired was “mostly inconsistent with recommendations from science education reform documents and informal science literature” (p. 211).

Teachers Question Differently on Field Trips Than in Classrooms

Questions asked on field trips have been a focus of study. Tal & Morag (2007) observed museum guides giving tours to school groups. They videotaped and transcribed what was said, and examined the questions that the guides asked. They found that nearly 400 questions were asked in 16 visits that were observed, and the social interactions among the students were “limited to the relatively short active parts of the visit” (p. 766). They found that the guides typically asked closed-ended questions, less than 5% of the questions asked challenged students “by pressing their thinking or by inviting them to share meaningful experiences with their classmates” (p. 757), and many questions were asked by the guides with no intention of soliciting a response. Their data revealed that the natural history museum guided tours they studied provided “limited opportunities for meaningful learning…[and] should shift from the traditional knowledge-transmission model of teaching to a more socioculturally contextualized model” (p. 747). The authors did not look for questions the students asked, probably because there were not many opportunities for students to talk since they were observing guides lecturing in museums.

DeWitt & Hohenstein (2010) also found patterns in the kinds of questions asked during field trips, when they examined the forms of talk among people in museums in the United Kingdom. They analyzed the discourse practices between teachers and students during lessons in the classroom before and after the field trip and compared this to the forms of talk between teachers and students on field trips. What they found is that teachers posed open-ended questions more often on field trips than in classrooms, whereas in classrooms they found teachers posed more closed-ended procedural questions. This is a clear and relevant result because it suggests that the abundance of genuine questions asked in a museum is an indicator of engagement, as is the “less dominant teacher role and a more balanced and interactive relationship…in which the students and teacher support each other” (p. 466).

When DeWitt & Hohenstein (2010) looked at patterns of talk during the pre- and post-field trip lessons, they found that the teachers and students were engaged in triadic discourse patterns of talk, while on the field trips dialogic forms of talk were much more common. In class, both before and after the field trip, the teachers mediated conversations more often, but on the field trip the conversations were more distributed and guided by the students themselves. The authors suggested that the context of the field trip experience was important because it caused a shift in how students interacted. On the field trip, students shared control of the learning environment, making choices and maintaining balance, but in class, the teacher was the clear authority arbitrating interactions. In this study, like the one in Tal and Morag (2007), the focus was the discourse between adults and students, yet the questions the students asked were not the focus. It is understandable why Tal and Morag (2007) and DeWitt and Hohenstein (2010) focused on the teacher’s questions rather than the students’ questions because the focus was primarily the teachers' role in student learning. However, the focus was the dialogic inquiry, so it is surprising that any questions students asked were not included in their analyses.

Field Trip Design

In my review of the field trip literature I found four areas of research about best practices for designing field trips. These areas are: technology, worksheets, field trip frequency, and the role of classroom activities related to field trips.

Technology Supports Collaborative Inquiry

On field trips, collaboration among peers is a productive means for supporting learning, when field trip activities invite the sharing of information using handheld mobile technologies (Rogers, Price, Fitzpatrick, et al, 2004; Chipman, Druin, Beer, et al., 2006, Kuhn, et al., 2010).

In a forest, Rogers et al. (2004) observed about a dozen pairs of middle school students making scientific discoveries about environmental processes. Smartphone technology embedded into the activity design was meant to help support inquiry about the animal species they found in the forest. Through the smartphones, the researchers provided full access to "contextually relevant digital information" about the woodland habitat. They provided small pieces of pre-recorded information to enhance the activities. This information included: (i) video clips showing seasonal changes over time and pictures with voice-over explanations; (ii) nature sounds; and (iii) visualizations of woodland processes. The technology afforded "student-initiated modes of digital augmentation…for reflection and discussion...involving self-initiated exploration, hypothesis building and testing, peer and facilitator collaboration and reflection on why something was the case" (Rogers, 2004, p. 7). The video data the researchers collected in this outdoor learning environment was analyzed for instances when students were interacting and using the devices for scientific inquiry. The researchers found that some features of the setting went unnoticed while other features were investigated in depth. The students were making "explicit links between what they are finding out via the [mobile devices] with what they are exploring and discovering in the physical environment" (p.8). The digital tools used on this inquiry-based field trip to the woods delivered just-in-time support in the hands of the learners, which facilitated collaboration and fostered deep, meaningful thinking.

In another field trip study about supporting collaborative inquiry, five early elementary children (and their parents) and a park ranger in a State Park participated in a research study that involved embedding technology into the physical environment (Chipman, et al., 2006). During this study, the children went on a scavenger hunt in the forest. Around a nature trail, they were asked to plant flags embedded with Radio Frequency Identification chips. The flags were planted in particular locations such as green places or prickly places. With a digital drawing pad, they could write notes and see digital traces left by others at that spot. Since the park ranger could assist all the students from her handheld device, she was able to provide a level of guidance for all the children even when they were distributed across the field site. Chipman et al. found that embedding technology into the field site supported the inquiry process because the locations for the initial discoveries (i.e., a planted flag) became physical and virtual contexts that motivated the children to make additional observations, invited questions, generated explanations, and supported further investigation and collaboration.

Worksheets as Surrogate Teachers

Worksheets are designed to provide opportunities for students to represent in writing what they see and experience (Kisiel, 2003). Teachers like worksheets because they are tools for managing individual behavior and provide a high-level overview of the entire field trip experience, as a sort of fill-in-the-blank record that provides proof that students saw things that the teachers believe are important (Kisiel, 2006). In a sense, worksheets are a stand in for the teacher. On field trips, when the group is distributed across large spaces, tools like worksheets and collaborative technologies are helpful to supplement and guide learning.

In practice, however, field trip worksheets are often completed in the first minutes of the field trip, and then abandoned for “off-task” activities such as ventures to the snack bar and gift shop (Griffin & Symington, 1997). Ballantyne and Packer (2002) found that “the use of worksheets, note-taking and reports were all unpopular with students, and did not appear to contribute greatly to environmental learning” (p. 228).

There has been some research into why field trip worksheets are not especially educational (Kisiel, 2003; 2006). One reason they are not especially educational is due to “a lack of connections to the classroom curriculum” (Kisiel, 2003, p. 14). Of the ten teachers Kisiel (2003) interviewed, all “had some sort of plan for what their students would do; this plan took the form of completing a worksheet”; however, just a small fraction of the teachers planned to follow up the visit with an activity in class the next day (p. 14). Another reason worksheets do not work well is because they “impede student learning by inhibiting true observation, preventing students from formulating their own questions, and causing students to focus on the narrowly described task to the exclusion of broader questions” (Price & Hein, 2001, p. 515). A third reason is students treat worksheets like textbook chapter questions, quickly copying text and rarely interpreting the meaning of the objects in the exhibit hall (McManus, 1985).

Curriculum Designs That Include Frequent Field Trips

The frequency of field trips affects attitudes and opportunities for learning. Orion and Hofstein (1994) found that more field trips made attitudes more positive toward the field trip. They found attitudes to be a function of both how often the trips happen as well as the amount of time that transpired between the event and when the students self-reported attitudes toward the experience. Attitudes in this study tended to attenuate with time elapsed post-visit.

In another study that had a field component that was extended over a prolonged period of time, Endreny (2009) conducted a yearlong study about students' conceptions of watershed concepts learned from a place-based inquiry unit. The study took place in a fifth-grade classroom that happened to be adjacent to a brook, hillside, and storm drains. The classroom capitalized on the proximity of a dynamic geological system that was specifically related to their learning goals. The students and teachers, who were serving as a supporting role while Endreny the researcher taught the unit, repeatedly went on excursions to the brook beside their school during various seasons in order to conduct fieldwork. The fieldwork they did was designed to be a function of the time of year that invited recurrent visits. For instance, by visiting the brook in the wintertime, the students learned about the freezing of water, and in the springtime they wondered about infiltration, run-off, and where water goes. This feature of the design led to observations about how the snow melts, how the water moves, how mud is made, and how the water color changes. Endreny concluded most students learned key watershed concepts. She discovered they learned this by seeing snow melting and draining to a nearby brook. The students' observations were reinforced with modeling lessons in the classroom that simulated stream run off. She argued that it was the combination of the field experiences and classroom modeling activities that led to the learning gains she observed. Based on researcher observations in the field and in class, the author found that frequently visiting a brook by experiencing real phenomena was integral to ongoing instruction and helped students develop a deeper conception of watersheds.

Stewardship-type activities are a special class of field trips. These are specifically intended to be about working in the community and usually involve visiting the same context many times. For example, Bouillon & Gomez (2001) examined how fifth grade learners value science by connecting real-world problems to their daily lives and scientific practices. By adopting a polluted river that the community of learners could easily visit from the classroom, the researches found evidence that the students learned about “concepts such as water quality, soil erosion, water conservation, and recycling…[which was] demonstrated in their talk about their activities in the Chicago River Project” (p. 888). Because the location was a short walk from the school and a place the students had a vested interest in restoring, this stewardship opportunity worked.

Classroom Activities Related to the Field Trip Reinforce Learning

Preparation (Orion, 1993) and the role of post-visit activities (Anderson, et al., 2000) are two areas of research that aim to maximize learning opportunities through field trips.

Student engagement and learning on a field trip may be connected to how well the teachers and students are prepared for the out-of-classroom experience (Price & Hein, 1991). For example, people have found that students have expectations about field trip purposes that could guide their experiences and influence what happens (Falk & Balling, 1982; Falk, 1983; Falk &

Dierking, 1997; Kisiel, 2005). When the purpose of the field trip was unclear and the teacher had not clearly articulated expectations and goals during preparatory activities, then students tended to display unenthusiastic attitudes toward the event in the post-visit interviews (Griffin & Symington, 1997). While there is some work on student and teacher expectations for a field trip, the bulk of research specifically aimed at maximizing field-trip learning opportunities through preparatory activities is really about moderating "novelty." This means preparatory activities aim to reduce potential interference so students stay "on task" (Falk, Martin, & Balling, 1978; Orion et al., 1997). This translates to familiarizing students with the locale, tasks, and expectations before the field trip to preemptively remediate potentially "bad," off task, or otherwise unproductive and undesirable behaviors.

Orion (1993) identified three novelty factors that could inhibit learning, which he theorized compose a "novelty space." *Psychological novelty* reduction is about designing activities that make students feel comfortable in advance of the field trip by alleviating all sorts of fears potentially related to the experience. For example, teachers could provide instruction and answer questions about the weather forecast and appropriate attire. The second factor comprising this novelty space is about reducing *geographic novelty*, which involves helping familiarize students with the field trip site. For field trips to outdoor settings, this usually means studying a map before leaving the classroom to go into the field. *Cognitive novelty* is about preparing students for the learning activities so students maximize the time they have away from the classroom. Pre-visit cognitive preparation involves answering questions related to field trip content and skills, practicing with the tools, and reviewing worksheets and learning objectives. Orion et al. (1997) found that preparation maximized learning outcomes, leading to more productive and focused field trips. Preparation may reduce the novelty of the field trip, but it cannot replace the actual experience of going somewhere. The work the preparation may do is it might put students in a position to better appreciate what they see there.

In addition to preparation augmenting learning, post-visit activities also support learning. Anderson et al. (2000) postulated that an integrated curriculum that weaves post-visit activities and field trips led to changes in students' understanding of the science concepts and big ideas. The first set of post-visit activities involved students working in pairs on two exhibits that piqued their interest. They were asked to describe and explain how physics exhibits worked. The second set of post-visit activities involved engaging students in experimentation that were similar to the exhibits they had seen at the science museum. One experiment was about electrical current and the other involved making an electromagnet. The design of the field trip and post-visit activities did not always have the intended consequence because some students constructed alternative conceptions at odds with accepted views of science. Importantly, the authors concluded by stressing the importance of post-visit knowledge integration activities because such activities could attend to "alternative conceptions," which were generated or became reinforced through a field trip.

Just as the quality of the preparation and the post-visit activities matter, the timing of classroom activities specifically related to field trips affects what is learned. Orion and Hofstein (1994) found that learning outcomes depend on the "place of the field trip in the curriculum structure" (p. 1116). For example, they found when students "participated in the field trip at the earlier stage of the course" (p. 1111) they learned more than students who went on a field trip later in the unit or not at all.

Summary

In the studies I reviewed, I found a wealth of empirical research that looks at what happens on field trips. The majority of this research takes place sometime after a field trip ends. There is however a good fraction of research that takes place during the actual field trip. This research, however, is lacking because the methods used to capture the field trips fail to capture all the layers of activities that are present. Another reason field trip research comes up short is field trip researchers tend to focus on affective and cognitive outcomes, with some researchers looking at links between the two. Few researchers explicitly look at the social dimensions of the field trip. A separate line of field trip research examines issues related to the design of enhanced field trips.

The research I uncovered suggests that field trips spark interest, engage learners, invite participation in inquiry activities, and lead to a greater accumulation of facts. Field trips affect attitudes and can lead to a positive effect on students' and teachers' inclinations and positions toward learning. Although most of the research on field trips points to these positive effects, there is some research that suggests field trips are anxiety inducing to the point of being uncomfortable and disruptive. It is possible that in the field an optimal level of anxiety is desirable to engage students in a conformably productive zone of inquiry. In addition to piquing interest, eliciting affective responses, and inducing stress, field trips can boost one's self confidence. This is because the field trip situation affords student directed behavior that in turn provides opportunities for learners to take ownership over their learning and the discoveries they make.

I reviewed an intriguing line of work looking at the connection between affect and cognition. These researchers posit that field trips are learning experiences because they create links between affect and cognition. The links are made in relation to “key episodes,” colorful memories of events that happened on field trips that link up to conceptual structures connected to long-term memory.

The research I reviewed suggests that students and teachers talk differently in the field than in comparable classroom situations. For example, teachers pose more open-ended questions and engage students in conversations rather than lectures. Researchers find that people enjoy socializing on field trips. But not all field trip talk is off-task or unproductive; on the contrary, researchers find that teachers and guides ask plenty of open-ended questions.

Researchers who look at what happens during field trips also investigate design issues. One issue is about timing. There is evidence that field trips foster learning when they are strategically placed in a curriculum and are supported with preparation to preemptively focus what could be seen and experienced. However, it is challenging to strategically align a field trip with classroom activities because scheduling is logistically difficult. Worksheets are another issue. They are a popular resource to collect field trip data but as a mode to engage learners worksheets are not too effective, so the data generated is not especially useful.

Perhaps the most significant issue related to field trip research, is that most research takes place outside of the field trip itself, and the research that does happen during a field trip tends to use methods inappropriate to capture all the layers of activity present. In the work I did, I solved this challenge of collecting data during a field trip when learners are distributed across vast spaces engaged in parallel activity.

Chapter Three: Methods

Overview

I collaborated with science teachers to design and observe a variety of field trips. The teachers provided classroom activities surrounding these field trips that in theory would connect to learning goals. In this chapter I discuss the methods used to generate the data before and after the field trips, that is, during the activities that surrounded the field trip.

I first describe the methods used during data collection. Then, I describe chronologically what happened over time, which helps tell the bigger story because this fills in details concerning how and where the residue data came from. I also describe the broader context for the two subsequent data chapters about the field trips themselves and the residual events. I do not discuss the methods and analysis of data collected during the field trips because I do this in Chapters Four and Five. I do however make mention of the field trips as part of the broader research endeavor, but in this chapter I do not go into the specifics of these activities.

Research Design

Design Research

This project employed a quasi-experimental research methodology known as design research (Brown, 1992; Brown & Campione, 1996; Edelson, 2002; Cobb et al., 2003). While traditional experiments and design research can both be ecologically valid methodologies for studying educational situations, what distinguishes design research from classical experiments is that design research allows researchers to build theories and hypotheses about the phenomenon under study, while the phenomenon that unfolds is being intentionally changed to better support teaching and learning. “Design research may still incorporate the same types of outcome-based evaluation that characterize traditional theory testing, however, it recognizes design as an important approach to research in its own right” (Edelson, 2002, p. 107).

My dissertation study involves (a) the design of a small number of out-of-classroom science learning opportunities so that the ecology of the field trip “can be studied in depth and detail” (Cobb, 2003, p. 9), and (b) collaboration among researchers and teachers who together “assume responsibility for instruction” (Cobb, 2003, p. 9). For this thesis, the unfolding phenomena under study were the field trips and the connections between field trips and classrooms.

Participants

Students

At West Elementary[3], I collaborated with one fifth-grade science teacher with three classes of 19 students for a total of 57 students; all but one student was consented to participate in this study. At Thorndyke Academy[3], I collaborated with a sixth-grade science teacher, who taught two science classes each with 23 students for a total of 46 students. Of these 46 students, 33 students were consented to participate. I focused my analysis on three of the five classes because I had the most complete data record for these three classes including two from the biology classroom and one from the earth sciences classroom. In sum, I collected data in two schools, with two teachers, and 90 students.

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[3] Pseudonym

I did not collect demographic data about the specific students in the classes that I observed; however, I can speak to race and gender. Of the students that consented at Thorndyke Academy, approximately one third were female, approximately one half were Hispanic, one third White, and the remaining one sixth were Black and Asian. Of the students that consented at West Elementary, approximately half were female. Approximately half were Black, one third White, and the rest Asian and Hispanic. In both classrooms, the consented students were representative of the race and gender makeup of the classroom as a whole.

Focal Students

The teachers picked five students from each class to be focal students. Students were chosen based on their good attendance record and because they were a representative sample of the students in the classroom in terms of gender and ethnicity. Of the 25 focal students I interviewed and followed over time, 15 focal students were in the three classes I analyzed for this thesis. I purposefully sampled eight of these 15 focal students because I had the most complete data record for them. Appendix D is a series of short vignettes about each of these eight focal students.

Teachers

Through existing connections, I found two science teachers in two local schools who were interested in collaborating on this field trip project. Mr. R has been teaching earth sciences for four years. He studied economics in college and now teaches two sections of earth science and two sections of mathematics. Mr. R is energetic and teaches with humor. He often draws from popular music, TV programs, and movies. His teaching style is conversational, leaving open ideas and concepts rather than telling answers. In his classroom, the students sit at rectangular tables, each with three to four students. An interactive digital projector displays media from Mr. R's laptop onto a whiteboard. He used this technology fairly often to show movies, to walk through worksheets, and before the schoolyard field trip he projected an aerial photograph of the schoolyard, which helped organize the preparatory discussion. He organizes an after school science club and during the summer he teaches a robotics course.

Ms. H, the biology teacher, was trained as a special education instructor. She has been teaching biology for less than five years. She also teaches Social Studies. On many occasions Ms. H told me that science and social studies are like bastard stepchildren, neglected and given short shrift compared to language arts and mathematics. The students in this classroom sit in pairs at rows of tables that line two sides of the classroom and face the front of the room. There is an aisle down the middle of the classroom. Ms. H has her teacher's desk in the back of the classroom, but at the front of the classroom is where she did most of the teaching from a small desk. This desk had her laptop that connected to the digital overhead projector. She routinely projected movies, websites, and other media onto it. Ms. H is the head of the Garden Club and knows quite a bit about plants. She was passionate about this garden space and was excited to share with me the grant applications that she applied for and received from various organizations to support the garden. Ms. H often yelled at her students, particularly when they were acting rambunctious, talking out of turn, or slow to settle down. She spent a great deal of time managing behavior. Ms. H felt strongly that the students needed "structure structure structure" when designing activities. She felt they needed to be told what to do or else they would lose focus. She saw herself as an authority, but was sometimes willing to yield control and turn to the Internet to find information that she did not know the answer to.

Other participants

On the field trips there were often adults in addition to the lead science teacher. I was present during every field trip. Occasionally, graduate students would chaperone the field trip, as well as schoolteachers, and parents of students in the classes. A river guide, Mr. H, who was a representative from a local outdoor education and river restoration organization, helped lead the field trips to the river. Mr. H led introductory activities, nature walks, and habitat expeditions.

Groups

Field trips close to the school typically had only one kind of group, small groups of two to five students. For trips offsite, field trip groups were often nested in two or three levels of groups. Pairs and triads were organized into larger chaperoned groups. These larger groups were often lumped together to create activity groups of 15 or more students and two or more chaperones. Table 3.1 is a summary of features of the field trips and the group arrangements.

		Biology Classroom	**Earth Sciences Classroom**
Field trip locations	On-school Property	Courtyard (2x)	Schoolyard
	Off-School Property	Either Chicago River or Arboretum	Chicago River Neighborhood
Field trip groups	On-school Property	Pairs of students	3 to 5 students
	Off-School Property	Two parent chaperoned groups, each with ~12 students grouped in pairs and triads	3 teacher chaperoned groups with ~15 students (River); Whole class as one group (Neighborhood)

Average Number of Students Per Adult	On-school Property	Bio1a (Courtyard) Bio1b (Courtyard) Bio2a (Courtyard) Bio2b (Courtyard)	5 6 5 6	ES1a (Schoolyard)	6
	Off-School Property	Bio1c (River) Bio2c (Arboretum)	3 6	ES1b (River) ES1c (Neighborhood)	6 6

Table 3.1. Features of the Field Trip Location and Group Arrangements.

With the exception of Bio1c, which had significantly fewer students relative to the number of adults, the student-adult ratio was roughly the same on eight of the field trips, approximately five to six students for every adult.

The biology teacher made a concerted effort to have as many adults on the field trips as possible and recruited by phone and email as many parents as possible to chaperone, even for the on-site courtyard field trips. The earth sciences teacher invited teachers and teacher aids on the field trips and did not recruit parent chaperones.

Study Design

During the winter and spring, I facilitated and observed 14 field trips across five classes. Each of the five classes went on at least three field trips. Two of the three field trips were class period walking trips, and one field trip was a special event involving a bus ride to a river and forest preserve or to an arboretum. The field trips involving a bus always integrated more than one class on the same field trip. For example, the field trips to the river included students from two classes. With the exception of one field trip to Northwestern’s Department of Earth and Planetary Sciences, the field trips happened during a focal science curriculum unit, either a biology unit on environments or an earth sciences unit on the earth’s surface.

The field trips were observational, which means students were provided with tools for generating evidence as well as for reflecting on and interpreting what was seen and experienced. I have included the lessons for the two schoolyard activities (Appendices A and B) and a sketch for one of the activities to the river (Appendix C).

In addition to observing 14 field trips from start to finish that were embedded into the particular science focal units, I observed class sessions specifically related to the field trips. Activities immediately following a field trip, either the same day or the next day, were crucial for me to observe, as were any preparatory activities that a teacher led prior to the field trip.

The following two figures depict three synced research activity timelines of the field trips, interviews, and classroom activities that happened for the biology and earth sciences classrooms. Figure 3.1 is a timeline of the field trips from the two earth sciences' classes. Figure 3.2 is a timeline of the field trips from the biology classroom. The longer horizontal lines in bold represent the one-day field trips. The shorter horizontal lines are the classroom and research activities that surrounded these field trips. The distance between events is proportional between February and July. For example, spring break lasted a week so the dashed line is quarter length between April and May. This figure is a roadmap to organize overlapping research activities and guide the reader through this chapter.

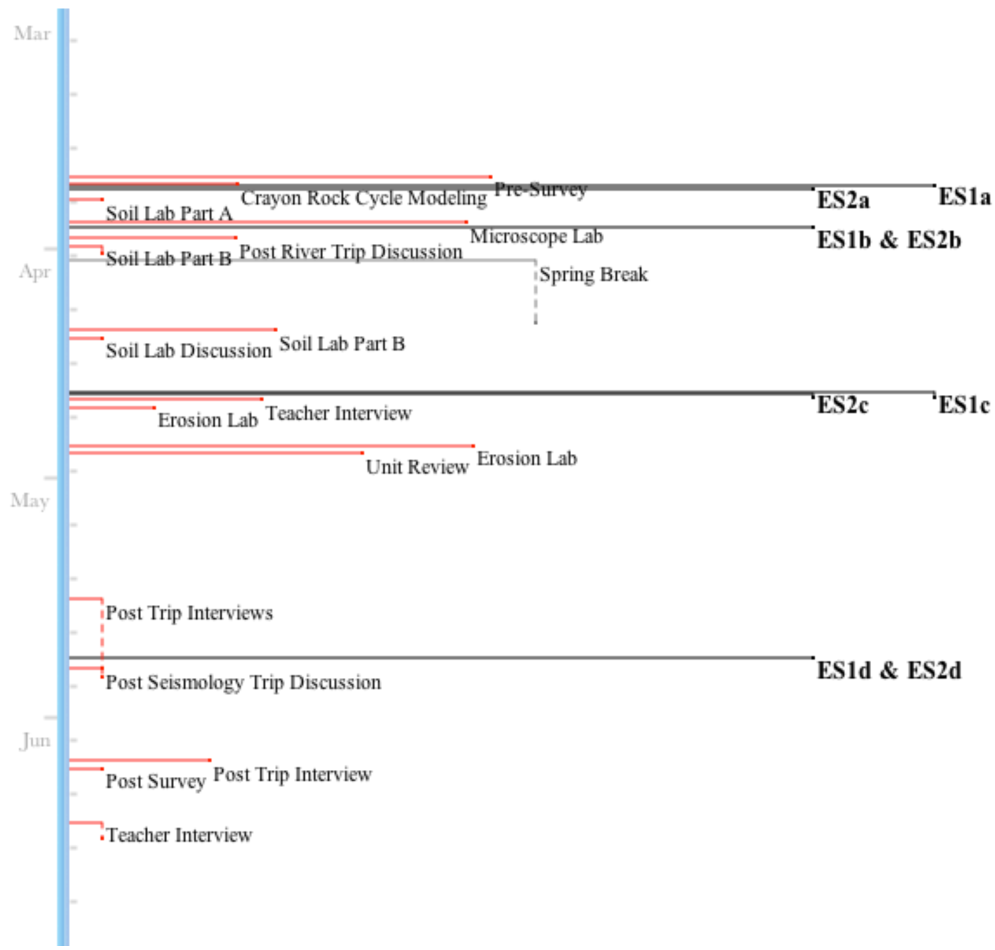

Figure 3.1. Timeline of Earth Sciences Classroom Research Activities. The bold longer horizontal lines represent the six field trips for the two earth sciences classes (ES1a, ES2a, ES1b & ES2b, ES1c, ES2c, ES1d & ES2d).

Figure 3.2. Timeline of Biology Classroom Research Activities. The bold longer horizontal lines represent the eight field trips for the three biology classes (Bio1a, Bio2a, Bio3a, Bio1b, Bio2b, Bio3b, Bio1c & Bio3c, Bio2c & Bio3c).

Data Sources

The data for this dissertation comes primarily from video and audio recordings collected in classrooms, on field trips, and during interviews between March and June 2011. In addition to the audio and video recordings that were collected on the field trips and in the classrooms, I collected a variety of other data. I maintained a logbook throughout the design and data collection processes. In the classroom, student work products were collected including PowerPoint presentations, and written field trip reflections. I continuously managed the various data sources, which included transferring, labeling, cataloging, and backing up the media files as well as scanning and organizing the written work.

On days when I observed classroom activities, I positioned a wide-angle Sony hard-disk camcorder on a tripod either on the side or back of the classroom. During small group discussions, I would either leave the camera on a tripod or hold the camera in my hand as I moved around the classroom. Occasionally, I would use two cameras, leaving one camera on a tripod pointing at a particular group or workstation and holding the second camera in my hand as I walked around. I wore an audio recorder as I moved around the classroom.

Research Context

Schools

I collected my dissertation data at two schools. West Elementary is a K-8 magnet school that emphasizes community building. Historically, the student body was predominately African American. The school was desegregated several decades ago, and White students were bussed in to increase diversity. In 2011, the student body was approximately one third White, one third

Black, one eighth Hispanic, one tenth Multiracial, and the remaining small fraction identify as Asian and American Indian. More than 80% of the students met and exceeded State standards for standardized aptitude testing. Nearly one half of the students qualified for free or reduced lunches.

The other school was Thorndyke Academy, a sixth to eighth grade middle school. Their mission statement emphasizes quality, equal opportunity in discussions and activities, respect, and learning through computer technology. In 2011, the student body was approximately one half White, one quarter Black, and one fifth Hispanic, and the remaining fraction identify as Asian, American Indian, or Multiracial. More than 80% of the students met and exceeded State standards for standardized aptitude testing. Two fifths of the student population qualified for free or reduced lunches.

Science Curricula

The classrooms used two different science curricula. The fifth grade learned with the FOSS curriculum (“Full-Option Science System). I observed the focal unit called “Environments” about organisms and the physical environment. This unit began in March and continued through June.

The sixth grade science classrooms work with McDougal Littell science curricula. I observed the sixth grade students learning from the focal unit called “Earth’s Surface,” about minerals, rock, and soil formation. This unit began mid February and ended in early May. Table 3.2 summarizes descriptive information about the classroom contexts.

	Biology Classroom	Earth Sciences Classroom
Curriculum	FOSS Environments	McDougal Littell Earth Surfaces
Grade	3 fifth grade Biology classes	2 sixth grade Earth Science classes
Students	56 students consented 31 boys; 25 girls	33 students consented 13 boys; 20 girls
Focal Students	15 students 7 boys; 8 girls	10 students 3 boys; 7 girls

Table 3.2 Descriptions of Two Different Classroom Research Contexts.

Interviews

Pre- and Post-Interviews

Over two days, March 23 and 24, 2011, I conducted pre-interviews with the 15 biology focal students. I was not able to conduct pre-interviews with the earth sciences students due to time constraints and the difficulty of pulling the students from class for the interviews.

The interview protocol for the biology students consisted of two parts (Appendix E). The first part was a five-to-seven-minute think-aloud about the students' general experiences and impressions of field trips. The second half involved five to seven minutes of interview questions specific to their science focal unit. The same questions were administered for the post-interviews as for the pre-interviews in early June.

Recall Interviews

I conducted recall interviews in mid May and these interviews all happened during science class. The interviews lasted approximately 15 to 20 minutes. A copy of the protocol is included as (Appendix F).

These recall interviews had two parts. The first part was a free recall, where the 25 focal students would say what they remembered happening during each of the field trips. The second part of the protocol involved stimulated recall. For the second part, I showed the student three or four short clips from the Flip videos shot by that particular student. After we watched a clip on the laptop, I asked the student to say what was going on in that clip. I prepared questions that helped structure our conversations. I had pre-selected clips that were moments when students appeared to be thinking scientifically, involved students puzzling over or expressing interest in something, were episodes that appeared to be interesting or engaging, or were episodes that left lingering questions. During the stimulated recall, when I showed students the video they had made, I did not know that I was investigating the phenomenon of reverberation. I selected clips that looked like moments when students were thinking scientifically.

Teacher Interviews

Partway through the focal units, I had the opportunity to informally interview each of the teachers. Ms. H and I talked on March 31, 2011 and Mr. R and I talked April 11, 2011. These conversations were audio recorded and transcribed verbatim. At the end of the school year, I again had the opportunity to sit down for an in-depth interview with the teachers. Over two days, June 14 and June 16, 2011, for a total of about 90 minutes, I interviewed Mr. R about the field trips. On June 16, 2011, I conducted a 90-minute interview with Ms. H about the field trips we had for her classes. I made detailed notes during the interviews and these interviews were also audio recorded. All five interviews were transcribed verbatim. A copy of the protocol is included as Appendix G.

Affect Surveys

At the end of each field trip, and when time permitted the students completed a quick affect survey. This survey was administered to the entire class (see Appendix H). This Positive and Negative Affect Scale (PANAS) is a validated tool for briefly measuring feelings about an event that happened during discrete amounts of time (Watson, Clark, & Tellegen, 1988).

Planning Meetings

In the fall, I met with the teachers to discuss the project and the possibility of their participation. I met with Mr. R, the sixth-grade earth sciences teacher on October 18, 2010, and two days later I met with Ms. H, the fifth-grade biology teacher, for an initial recruitment meeting. We met for about 30 minutes. At the end of the meeting, I provided printed information about my dissertation project (Appendix I). As they both expressed interest in collaborating with me, I scheduled a follow-up meeting to discuss in detail the field trips we could build together. A follow up meeting with Mr. R occurred October 19, 2010 and with Ms. H on November 4, 2010.

During these initial planning meetings, I aimed to see their perspective on field trips. I wanted to design experiences that met their goals and addressed their concerns, while still addressing the core research questions. I learned about timing for specific classroom activities, school and district events, and holidays so the field trips had the best chance at succeeding. During this conversation, I asked each teacher: (a) What their science curriculum looks like (i.e., the scope and sequence); (b) What happens on field trips? (c) What they like and dislike about field trips (d) What field trips they have planned; (e) What is planned for the upcoming school year and when would field trips fit. And (f) Do you have any special needs students? I typed notes during these meetings into the design logbook.

An important goal of these meetings was to identify specific focal units in which to embed the field trips. For Mr. R, we scheduled field trips for the winter because we identified the Earth's Surfaces unit as the best option for field trips and because the content matter fit well with learning in the field. For Ms. H, the springtime Environments unit was the best curricular fit.

In early November, I met with each of the teachers to brainstorm what could happen during the field trips, to understand the science content and process learning goals, and to learn more about the students. These meetings were each 30 minutes in duration. On November 9, 2010, I met with Mr. R for this follow-up meeting to continue work on collaborating on the design of the research study. Mr. R aimed to cover rocks, minerals, soil, and briefly cover deposition. Mr. R gave me a copy of the lessons and chapters from the science units that the district required him to teach. We discussed organizing the field trips around a common driving question: "How does soil form?"

Over the next two months, Mr. R and I continued collaborating on the field trips and classroom activity design. We met in his classroom during lunch on December 7, 2010. We talked about the specifics for a schoolyard field trip activity around learning about the properties of soil. Mr. R proposed what he felt was an important learning objective: the idea that soil is not dumped by trucks or comes in bags, but is formed naturally in situ. We agreed on a meaningful learning goal: with the soil the students collect and study, the students examine the properties of soil to understand what soil is made of and compare how soil varies from place to place.

On November 4, 2010, Ms. H and I met for a similar meeting. We discussed covering living organisms and environmental factors that affect how things survive and thrive, and we considered motivating the field trip activities with an “essential question” from their science book: “How do living things survive and thrive?”

On February 8, 2011, Ms. H and I met to pencil in field trip dates. She shared a copy of the curriculum and identified the learning goals she planned to cover in her classroom. In her classroom, Ms. H and I met during lunch on March 3, 2011 to discuss the field trips that would not involve a bus. She preferred that one courtyard trip happen before spring break and the other after break for several reasons. First, they would see the courtyard before the big spring break cleanup. Second, they could see the courtyard before and after it bloomed. Third, the courtyard was a confined environment much like the terrariums the students had made in the classroom. Like the terrariums, Ms. H felt the courtyard provided for learning about optimal and controlled living conditions.

Throughout this planning process, the teachers and I talked on the phone and emailed regularly. After class we occasionally had time to check in about what transpired that day in class and what would happen in the coming days and weeks.

Earth Sciences

Near the beginning of the school year, I was invited on a field trip that was in addition to the field trips we had been designing to outdoor places. On November 12, 2010, Mr. R invited me to chaperone this field trip for four sixth-grade classes. We went to the Museum of Science and Industry. I rode the bus and gained a firsthand look at a field trip that Mr. R had planned and facilitated. There, they saw the new Science Storms exhibit. For the students, Mr. R had adapted the exhibit workbooks created by the museum. On this field trip I noticed that students were moving from exhibit to exhibit very quickly. They spent the first ten minutes filling out the workbooks and then put them away for good. Mr. R collected them, but when I met with him a month later, he said he no had time to look them over and they were not used in class.

Mr. R began enacting the Earth's Surfaces unit in early February. He began with the chapter on minerals. On February 24, 2011, I was again invited on a field trip that was beyond the ones we had been designing. This field trip happened at the start of this unit, he took his students on a field trip the Field Museum of Natural History to see gems and minerals. I brought along some of the recording technology, including the audio recorders and flip cameras, to test the tools in a setting similar to the outdoor field trips we were planning for the spring.

Biology

Ms. H and I had the opportunity to reconnoiter the field trip sites. On March 13, 2011, the district had a half-day for professional development, and Ms. H was granted permission by the principal to take the afternoon to plan with me. We drove 20 minutes to the river. There I showed Ms. H where the various activities could take place and we talked about different ways the day might flow. I wore an audio microphone during this two-hour excursion that captured what we talked about.

On March 21, 2011, Ms. H and I walked to the courtyard to see what the students might see. We talked about rain barrels and looked for things in the courtyard environment that students would see that connected to the curriculum. Ms. H had drafted an activity, which was a list of questions about the courtyard (Appendix B). I proposed a revision that was more open ended and aimed to get students to ask their own questions rather than answer Ms. H's questions. The task we agreed on was designed to set up a situation that provided enough structure to motivate pairs of students to focus their observations and generate questions, while also generating data about the environment that they could take with them back to the classroom. We planned to have student's build PowerPoint slides to explain how living things in the courtyard survive and thrive. The students would use their photographs and insights from the field to build slides on laptops.

Science Classroom Activities

This section describes the classroom activities that happened surrounding the field trips. I outline the earth sciences activities and then I do the same for the biology classroom. I briefly mention the 14 field trips to provide a sense as to when they happened.

Earth Sciences

I describe the research and classroom activities between March and June 2011 for one of the two earth sciences classes that I observed (ES1). I selected only one of the two earth sciences classes to analyze for this thesis even though I have data from both because I had the most complete data record for that class. Except when the two classes shared the same field trip, I did not analyze the data from ES2. Table 3.3 summarizes the focal unit activities.

Activity	Task	Date	Learning Goals
Rock Cycle Crayon	Model the rock cycle with shaved crayon and heat	3/23/2011	Know that rocks break down into smaller bits; Know that pressure compacts sediments; Know that changes in heat cause rocks to form and reform
Schoolyard Field Trip (ES1a/ES2a)	Collect, observe, and locate soil samples	3/24/2011	Know where soil comes from and goes to in the schoolyard
Soil Lab (Part A)	Discuss the field trip; Describe the color, texture, and note any living	3/25/2011	Know how soil is made; Know how soil changes from place to place, and how minerals and rock

	things or things of interest; Compare soil properties		make up soil
Microscope Lab	Predict what soil looks like under magnification	3/28/2011	Know what soil is made of by investigating soil specimens using microscopes
River Field Trip (ES1b/ES2b)	Collect, observe, and locate soil samples; Observe and reflect on the river environment; Sample macroinvertebrates	3/29/2011	Know that soil by the river is fine grained compared to soil from the schoolyard; Become tuned into the environment; Know that different organisms live in different river; Know how the river system and environment change
River Reflection & Soil Classification / Microscope Lab (cont.)	Write reflections and discuss the field trip; Observe soil under magnification	3/31/2011	Reflect on the field trip; Know what soil is made of by investigating soil specimens using microscopes
Soil Lab (Part B)	Compare and contrast four soil samples, two from their schoolyard and two from the river, and describe five physical properties	4/1/2011	Know what soil is made of by investigating soil specimens using microscopes
Spring Break		4/2/2011-4/10/2011	
Soil Lab (Part B) pH Lab (cont.)	Identify five mystery liquids by their pH; Measure pH of soil specimens	4/11/2011	Know that the pH of soil is slightly alkaline
Soil Lab Discussion	Compare physical and chemical properties of two river and two schoolyard soil samples	4/12/2011	Know that different samples from different places have the same pH
Neighborhood Walk Field Trip	Walk, observe, and discuss examples of	4/20/2011	See and experience real world examples of

(ES1c/ES2c)	weathering and erosion		weathering and erosion
Erosion Lab (Part A)	Model physical and erosion using sand, ice, water, and wind	4/21/2011	Perceive patterns in how sediments move from place to place
Erosion Lab (Part B)	Model physical and erosion using sand, ice, water, and wind	4/26/11	Perceive patterns in how sediments move from place to place
Unit Review	Review erosion content; Watch time lapse video and stream table models	4/27/2011	Understand the main ideas from the unit
Seismology Field Trip (ES1d/ES2d)	Model earthquake data using USGS software, model earthquake waves with Slinky's, simulate earthquakes by jumping near a seismometer	5/24/2011	Know what an earthquake is, how they are measured, and how and where they happen
Follow-Up Discussion	Write reflections and discuss the field trip	5/25/2011	Reflect on the field trip

Table 3.3 Summary of Earth Science Classroom Activities.

In March, the students learned about minerals, rocks, and manmade materials. In late March we went to the schoolyard to collect soil samples. 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.

The following week, on March 29, 2011, Mr. R's classes went on another field trip. This time the field trip was more of a special event because the class 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 these two field trips, the students continued to investigate their soil samples during various hands-on laboratory activities that extended through the middle of April. These laboratory activities coincided with the book chapters on rocks and soil. The focal science unit, Earth Surfaces, the one in which the field trips were embedded, was scheduled to culminate with a unit test before spring break; however, Mr. R decided to extend the unit through April in order to cover new material about weathering and erosion.

In late April, we went on a field trip to the neighborhood to see examples of natural and manmade materials that were physically and chemically breaking down and moving from one place to another. The last week of April there were laboratory and modeling activities in the classroom to learn about erosional processes, and to see these processes active over vast temporal and spatial scales.

The unit review was on April 27, 2011, and the unit test the following day. On May 24, 2011, during the unit on the earth's structure, we had the opportunity for an additional special-event field trip to the Northwestern seismology department. This field trip, ES1d, was outside the earth's surface focal unit, so it is not the focus of my analysis.

Biology

In this section I give an overview of classroom activities between February and June 2011 for the biology classes. Ms. H began teaching the FOSS Environments unit in February, allotting the remainder of the school year for this science unit. The students learned about ecosystems and environments and how organisms survive and thrive.

During April, the students worked in pairs to construct PowerPoint slideshows using observations they made during the first courtyard visit. During the days when students were building their presentations, there was quite a bit of talk about the presentation software and about file management, but not much talk about the science. In early May, each group presented a slideshow to the class. Their slides were presented for the whole class as an opportunity to question and comment.

Each of the three biology classes went to the schoolyard twice, once in late March and again in late April. The first set of courtyard field trips (Bio1a, Bio2a, and Bio3a) occurred during early spring, but it still felt and looked like winter. The courtyard garden showed few signs of life and looked as though it had not been maintained since the fall. The second set of courtyard trips occurred in late April (Bio1b, Bio2b, Bio3b), after spring break and when the garden was in full bloom. The last week of school, there were two special-event field trips. These field trips involved going on a bus ride to reach the field site and were originally scheduled for mid April, but were twice postponed due to inclement weather. Students either went to a local arboretum nature conservancy or to a section of the Chicago River in the Cook County Forest Preserve System. The fifth period class (Bio3) was split between the two field trips. So, one and a half classes went to the arboretum and the remaining students went to the river. After these two field trips, Ms. H facilitated a classroom discussion about that field trip. Ms. H went on both field trips so the students who did not go on that particular special-event field trip were with their language arts teachers during the duration of the field trip and post discussion.

The following table, Table 3.4, summarizes the science activities for the biology classroom.

Activity	Task	Date	Learning Goals
Courtyard Field Trip Preparation	Listen to a teacher talk about the field trip	3/29/2011	Know the rules, expectations, and what to do in the field
Courtyard Visit, Initial (Bio1a); Computer Lab 1a	Find, observe, map things in the courtyard Upload photographs to iPhoto and begin PowerPoint Presentation	3/30/2011	Know how organisms survive and thrive in the courtyard environment Explain how things survive and thrive through three distinct field observations
Courtyard Visit, Initial (Bio2a) Computer Lab 2a	Find, observe, map things in the courtyard Upload photographs to iPhoto and begin PowerPoint Presentation	3/31/11	Know how organisms survive and thrive in the courtyard environment Explain how things survive and thrive through three distinct field observations
Courtyard Visit, Initial (Bio3a) Computer Lab 3a	Find, observe, map things in the courtyard Upload photographs to iPhoto and begin PowerPoint Presentation	4/1/11	Know how organisms survive and thrive in the courtyard environment Explain how things survive and thrive through three distinct field observations
Spring Break		4/2/2011-4/10/2011	
Computer Lab 1b	Continue work on PowerPoint Presentation	4/12/11	Explain how organisms survive and thrive
Computer Lab 1c Computer Lab 2b Computer Lab 3b	Build PowerPoint Presentation	4/14/11	Explain how organisms survive and thrive
Courtyard Visit, Follow-up (Bio1b); Computer Lab 1d	Find, observe, map things in the courtyard Upload photographs to iPhoto and update	4/25/11	Observe changes over time; Explain how organisms survive and thrive, and vary from place to place

	and revise PowerPoint Presentation		
Courtyard Visit, Follow up (Bio2b; Bio3b); Computer Lab 1e; Computer Lab 2c; Computer Lab 3c	Find, observe, map things in the courtyard Upload photographs (only Bio2 and Bio3) to iPhoto and revise PowerPoint Presentation	4/29/11	Observe changes over time; Explain how organisms survive and thrive and vary from place to place
Computer Lab 1f Computer Lab 2d Computer Lab 3d	Construct and revise PowerPoint Presentation	5/4/11	Observe changes over time; Explain how organisms survive and thrive
Computer Lab 1g Computer Lab 2e Computer Lab 3e PowerPoint Presentations 1a PowerPoint Presentations 2a PowerPoint Presentations 3a	Construct and revise PowerPoint Presentation Present PowerPoint	5/5/11	Explain how organisms survive and thrive; Communicate three observations to the class
PowerPoint Presentations 1a PowerPoint Presentations 2a PowerPoint Presentations 3a	Present PowerPoint	5/6/11	Explain how organisms survive and thrive; Communicate three observations to the class
PowerPoint Presentations 2c	Present PowerPoint	5/11/11	Explain how organisms survive and thrive; Communicate three observations to the class
Arboretum Field Trip + Follow Up Discussion	Construct a sketch of an ecosystem	6/9/11	Know how to construct a model of an ecosystem on a very small scale
River Field Trip + Follow Up Discussion	Construct a sketch of an ecosystem; Observe river environment on guided and self guided nature expeditions	6/9/11	Know how to construct a model of an ecosystem on a very small scale; Use senses and intuition to make observations about the river environment

Table 3.4 Summary of Biology Classroom Activities

On March 29, 2011, prior to the first set of courtyard field trips, each biology class was given a 30-minute preparatory introduction. They were provided detailed instructions on what to do and how to behave on the field trip. The same material was covered in all three classes in approximately the same order. They discussed the meaning of "environments," paired the students up into field trip groups, and introduced the driving question. Ms. H also introduced the goal of the field trip. "Our goal is to make really careful observations. To discuss in our pairs or in our one group of three and pose questions about our living things. Our living things can be plants, animals. And how they relate to the environment they're in."

In terms of motivating the project, Ms. H explained that the PowerPoint presentations would have four slides and a title slide and the students could "choose your three pictures that you have the most ideas about." It was not clear from her instructions how they were to use the questions and photos for their projects. The students were not told that the ideas they came up with for captions for their pictures were meant to provide added context to explain or describe a relationship in the environment. The final ten minutes of the preparatory activity was used to pass out the digital still cameras, allowing time to test them out and practice using them.

Before each of early spring field trips, just before going downstairs to the courtyard, Ms. H led an introduction for about 10 minutes. She used this time primarily to refresh students about the task, which they had learned earlier in the week, and to manage materials and groups. Prior to going to the courtyard, the student pairs were each given a bucket filled with a number of different tools for making observations (e.g., pencils, hand lens, tape measure, gloves, shovel, orange flag, a string of the numbers 1-20 on a lanyard, etc.). Each group was given a clipboard, a map of the courtyard, and a table to record their questions. Ms. H. identified each of the materials and said what they were for and how they would be used during the field trip. The teacher also handed each student pair (and one triad) a Canon Powershot digital still camera to document things in the environment.

Environments slideshow construction

There were six days in April and May when everyone was given the opportunity to work on their PowerPoint presentations. Usually these class periods involved students working and talking in their courtyard groups creating a presentation. Occasionally, Ms. H would get the students attention, lead a brief discussion, tell a story, or give instructions, but for the most part these were student-directed work periods. The vast majority of questions I observed during the PowerPoint construction activities were technical questions about the PowerPoint software.

Presentations

Students presented their final projects over two days in early May, shortly after the second courtyard field trip. Each partnership used approximately five to 15 minutes to present their slides to the class. The pairs stood up at the white board which had their presentation projected onto it. The students were asked to share questions and comments, so usually after each slide the teacher would open up the floor for discussion. Typically, students would take turns reading what they had typed on their slides. Some students chose to read the slides. Some tried to tell the answer to the questions generated in the field, while other students raised additional questions in the text they wrote. There were even some students who offered “theories” about how they think things survive and thrive.

Late spring field trips (Bio1c, Bio2c)

The special-event field trips were originally planned to happen April 18 and 19, 2011, between the two sets of courtyard field trips. However, April was very wet and unseasonably frigid. The morning of April 18th, the district decided it was too cold for the students to go outside, so we postponed both trips. I decided to reschedule these field trips for early June.

The rescheduled field trip to the river (Bio1c) happened on June 10, 2011, the last full day of school. Bio1c was for the third-period biology class and the remaining half of the fifth period class. Ms. H decided how to divide the classes between the two trips. Four parents volunteered for Bio1c. Another mom chaperoned and drove with her son separately in their car. Ms. H divided the students into chaperone groups in the classroom.

The morning of the river field trip was a 20-minute preparatory activity. Students interpreted a Google map of the field site projected on the classroom wall. I led a brief discussion about this map of the field site, where we were going, what we would be doing, and what the purposes of the field trip were.

On Bio2c, there were two main observational activities. The first involved looking at animals living inside the nature center. The other involved the students sketching what they saw living in an environment of their choosing in the forest behind the nature center. Bio2c lasted approximately 90 minutes and we returned to school in time for lunch. Two parents and the school psychologist volunteered for Bio2c. One mom met us there in her own car and the other parent rode the school bus with us. There was no preparatory activity prior to this field trip.

After each of the field trips Bio1c and Bio2c, there were lengthy and lively discussions in class. Sample prompts for the discussions were given to Ms. H and she chose the questions to ask and determined the order. My participation in the discussions ranged from passive to active. At times I offered ideas to ponder and questions for the students to consider. Student participation was strong during these discussions and there were many different students eager to share their observations, ideas, and questions. Considering these were the last days of school and most of the student body was in the auditorium watching *The Incredibles* or in the hallway cleaning lockers and signing yearbooks, it was an impressive sight to see so many students focused and participating in a science discussion.

In this chapter, I aimed to describe the methods I used for generating and collecting data mainly during the activities that surrounded the field trips. In the next chapter, Chapter Four, I take a microscope to the field trips and show what happens on them, and then in Chapter Five, I show how the field trips, classrooms, and interviews are related by memories of events that reverberate across contexts.

Chapter Four: The Field Trips' Precipitating Socioemotional Events

In this chapter, I describe what happened on the field trips. I describe the methods used to collect data during the field trips and the techniques I used to reconstruct and analyze them. Then, I give a general synopsis of how time was spent for these 14 field trips. Next, I describe in detail one field trip as an example of what happens. I show the talk and action in sufficient detail to give a flavor of what happened, and then I compare what happened on this field trip to the full set of field trips I analyzed. Finally, I summarize the main findings for this chapter.

General Synopsis

This chapter is about what happens on field trips. The audio from the microaudio recorders that the focal students wore and the audio and video from the researcher cameras are the two main sources of data I used to reconstruct the field trips. As I reconstructed the field trips to be able to say what happens on them, I began to notice times when both the activity and participant structures changed. I looked more carefully at how students transitioned, that is, how they moved from one setting to another, for example, from the classroom to the site and back again. All of the field trips that I observed involved significant amounts of time for transitioning, for "inter-activities" involving the movement of people and supplies from place to place. A lot of time was spent on activities that had little to do with learning content, however, a substantial fraction of time was still used for engaging in field trip activities.

The meat of this chapter is the retelling of one field trip, which I narrate through a sequence of vignettes. I emphasize socioemotional events that precipitated residue because they lay the foundation for the analysis I do in the next chapter on reverberations.

Methods of Data Collection and Analysis

Data Sources

I invented a method where students collected data in a distributed environment because on field trips and in classrooms it is very hard to see what is happening when everyone is distributed across a large space. On the field trips, the focal students wore the audio recorders around their necks. The array of micro recorders provided sufficient coverage to hear what students said. The combination of video cameras and external audio devices proved to be a helpful innovation because it afforded hearing conversations with exquisite detail, even ones many yards from the video camera. For example, one conversation involved a group of students 20 yards from the camera theorizing that the forest floor is green because leprechauns make it so. This conversation was audible only because of the multiple and overlapping layers of technology that were pieced together in Final Cut Pro X, professional editing software. This software allows one to watch and to listen to any combination of audio and video tracks. These tools helped solve an important methodological challenge of hearing and seeing what happens when learners are distributed over a large geographic area.

From the field trips, the data I collected include student journals, annotated maps, question logs, and the affect survey self-reports. Digital still cameras provided an important data source for two reasons. First, the still cameras were tools that the students used to capture what they saw and experienced in the courtyard. The objects students photographed in the field became fodder for discussion during classroom presentations. Second, photographing with digital cameras appeared to be a popular practice, particularly during moments that left residue. Usually during a precipitating event, cameras were in hand. Student generated video data was a useful supplementary data source to the primary researcher cameras. The videos captured with these handheld video cameras, which the focal students used in the field, were useful during the stimulated recall interviews. The act of recording may make it easier to recall memories. It is possible that the students were learning through the act of making video recordings (Stevens & Hall, 1997; Hall, 2000), which in turn, may have helped make the events even more memorable had the students not had a camera.

Data Collection

The goal for the data collection was to gather evidence during field trips and during any classroom activities specifically related to them. My role on the field trips was a "participant observer" (Spradley, 1980). The degree of my involvement ranged from passive to active. This means that sometimes I was a fly on the wall with a video camera, while other times I was asking and answering questions and directing observations. Occasionally, I talked into the camera, giving some description and analysis. These "event casts" (Ochs, et al., 1992) provided a running narrative of the action as it unfolded (Heath, 1996). Although I had a pen and notepad to jot down interesting moments, I preferred to talk into the camera because I could keep my focus on the action rather than on writing observations.

I personally recorded the field trips and classroom activities with a Sony Handicam (HDR550) equipped with a 5-hour battery pack, wide-angle lens, and a 250gb hard drive. I named this camera RC1. A large hard drive and battery pack meant RC1 could always be recording, even if there did not appear to be anything too important happening. This proved to be a key affordance because it meant there was a continuous record of the field trip that the other video and audio files could be synced to. RC1 was usually on, although during field trip ES1b this camera was not always on, which consequently made constructing the field trip narrative significantly more challenging and time consuming. Additional digital camcorders were intermittently used by adults such as teachers and chaperones who offered to help document what they saw happening. I refer to these cameras as RC2 and RC3. These digital cameras included: Canon HG10a, Canon HFS10, Canon FS100, Canon FS200, Canon T2i, JVC330, and one Sony Handycam Hi8 digital videotape recorder. In addition to the researcher video cameras that captured the field trip situation, focal students recorded what they saw and experienced using handheld microvideo recorders (i.e., Flip video cameras).

The multiple and overlapping streams of video and audio data were imported into the professional video editing software, Final Cut Pro X v 10.0.0. This process involved importing into Final Cut Pro, all the audio and video clips from the various cameras and audio recorders, and aligning and syncing the recordings for each of the nine field trips I analyzed. I did this by listening for “syncable moments” that I could hear on different files. For example, a school bell or a student’s loud scream could mark an instance on one clip that I could use to align to the other clips that also captured this moment. Since the audio recorders and RC1 were usually recording continuously, it was possible to sync all the audio and at least one video camera. The resulting narrative case I present below is derived from the analysis I did.

After I assembled each of the field trips in Final Cut Pro X, I created a summary of what happened for each of the field trips. To do this, I listened and watched the field trip from the perspective of RC1. To record what I saw happening in text, I captured talk and action in an Excel matrix.

Data Analysis

The goal of the first phase of the analysis was to construct something like field notes. Once the files were fit together in Final Cut Pro, I listened and watched them carefully. I constructed summaries, replete with verbatim quotes and descriptions of the action, from the audio and researcher video recordings. The high-resolution audio and video from the Flip cameras provided crucial supplementary footage that at times filled in gaps in the data record. The constructed accounts of what happened are like field notes; however, they weren't constructed from jottings taken in the field and instead were written from the audio-video record, so they are more like narrative summaries.

The narrative summaries captured what happened from multiple perspectives and from action that temporally overlapped. Since every interaction I transcribed was not captured on video, I am not always able to say with complete confidence which student was talking. Instead of identifying these students I wrote "someone" or "a student" as a placeholder. I transformed these descriptive accounts into brief summaries of what happened. The summaries were organized thematically (e.g., by moments of heightened engagement) and chronologically. I completed this process for the nine field trips from the three classes I sampled. This stage of my analysis lasted from June until November 2011.

How I categorized activities

Assigning students to groups is an integral part of the field trip experience because it distributes labor. This allows students to help one another to complete the field trip tasks. A way students help one another is by sharing the work. Another way they can help one another is by talking through the task. For the special event bus ride field trips, assigning students to activity groups is important because it holds chaperones responsible for the safety of a smaller number of students, especially when a teacher can't see a dozen small groups at once.

I organized my observations according to times when the participants regrouped. This means I looked for instances when the assigned groups dissolved and reformed into some other combination of students. For example, students were assigned to work in pairs before going to the courtyard. Once they left the classroom to head to the courtyard, the students regrouped to be with their friends. Then in the lobby students began to reform into their assigned pairs. When the courtyard doors opened, students were for the most in their assigned pairs. This is an example of pairs of students regrouping.

These periods of regrouping corresponded to changes in the activity structure. In the classroom, the activity was preparing for the field trip including assigning students to groups. While walking to the courtyard, during this inter-activity, most students regrouped to be with students who were not in their assigned groups. After this transition, in the field, these new groups dissolved and the students went to work with their assigned partners. After another transition, this time back to the classroom, there was a post-trip wrap up activity about the field trip, during which students would sit with their assigned pairs.

I found four major categories of activities that were bounded by changes in both the participant and activity structures: (a) classroom preparation immediately prior to disembarking to the field; (b) transitions between the classroom and the field site, between areas of interest at the field site, and between major activities; (c) time at the field site engaged in the field trip activities; and (d) reflections and post-trip wrap up activities in the classroom immediately following the field trip either the same day or first thing the following day. I did not include in this analysis changes in participant structures *within the field trip activities* as those changes were folded into the category of the field trip activity. I do however look at field trip changes to group structure during the actual field trip in the next chapter when I examine precipitating events.

How Time Was Spent

It was useful to measure just how much time was actually spent doing science activities compared to other things for several reasons. If 95% of the field trip was unproductive time transitioning, then we would want to know this and to understand why this was the case. Another reason to conduct this analysis of time on task is to calibrate just how much time is spent on task compared to how time is spent in science classrooms. If we know the efficiency of normal classroom activities, then this would give us some sort of comparative measure to index these observations. I am not aware of any such study. A third reason to look at how time was spent on the field trips was to see how time was used across the different kinds of field trips. Field trips can be inefficient with large chunks of time devoted to riding the bus, for instance. Given how difficult field trips off school property are to organize and carry out, it is meaningful to know, for example, how field trips to places accessible by foot compare to places accessible by school bus. Comparing how time was used within and across field trips could lead to insights about how to enhance field trip design. Figure 4.1 depicts how time was spent on major activities.

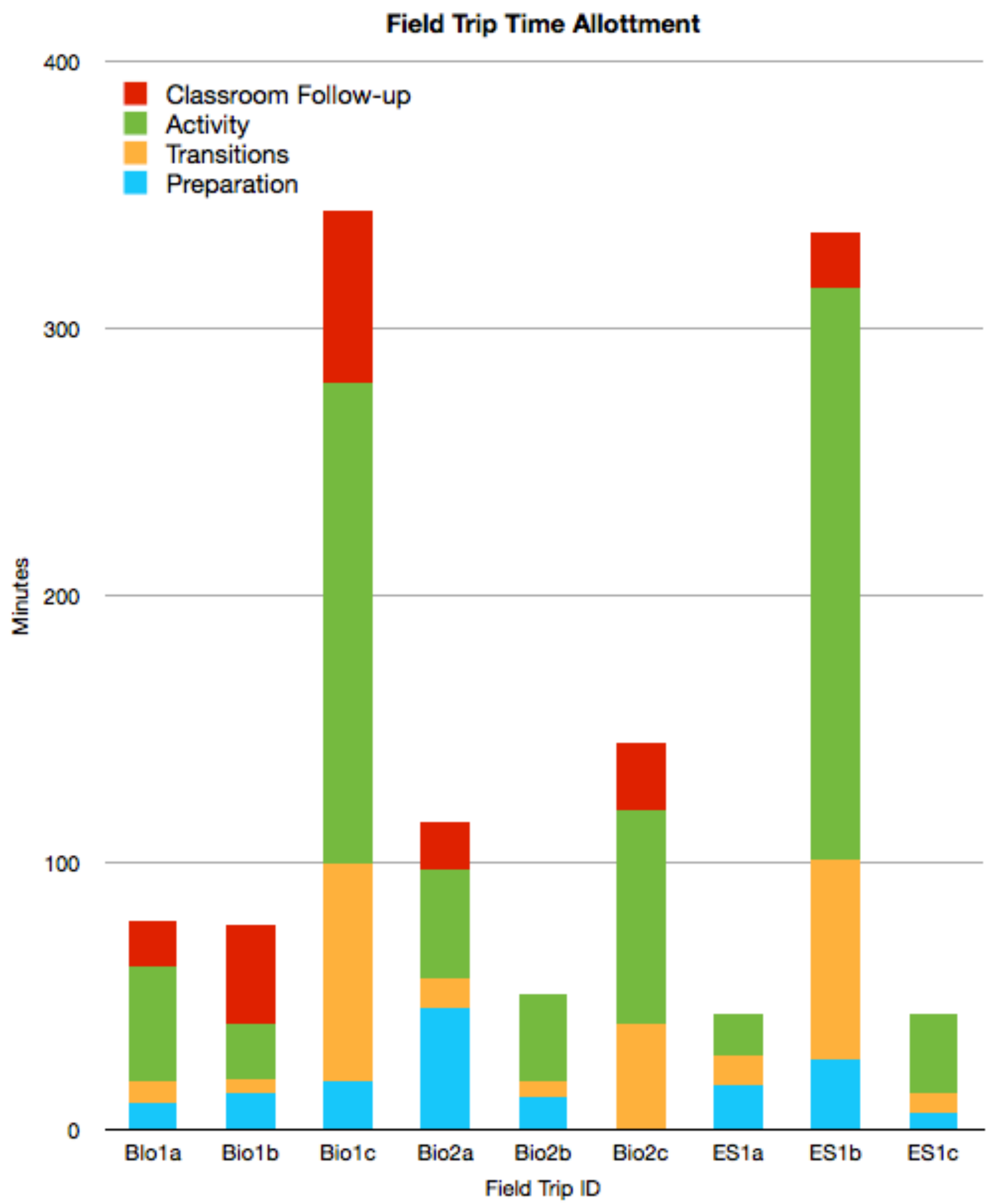

Figure 4.1. How Time Was Allocated during Nine Field Trips.

The field trips typically involved some sort of preparation before leaving the classroom, but preparation was rarely about science content tied to the focal unit. Occasionally preparation was about scientific practices such as mapping or soil sampling. Usually, preparation was for readying students for the task and setting, outlining expectations, managing materials, and assigning students to groups. Preparation typically lasted 10 to 20 minutes.

A significant amount of time was spent transitioning. The shorter duration field trips generally involved a smaller fraction of time for transitions relative to time on task doing science activities. For the longer duration field trips (i.e., Bio1c, Bio2c, and ES1b), I observed a significantly greater fraction of time for transitions than the shorter duration trips. On average, one third of the total field trip time for the longer duration field trips was used for getting from one place to another, for forming introduction circles, and for transitioning between activities. For the shorter field trips, students were engaged in the science tasks 80% of the time, with just 20% of the time needed for transitions. Because they happened to be closer to the school than the longer duration field trips that involved a bus, proportionally less time was allocated for getting from place to place. This is noteworthy because the bus ride accounts for a good percentage of the time transitioning for the longer duration field trips. Since special-event field trips lasted many hours, a third of the time on conducting science activities is nevertheless a good amount of time for engaging students in meaningful learning.

Following the field trips, there was usually some sort of post trip wrap activity or discussion. The post trip activities following the walking field trips tended to be brief. This time was not usually for discussing the actual field trip but for managing materials. In contrast, following the three bus ride field trips, there were lengthy in depth discussions. Although these discussions were significantly longer than the follow up activities after the walking trip, they were proportional to the total length of time as the shorter duration post trip activities. On average, post trip activities were approximately 14% of the total field trip time.

In what follows, I present one field trip as an example to show what happens in detail. I selected Bio1a because it generated a representative amount of residue. In the next chapter, I discuss precipitating events and the residue stemming from these precipitating events. Even though I draw from the full set of field trip data I analyzed for this thesis, the vignettes I use to illustrate my argument are drawn primarily from events that transpired in Bio1a.

Bio1a: Schoolyard Ecology

The first field trip for the biology classroom, and third field trip overall for this dissertation, happened Wednesday March 30, 2011. It was relatively ephemeral, lasting 80 minutes, from 9:22am to 10:42am. It occurred during two consecutive science periods. I chunked the first 10 minutes at the start of the class as preparation. The transition to the courtyard lasted four minutes. The class regrouped in the lobby and then went into the courtyard for 43 minutes. In the courtyard, pairs of students worked on the field trip activity. When the field trip was over, everyone went inside the building to walk back to the classroom. For this 80 minute field trip time was spent on the following activities: 28 minutes preparation/wrap-up (35%); 9 minutes transitioning to/from the field site (11%); and 43 minutes doing the field trip science activity (54%). These numbers look similar to the other shorter duration field trips in terms of time spent on the science task relative to time transitioning (approximately 6:1), but is quite different than the longer field trips, which have a ratio of 3:2.

On the field trip were 19 students and their teacher, Ms. H. Additionally, three other adults were present: a student teacher (Mr. D), a parent chaperone (CH), and a student investigator (Jon Boxerman aka JB). JB recorded the field trip activities inside the classroom before and after the field trips. RC1 was placed on a tripod in the back of the classroom. When it was time to transition downstairs to the site for the main event, JB removed the camera from the tripod and carried it by hand for the duration of the time out of the classroom.

The descriptive summary of what happened on field trip Bio1a tells the story of what happened chronologically, beginning and ending this analysis in the classroom. Through my retelling of the field trip, I focus on four major events that reverberated (i.e., dead bird, rain barrel, hornets' nest, pampas grass) and several smaller ones that involved fewer people (e.g., Purple Crocus). The following Figure 4.2a is a map that includes the approximate locations of these precipitating events followed by Figure 4.2b, which is a timeline with the approximate timing and duration of these events.

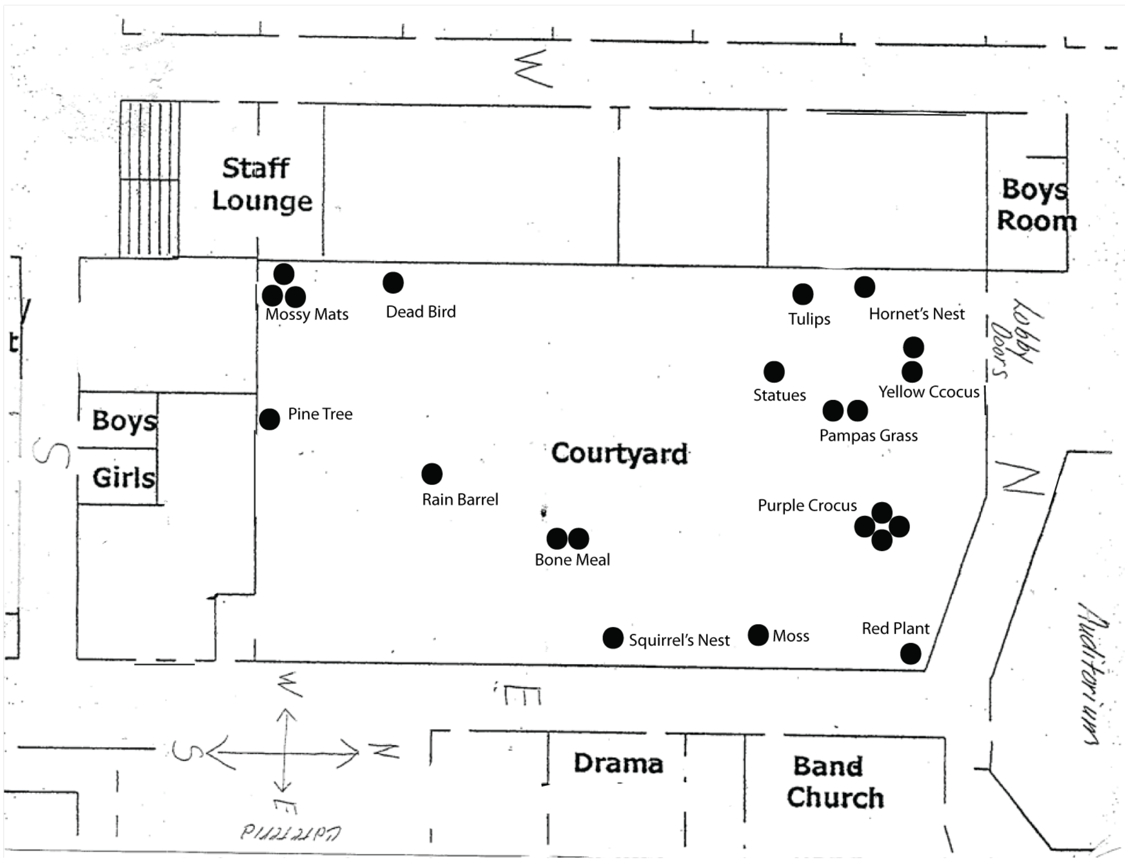

Figure 4.2a. The Courtyard Map Depicting Precipitating Event Locations. The black circles represent the approximate location of the precipitating events that transpired on field trip Bio1a.

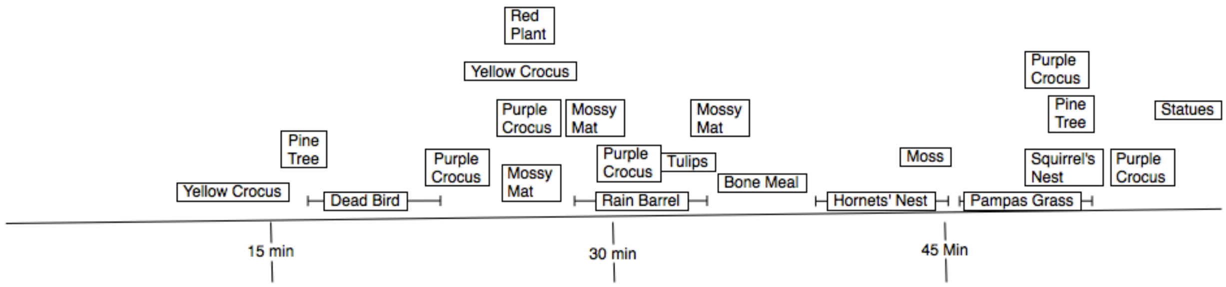

Figure 4.2b. Timeline Depicting Approximate Sequencing and Duration of Bio1a Precipitating Events.

Pre-Trip Setup (9:22–9:32)

After the students returned from gym class and settled in to their seats, Ms. H led a 10-minute pre-trip setup. The preparation involved assigning students to small groups, passing out materials, and reviewing the task (they had reviewed for the field trip the day prior). Ms. H reseated the students in their field trip groups. There was quite a bit of behavior management during these initial 10 minutes, reminding students to “sit down” and keep their “voices off.” The field trip created an air of excitement.

The students on the courtyard field trips were tasked with finding things of interest that were about how organisms survive and thrive, then coming up with questions about them, photographing them, and marking on a map where they were found. The students were instructed to: (a) make careful observations; (b) talk about and record questions and wonderings about how that thing (living or non-living) relates to the courtyard environment; (c) record these observations on their group’s worksheets; (d) take a picture of that thing and a corresponding number on the lanyard to index that observation; (e) locate their observation on the map and mark it with the corresponding number.

Eight pairs of students and one group of three were provided with a variety of materials for completing the observational activity. Students were each given a bucket filled with a number of different tools to support their fieldwork (i.e., pencil, hand lens, tape measure, latex gloves, shovel, orange flag, a lanyard with the numbers 1 through 20, and a Band-Aid). Ms. H identified each of the materials in the bucket and described what they were for and how they would be used during the field trip. She handed each student group a Canon PowerShot digital camera to photograph things of interest in the environment. Ms. H clearly stated that yelling and taking social pictures were off-task, except for a picture of their partnership, which she encouraged because they could use it for the cover slide of their slideshow presentation. In addition to the cameras and observation buckets, each group was given a clipboard, a map of the courtyard, and a table to record their questions and observations.

Ms. H read from a worksheet that they would be “making observations and asking questions about things of your choosing. With the photographs you made (e.g., living things, man-made things, environmental factors such as soil, water, and sun) and your insights from the field trip, each team will be making a PowerPoint presentation to present to the class about how these living things survive and thrive.” Ms. H read aloud: “The essential question you are trying to understand is how do things in the courtyard survive and thrive. To better understand how things survive and thrive, you will be investigating living things and their relationship to the environment. To help you understand this you will be collecting data by taking photos, making notes, posing questions, and coming up with ideas about living things and how they relate to the environment and to other living things.”

Before going outside, Ms. H asked students to recall the purpose of the field trip. One student stated, “To find environmental factors and take pictures of living things.” Ms. H replied “we want to tie them into…what were those words we talked about yesterday?” “How do they survive and thrive?” Ms. H probed the class deeper on the meaning of these terms. “Survive is to do what?” “Thrive is to do what?” She answered her own questions. “To grow to prosper, to do well, right? We want to look at how these environmental factors are helping things survive or not survive." Ms. H attempted to tie the field trip task to the curricular learning goals by motivating the activity with an essential question that she elaborated with more specific sub-questions.

Transition (9:32–9:36)

The students eagerly jumped to their feet and briskly walked from the classroom to wait downstairs in the lobby by the locked door to the courtyard. During this transition, while a number of students went to their lockers and to the bathroom, I met for two minutes with the five focal students from this class. These students stayed in the classroom with me while the rest of the group, including the teacher, made their way downstairs to begin the activity. These focal students were each given the microaudio recorders, Flip Video cameras, and brief instructions about what kinds of things to record. They were asked to capture things of interest, importance, or things that raised questions for them. Two of the students were pleased to be in what they termed the "camera crew." The five focal students were told not to conduct interviews with the cameras. They were also asked not to share these cameras or to let filming come at the expense of doing the science activity. They were encouraged to film what they say happening, focusing on people rather than things.

Several minutes later the entire class congregated by the lobby doors. The students were talking loudly and appeared energized and excited to go outside. Ms. H arrived with the key and opened the lobby doors. Being that the floodgates opened, the students poured out into the courtyard.

Courtyard Exploration (9:36–10:19)

Outside, the sky was clear and the air was cold. Temperatures hovered in the upper 30s to low 40s.

The courtyard is a 150x60-foot open air space in the center of the school. There is a mix of concrete, trees, shrubs, statues, and plaques of important school community members, wood and concrete benches, and a bulb flower garden. The interior of the courtyard is mostly paved with concrete and the perimeter is soil, grass, and trees. All but one of the dozen trees was barren. A lone evergreen pine tree grew at the south end of the courtyard. A bird feeder partially filled with water sat on a perch next to this tree. A few flowers were seen sprouting up through dead ground cover from the previous year's growing season. Barrels and planters were scattered throughout courtyard filled with clumps of dirt and bark. Dead plant matter draped over the lips of the barrels. A 55-gallon rain barrel was lying on its side in the dirt near the center of the courtyard. The courtyard looked stark and had few signs of life.

The glass and brick two-story school surrounds the entire courtyard. There is one door at the north end by the auditorium. A long concrete ramp and stairs leads down into the courtyard. Awnings wrap the edge of the roof. AC units hum along the interior walls of the west side of the courtyard.

Classrooms and hallways bound the courtyard on all four sides. They are easily visible through the windows. These walls caused some echoes, which amplified the sound inside the courtyard, as well as, caused some distractions with students inside the school. For example, students sitting in other classes or wandering down the halls would peer into the courtyard and interact with the students on the field trip through the glass. Even though students walk by this area on a daily basis and can see into the courtyard from their classrooms, they rarely are in it.

In the initial minutes in the courtyard, most of the students stood clustered around the ramp by the door. A few teams had started to spread out and explore. They were primarily focused on taking a picture of the whole courtyard, which Ms. H instructed would be everyone's initial observation to photograph, map, and log.

During these first few minutes, a number of students messed around with the technology. One student, Minos, had some difficulty operating his Flip Video camera. He asked JB, "Hey, how do you zoom?" Flanna and Ziva walked in front of RC1 and said, "let's take a picture." Ms. H reminded them, "Remember to turn your camera off" when it was not being used. A group of six students huddled around bunches of yellow crocus flowers taking pictures and writing on clipboards. JB asked Marcy what she and Louise were observing. Marcy boasted to some other students "it's not taking a picture," seemingly ignoring the question about observing and instead reacting to her difficulty with the technology. Minos tried to use the Flip camera as a still camera by taking one second clips because these cameras do not take photographs.

In the following vignettes, I focus on special events that precipitated socioemotional interactions during the field trip and later reverberated across time and place. I present these vignettes because they are rich examples of precipitating events. For example, some of these events left a lot of residue, such as the dead bird episode. Other events left less residue, such as a conversation about a squirrel's nest. I also chose these particular events because I revisit some of them in the next chapter.

Dead bird

Seven minutes after entering the courtyard, an event occurred that would be one of the most powerful precipitating events in my corpus. I refer to this as the "dead bird" event. As I hope to show, the dead bird event typifies many of the central features of precipitating events. It 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.

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.[4]

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. Nagle fed off their attention and gleefully touched the rotting fruit peel that lay a foot from the bird. His peers

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[4] Incidentally, this event happened in the film but not the book, when Errol the owl, the Weasley’s owl, delivers the post and causes quite a stir when he smashes into the window while the Weasley family eats breakfast at the burrow.

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.

Purple flowers

Partway through the dead bird event, a handful of students left the bird to observe a patch of purple flowers. Unlike the dead bird, the flowers did not cause a big excitement and only involved one small group of students. Nonetheless, like the dead bird event, this event precipitated a good amount of residue.

This 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 reluctantly agreed and the two of them walked over to the flower patch.

Calvin noticed his group mates, Manuel and Marcy, were at the purple flowers. He leapt over the flower garden and the family of stone ducks. He then squatted next to his partners who were investigating a cluster of purple crocuses. They were about to start filming the movie about the flowers. The petals of some of the flowers appeared wilted and were dying. "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." Manuel also challenged Marcy and questioned, "Ducks, really?" Marcy referred the group to evidence of ducks she saw elsewhere in courtyard to back her claim. Marcy proposed an alternative explanation that bunnies are what ate it. Since Marcy held the clipboard, she controlled what ultimately was written down, and so her question about what ate the flowers was recorded. The group dispersed as Marcy wrote down her question.

Rain barrel

Ms. H was inspired to help students see the connections between rainwater and latex paint. Her inspiration came from conversations she had during a site visit in which she and JB planned for the courtyard visit. During the field trip, Ms. H decided to organize an impromptu teaching moment.

Beside the birdfeeder was a blue rain barrel lying on its side. Ms. H summoned Emogen and several other students. They walked over to the barrel and stood in a half circle peering at it. Ms. H asked them to "take a look at paint flakes on ground." She probed Emogen and the other students nearby to explain why there was paint on the ground. Ms. H pointed to the water hose and to the paint chips, inviting students to make the connection between water and paint. Emogen suggested it got wet and wind caused it blow off. Ms. H decided to tell them the story about the rain barrel falling over and the water coming underneath, which caused the paint to peel off. The students with Ms. H theorized that water was the agent that caused the paint to chip. Then Ms. H said, "That's definitely an environmental factor" and stepped aside after planting this idea.

The group that had formed around the rain barrel continued to think aloud in a relatively unconstrained manner. Emogen thought the environmental factor was wind that could have blown the barrel over, but then she revised her thinking that the water-filled barrel was too heavy for wind to knock over. Emogen thought, “Maybe it was an animal.” The brainstorming continued and Ms. H proposed, “Maybe it was a person.” JB posed the question to the group, “How does water make paint come off?” Jedidiah was writing questions down about the rain barrel while his partner Emogen talked. Jedidiah asked, “What caused the paint to flake?” The students were by now taking a closer look and observing the paint in the soil.

Hornets’ nest

Approximately 10 minutes after the rain barrel event, another moment of heightened engagement enveloped the class. In a lot of ways this event had the look and feel of the dead bird event. Like the event at the rain barrel, Ms. H also initiated the hornets’ nest event. The event began when Ms. H walked up to JB and confidently stated, “No one has seen the…” and then stopped short of saying ‘nest.’ She turned away and announced loudly to everyone who could hear her look up high. Arwin said, “We found a moss mat.” Ms. H did not give Arwin her attention and suggested to him, “Over there, I think you will see something.” She added, “Look by the air conditioner in the library.”

Seconds later, Norbert spotted a nest on the north awning. He yelled out. A group of students scurried over to the nest and gathered near him. Seeing the remnants of a nest, another student blurted, “Oh, my god. Look! A hornets nest!” They were yelling and screaming with excitement. The group came together like a flash mob. They gathered beneath the awning. A second nest was seen on the west awning, and this caused another wave of excitement. They looked up and what they actually saw was the footprint of two former hornets' or wasps' nests under the 2nd floor roof. The nests were no longer there, but the muddy print where the nest had once been was clearly visible from the ground.

While in the gusto of the moment, they pointed and spoke enthusiastically. Some of the students were looking for additional nests. Most of their cameras were held high. They were being used like telescopes to zoom in on the awning. While the students talked beneath the former hornets' nests, Ms. H asked, "Whose room is that? The students replied "Our room. It's our room!" They recognized they were looking at the awning outside their own classroom. This was a positive and rewarding connection for them.

The class was in the flow of the activity observing the hornets' nest. Nearly everyone was on task and making observations about the environment. Some groups were managing technology issues they had with batteries and memory cards. Roughly a minute into this precipitating event, the groups began to disperse and move to other parts of the courtyard. The excitement faded.

Not far from the hornets' nest, Arwin held a fist sized dried clump of wood chips, compost, soil and plant matter that he thought was a fragment of the nest. JB asked Arwin how he knew what he was holding was a hornets' nest, to which he replied, "Because it was made from wood." JB questioned whether in fact these nests are made from wood. Arwin went to get gloves from his observation bucket, and then played around with the dirt for a little while. When JB returned some time later, he asked Arwin what he saw. He replied, "I didn't figure anything out.” He decided the clump he had was probably not a hornets’ nest. Shortly thereafter, Arwin decided that the clump he was holding was dried dirt and wood. He said, “I don’t know what it is but it is that” (referring to the large oak planting barrel nearby and to the dried mulch that is inside the barrel). What he found on the ground matched what he saw inside the barrel. Arwin said, “It doesn’t look natural…looks like people had put gardening stuff in it. And then you have plaster. It kinda looks like plaster that plastered the dirt and the wood together.” He leaned over for a closer look to find more evidence to help identify it and to help explain what was holding it together.

Pampas grass

A few minutes after the hornet’s nest event attenuated, a handful of students were still over by the door to the courtyard. There they played in a large patch of pampas grass. The tall dry stalks of grass had feathery clusters of seeds on the ends that looked like brushes. Marcy noticed the pampas grass, grasped the stalk in her palm, and bent a long brown stalk. Her partner questioned her, “Are you trying to kill the plant?” Marcy replied curtly, “It’s dead already.” Manuel stroked the fluffy feathers on the tips of the blades. He enthusiastically observed, “Each one of these is fluffy when you go like this” as he stroked the feathered branch in the other direction he said, “It feels prickly and I’m thinking that is because the spine prickly things are going this way and you don’t really feel those.” He demonstrated how the feathers come off as it is brushed in the reverse direction. JB asked him what the feathers were for. He guessed, “When you go like this they fly around, and Marcy’s jacket got really dirty when she did that.” Ms. H was heard in the distance, “She’s full of burrs.” JB asked Manuel “What are those things flying around?" and "Why would it be smooth one way and prickly another way?" Seeing some students playing with the shafts of grass, Jedidiah and Emogen joined up. As the group grew so did the level of excitement.

The group of students then began to notice and talk about why the feathers were smooth in one direction but prickly in another. Manuel talked about the form that he believed caused the feathers to be prickly one way and smooth another. Mr. D asked Manuel why he thought that happened, and Manuel described the spatial arrangement of the spines. Manuel gestured and showed "acute angles" with his hands. Mr. D asked him why he thought it grows like that. Manuel observed the "acute angles" to describe the intersection between the feathers and the stalk. Emogen said, "It is his defense," meaning that a prickly feeling will repel animals who feed on it. "It is a defense against things that eat." Manuel added that it is "a defense against things that climb up the shafts and eat the plant because when they climb up they get hurt."

Marcy and Emogen were sharing ideas about what happened when it was brushed and it lost all its feathers. "It's actually really soft," Marcy said as she brushed feathers through her fingers. Emogen was surprised when she noticed that Marcy's jacket was full of "feathers," and exclaimed, "Oh my gosh" when she felt the soft plant. JB asked Emogen if the feathers helped the plant. She stumbled a bit; her gut reaction was "yeah," but she was unsure how. Without feathers "it would just be tall stalks…"

Suddenly, Jedidiah made a connection and blurted his idea, "They might be seeds to spread the growing." Ms. H was standing approximately 15 feet away and heard Jedidiah say the word "seed" and she repeated it loud enough for the group by the pampas grass to hear. Manuel interrupted him and said, "Yeah, they might be seeds too." Jedidiah stroked the plant upwards to remove seeds and "then sprinkle it in another part of courtyard it might just grow." Manuel thought it would grow if you "plant it and give it right the nutrients." The students were in agreement that these were seeds. JB asked them if it made sense that they were seeds, and Jedidiah and Emogen replied that when the wind blows it takes the seeds up in the air. She made a comparison to dandelions and how the wind spreads those seeds. Recognizing a moment of piqued curiosity and engagement, JB asked them to point out where the seeds were. The students leaned in and took a much closer look. They identified them as the little "puffy things." Manuel grabbed a handful of the pampas grass stalks and began shaking them vigorously and waving to demonstrate how the seeds could be released.

While Jedidiah and Manuel were working together to make seeds fly away, Emogen and Marcy did the same while Minos shot video. Manuel was giving directions to Jedidiah about how to make the seeds fly away. He forcefully commanded, "Not like that" to Jedidiah who tried to wave the clipboard to make them fly away. Manuel wanted him to use his hand to brush the seeds off. "See? They're all coming off." Manuel waved around the stalk to scatter the seeds; he gave it to Emogen and said, "You try." Manuel showed Teresa what happens when the plant was brushed in one direction, "Everything comes off but if you go in another direction nothing comes off." For Teresa, Manuel was happy to demonstrate his discovery of this phenomenon. After playing with the pampas grass for approximately five minutes, the students left the pampas grass.

Squirrel's nest

By now the field trip was beginning to wind down. Several groups were dispersed in the courtyard making observations, but most students were standing around the center of courtyard. JB walked to the center of courtyard.

"There! There's one! I found it! I found the squirrel's nest. Come on." Flanna tapped her partner Ziva's arm as she tried to get her attention. Flanna walked over to the tree and took out the Flip camera and recorded the nest while narrating her impressions of the nest and the plastic bags caught in the branches 30 feet off the ground. Flanna was captivated by the nest and gazed at it for a while, shading her eyes from the bright sun beaming through the trees branches. The nest was approximately two feet in diameter and made of sticks. A plastic bag stuck to the nest waved in the wind. Ziva stood next to her pointing the camera at the nest. Flanna asked her if she "got it?" and suggested that she zoom in. She leaned over to look at the preview and then looked back and JB and his camera. Flanna said, "Oh that's a good picture." Flanna was interested in the nest, "Because squirrels just make me happy but I don't know why." The hornets' nest in contrast did not make Flanna feel happy, "Because I don't like hornets, but squirrels are okay." JB then challenged the assumption that it was a squirrel's nest, "How could you tell the difference between a squirrels nest and another kind of animal?" Flanna drew from her prior knowledge that squirrels can climb trees, and that cats don't live in nests, and it's "too big for a bird to use…so I'm just using some common sense."

Flanna and Ziva walked away together to go and record their observations on their clipboard. They strolled over to the rest of the field trip group group's observational tools that they had carefully arranged on a concrete wall.

Transition (10:19–10:24)

At 10:19am Ms. H informed the students that they had been outside nearly 45 minutes and it was time for everybody to head upstairs. "Voices down. No running." Manuel did not appear to be listening to Ms. H and he told JB he took a lot of pictures of plants. He pointed to all three places where he found different kinds of plants. He continued to say, "And the plants over there and over there and over there and the dead bird over there." JB asked Manuel why he was focusing on the plants and the dead bird and he said, "Because they seemed interesting." Manuel ran inside the school.

A group of five students were taking a group picture. I followed Ms. H inside and Mr. D waited outside with these students taking social pictures. Mr. D closed the door when the last of students exited the courtyard.

Ms. H and JB arrived at the door of the classroom and about a dozen students stood crowded in the doorway. A few students were interviewing one another about their experiences on the field trip. Ms. H asked the students what the rule was about standing in the doorway. They moved out of the doorway so Ms. H could unlock the door and open it. She commanded, "Wait till I get the doorstop." Some students were debriefing with one another outside the classroom. Norbert said to Oliver, "It was awesome." Oliver answered, "At least we got nine of them," meaning they were able to make nine observations. There was a hint of frustration in his voice that he was not able to get more than halfway to 20 observations. Inside JB set the camera back on the tripod. From the front of the classroom, Ms. H instructed, “Please sit down.”

Post-Trip Wrap-up (10:24–10:42)

Inside the classroom the students sat with their field trip partners. Once everyone had returned to the classroom, for 18 minutes the students completed the post-trip emotion surveys, debriefed the computer lab components of the field trip that they began later that afternoon during their resource period, and collect and organize materials. I did not observe any conversations or discussions that related to the focal unit.

Discussion

There is something special about the way the field trips are social and emotional events that adds to the memorability of them. During spontaneous moments of heightened engagement, students precipitate new ideas, which I saw cultivated and expanded on in the classroom. One of the most notable findings in this chapter is these precipitating events had a clear set of features: they were on the order of a few minutes long, had a fairly clear beginning and end, involved some reconfiguring of groups (if only because a teacher came over), and were emotional and conversational. I discuss this phenomenon of a precipitating event in the next chapter about residue. In the following discussion, I look at how curiosity as an emotional facet and collaboration as a social facet are key properties of what happens on field trips.

On Field Trips Students Have on Their Curiosity Detectors

Curiosity is an important property of field trips because it provides the catalyst for engaging students in the field trip activities. Danny Edelson argues that curiosity results from students encountering unanticipated gaps in their understanding. Curiosity arises when one's "expectations are violated by their observations or experience…When an expectation-violation is optimally discrepant, it creates the motivation to learn…Curiosity is the motivation to acquire the knowledge that will explain the discrepant event and allow the learner to resolve the gap in his or her understanding" (Edelson & Joseph, 2004, pg. 3).

On the field trips students expected to find gross and frightening things, which was confirmed in post field trip recall interviews. They were actively seeking out these sorts of things to pique their curiosity. When they did encounter them, they were motivated to identify the thing they were seeing. They wanted to know how it arrived in the current state. They were curious to learn more about it. For example, we saw this happen beside the dead bird when the students wanted to know what it was and how it died. We saw this beneath hornets' nest when the students wondered where the hornets went and when they would come back. We also saw this with the pampas grass as students wondered what the feathers were for and what their function was.

Across the data corpus, gross things, missing things, and mysterious things sparked curiosity, raised emotions, and tended to dissolve assigned groups and motivate students to congregate into new and different arrangements. The students would spontaneously gather around to see a discrepant artifact up close and to share their reactions, comments, questions, and ideas with others. Gross things in particular would lead to a big excitement. While other objects such as plants and rocks were also found to spark curiosity, these often did not lead to the big hubbub and heightened engagement triggered by gross things.

On the field trips, students were motivated to seek out, identify, and fill gaps in their understanding. This motivation to learn is a necessary ingredient of field trips to be learning environments. For without curiosity and the motivation to learn the field trips would leave little opportunity for questions to arise and ideas to be shared.

Groups Build Ideas

There were instances when students collaborated and shared what they saw to achieve a common goal. They raised questions and offered best guesses to one another. They used other people to understand what it is they were seeing and how it came to be in the current state. These moments appeared productive and constructive in the sense that they were generating meaningful ideas and talking about topics related to the science content.

The dead bird is an exemplar event of students drawing on peers and teachers to make sense of what it was they were seeing. Emogen and Jedidiah noticed that the dead bird was near a window. They put one and one together to surmise that the bird crashed into the window and died. Manuel also suspected that the bird died when it crashed into the window. But instead of drawing on memories of birds having crashed into windows at their school as Emogen and Jedidiah had done, he reasoned from a memory of a movie he saw. Importantly, in both cases, Emogen and Jedidiah as well as Manuel were in conversation with Mr. D. They talked about how they thought the bird had died. Through conversation they surmised that this bird died by a catastrophic collision because they had seen this happen before either at home or in a movie. This socially constructed idea that the bird died by crashing into the window reverberated across a variety of settings.

Summary

This chapter examined what happened on the field trips. First, I summarized what happened for the nine field trips I analyzed in detail and then I showed by example what happened on one representative case, Bio1a. In my retelling of this particular field trip, I highlighted major events that transpired and some more minor ones that involved fewer people and less excitement.

I find that there is a range of amounts of time spent on getting to the site and back from it. More importantly, I see groups of students moving independently through a set of tasks in a relatively straightforward way, punctuated by moments of high engagement where groups tend to cluster around something of interest.

Discrepant and gross things that disrupt expectations were especially captivating and piqued curiosity. Often social arrangements would spontaneously dissolve and reform around such things. During these punctuated periods of high engagement ideas precipitated. In Chapter Five, I examine precipitating events and the reverberation phenomenon.

Chapter Five: Reverberations Connect Classrooms and Field Trips

In Chapter Four I characterized what happens on field trips. Chapter Five is about what field trips events are memorable and why. I organized the current chapter into two sections. The first section describes the methods I used to identify and connect field trip events with what I saw happen in the classrooms, interviews, and subsequent field trips. In the second section, I describe the nature of the residue, that is, the memories of specific field trip events. I do this in two parts. First I describe the features of a precipitating event that I saw leave residue. In the second part of this section, I examine the relationship between precipitating events and these events that reverberated. I do this through several examples that I followed over time, across field trip, interview, and classroom learning environments.

Methods for Tracing Learning across Contexts

In the whirlwind of collecting data, I began to notice residue of field trip experiences across time and place. I saw evidence of experiences being remembered during classroom activities and discussions, during clinical interviews, and even on subsequent field trips.

I sampled two thirds of the classes to analyze because I had the most complete data record from these three classes. Once I had all this data cataloged, transcribed, and I had constructed fairly complete narratives of what happened for nine of the 14 field trips, I began the next stage of my analysis. This entailed looking for and characterizing connections across field trip, classroom, and interview contexts.

Residue

Residue could be any talk about a field trip event some time after the field trip. The residue could be talk as brief as two turns of talk. For example, a question posed by the teacher about what was surprising during the field trip followed by a response by a student claiming what made her feel surprised is one reverberating event. A single residual event could be a 15- or 20-minute discussion, if that discussion is about a single field trip event. For example, when a pair of students shared their PowerPoint presentations, they projected a slide about purple flowers. This image led to a rich discussion about why two flowers that look alike can be either purple or yellow. This provided fodder for an even deeper conversation that ensued about genetics and skin color. I identified this entire discussion as a single residual event in relation to the precipitating event when this photograph was first made in the field. The talk about the purple flowers is the residue.

Two conditions needed to be satisfied to count as residue. The first condition was at least one actor, who was present at that precipitating event in the field, needed to participate in the residual conversation. I bounded this analysis by only counting talk by students who were present at the event in question, mainly because it proved easier to align the residue with precipitating events if the same student was an active participant in both contexts.

Second, residue needed to be about events. By event I generally mean interactions with physical objects, although there are a few exceptions of stories about physical objects, which I discuss later in this chapter. My argument is about socioemotional constructions. A focus on physical objects is a way to operationalize my analysis. Initially I had incorporated all precipitating events including longer activities, but later excluded certain ones because it was unclear what part of the activity students were referencing.

Stages of Analysis

The episode with the dead bird was a moment of big excitement for the students: The dead bird sparked interest, it held attention for a prolonged length of time during which questions and hypotheses were generated, it led to nearly everyone reorganizing in new social arrangements and physical spaces, invited playful interactions and creative uses of technology to support observations, and evoked strong emotional reactions. What captured my attention was I saw remnants of this episode carrying over to the classroom and on subsequent field trips. I figured that if I was seeing reverberations in some places I was sure to see them in others.

I analyzed the data in three stages. Each pass through the data employed central tenets of grounded theory (Chamarz, 2000). My analysis was not theory driven instead it was theory constructive. Each pass through the data I attempted to more precisely characterize the defining features of a precipitating event and the residue it left. The first stage of analysis involved looking for moments of heightened engagement and the residue they generated. The next stage of analysis involved cataloging all phenomena that left residue, including ones that weakly resonated or did not resonate at all, though I thought they could have. The third stage involved a careful pruning of the data set. This involved the meticulous alignment of precipitating events and residue as well as a thorough analysis and categorization of the precipitating events.

First stage of analysis

This first stage of analysis centered on the memorable episodes. I began with field trip Bio1a, the field trip with the dead bird episode because it appeared especially memorable and therefore potentially a rich source of data to flesh out my third research question about how to best integrate field trips and classrooms.

I read the field notes, the analytic memos, the design log, and the field trip and classroom transcripts and content logs. I looked for other precipitating events like the dead bird one that were moments of heightened engagement. I traced the history of these emotional events from their genesis in the field through classroom discussions, interviews, and other field trips. I reviewed my transcripts and identified all the moments that looked like they were especially memorable. My hunch was that it was the moments of heightened engagement, like the dead bird event, that were examples of precipitating events. I began to look for more moments that were characterized by strong emotions.

In the first stage of my analysis I tried to unpack the properties of these emotional events to see the conditions that gave rise to them. Technology was sometimes important, other times it was not. Was it that many people would come together and mix groups? Was it the duration that attention was held? Was it the kind of the phenomena under investigation? Was it the person who discovered it or initiated it? Was it the number or variety of students talking and participating? Was it how they were talking, were they yelling and screaming? Was it the design of the task? Was it all of these things, or none of them? I set out to figure out what helps make field trips memorable. The following matrix, Table 5.1, shows an example of what this first stage of analysis looked like.

Field Trip	Date	Location	Episode	Object/Phenomenon	Time into Fiel	Duration	Description	Emotions
Bio1a	Mar 30, 2011	Courtyard	Dead Bird		0:17:30	4:00	Marcy discovers a dead bird behind the bushes in the southeast corner of the courtyard. She exclaims, "We found a dead bird! Perfect." Go. Go. Go. Take it." A few students nearby buy scurry over to bushes. Shortly thereafter, Calvin one of their group members announces to the whole class about the discovery and within a minute most of the class is over there to observe the bird skeleton. Some run to capture it. Students ask questions about how it died, looking at the carcass closely, and many students were capturing it with their cameras and videos recorders.	Heightened

Table 5.1. Example of the Data Table from the First Stage of Analysis.

I went through the transcripts and pulled out all the moments that I suspected showed students with elevated engagement. In these situations, students would show piqued emotions such as yelling and laughing, ask questions, and appear engaged for a prolonged period. In building this catalog, it turned out that I was seeing quite a few exceptions. There were many instances when the same phenomena was observed on different field trips, while on one field trip that phenomenon would not cause students to reorganize and elevate their emotions while on another field trip it would. So it could not just be a property of that object that contributed to elevated engagement. Perhaps, it was a property of the situation? For the next stage of analysis, I began to catalog all the events that reverberated, even ones that did not appear especially exciting for the students. I looked for patterns in the conditions that left residue as well as the nature of the situations that led to this event being recalled.

Second stage of analysis

For the second stage of analysis I expanded on this analysis. I included all interactions about specific phenomena that reverberated. I expanded the catalog and included more information about the events. I cataloged the precise time when it happened, the duration of the event in 30 second intervals, the key actors involved, a brief summary of the social interactions, the source of the data, and I made some attempt to categorize the kind of the phenomena (e.g., a gross thing, an interesting thing, etc.).

The following matrix, Table 5.2, is an example showing portions of the catalog for the second stage of analysis.

Event / Specimen / Object / Phenomenon	Field Trip	Date	Time	Duration	Who	Source	Student Generated Flip Data	Notes	Kind of phenomenon	class of phenomenon	Min Range	Max Range	Max # of students who experienced it	Social Interactions	Technology	Initiated
Dead Bird	**Bio1a**	3/30/11	18:00	390	Brandon/Arwin/ Maddy/Luise/ Flanna/Jedidiah/ Marcy/Clay/Renny/ Emogen/Thelma// Ziva/Norbert/Nagel/ Calvin/Manuel/ Adara	Researcher Camera 1/ Researcher Camera 2/ Researcher Camera 3/ Flora Flip Video/Nagel Flip Video/Manuel Flip Video/Minos Flip Video	VID00003.mp4; VID00004.mp4/ VID00001.mp4/ VID00003 (~0:20-1:32)	Clay and Arwin are at the dead bird and hypothesizing about how it died after most of the students have gone. Arwin observes the seed pod, which is like the worm episode in ES1a after discovery go and look for more evidence (residual effect); Oliver only student who missed the moment because he was inside school building with Ms. H	dead animal	gross; mysterious	2	13	18	Marcy sees it and shares discovery with Manuel and Calvin. Manuel runs around the back of bushes. Marcy walks along wall to get behind bushes. Maddy follows Marcy. Norbert comes over from north side. Brandon, Minos, Thelma, Adara, and Norbert walk behind bushes and crowd around. Calvin signals other half of courtyard, runs over to other group and identifies out the skull. Brandon also signals. Norbert and Brandon leave. Maddy leaves to be with Luise. Clay, Flanna, Ziva, Jedidiah, and Emogen running. Luise, Renny, and Nagel near the bird. Arwin last one there. Nrbert returns to bird after talking with Brandon about how it died. Manuel theorizing about demise and instructing group to come up with questions for assignment. Jedidiah and Emogen hypothesizing about death with Mr. D. End of episode Arwin and Clay taking close up photographs theorizing about demise, with Researcher 3. Calvin is noticeably shaken with fierce look in eye and rapidly shaking leg.	4/5 Flip video cameras; 9/9 still cameras	Marcy

Table 5.2 Example of the Data Table from the Second Stage of Analysis.

In addition to cataloging temporal and social dimensions of the precipitating events, tools, especially digital video technology, played a prominent role on the field trips. I noted which researcher cameras captured the action. I also noted if still cameras provided to the students for their observations were used to collect data. I identified exactly which focal students were using the cameras and correlated the movie files they created during that particular episode. The Flip Video data helped me add finer detail and fill in gaps in the researcher camera record. Interestingly, when I went to the raw data to watch these episodes from the students' perspectives, it turned out that not everyone was actually recording even though it looked like they were from the researcher camera footage, so I noted this in my analysis. If the student had a camera on and was recording for an extended period of time, then I found just that episode and logged it.

In the first stage of my analysis, I identified key actors, such as the students who were especially vocal during that event. I realized that in order to more carefully align precipitating events with residual events, I needed to know precisely who was there. I identified everyone who was present during that field trip event. If a student was within a 2-meter radius of an object and appeared involved in that situation, then I counted that person as present; however, a student walking through an event but not stopping to look or talk did not count (Goffman, 1981). I counted the minimum and maximum number of students present at any given moment during that event. This analysis gave the range of students who saw it. I also calculated the total number of students who saw it. This means that the total number of students is equal to or greater than the maximum number of students present at any given moment.

As I watched these field trip interactions from multiple perspectives, I asked myself: Why are they interested in this particular thing? What is happening in this situation for everyone involved? I kept notes about the phenomenon, to see if there were any themes or patterns in what people were drawn to that could help me understand why certain things appeared of interest.

While building the catalog of precipitating events, I also began to catalog the residue. I created a corresponding table that tracked specific events over time. I logged similar kinds of information. The following matrix, Table 5.3, is an example of the residue catalog for the dead bird event.

What	When	Who	Context	Slides
Preparing for activity (Who can give me an example of something found out in the courtyard?)	3/29/11	Oliver/Ms. H	Classroom	
Uploading photos; screaming	3/30/11	Adara	Computer Lab	
Watching Flip Video	3/30/11	Minos	Field Trip	
Bird gone during spring clean up	4/12/11	Ms. H	Classroom	
Building PPT; theorizing	4/14/11	Manuel	Classroom	
Building PPT; making	4/14/11	Clay/Arwin	Classroom	
Observing it is gone	4/25/11	Manuel	Field Trip	
Observing it is gone	4/25/11	Calvin	Field Trip	
Looking for the bird; finding it	4/25/11	Clay/Arwin	Field Trip	
Building PPT; Talking about why it is interesting	4/29/11	Emogen/Jedida	Classroom	
PPT Presentations; rules	5/5/11	Ms. H	Classroom	
PPT Presentations	5/5/11	Emogen	Classroom	
PPT Presentations	5/5/11	Minos	Classroom	
Talking about why it is interesting after class	5/5/11	Minos	Classroom	
PPT Presentations	5/6/11	Thelma	Classroom	
PPT Presentations	5/12/11	Marcy	Classroom	
High Point	5/11/11	Manuel	Interview	
Stimulated (Flip)	5/12/11	Flanna	Interview	
Maggot Patch	6/10/11	Manuel	Field Trip	

Table 5.3. An Example from the Residue Catalog for the Dead Bird Event.

It proved difficult to align specific residue to a particular moment. I did not always have high confidence where the residue I was observing had originated. For example, a student could be talking about a worm in class but in the field there could have been multiple instances when that student was interacting with worms. This analysis was aided by the fact that very particular language was used to describe very specific things. There was only one event involving that student and the “rain barrel,” “dead bird,” “mossy mat,” “beaver dam,” and “hornets’ nest.” In many cases, I knew exactly who was involved in the conversation about a particular precipitating event. A third level of analysis was needed to even more carefully align the residue and the precipitating events. Time permitting; I took the opportunity for a third pass through the data set to dig in even more precisely to align precipitating events and the residue.

Third stage of analysis

For the next analytic iteration, I polished the massive catalogs I was building. In the first pass through I had included all residue that stemmed from the field trips that appeared to be about moments of heightened engagement. For the next pass through, I broadened my analysis to be about any phenomenon that left a noticeable trace. This included all observable happenings that resonated across time and place. For the third stage, I watched these events for the third time. I added greater detail about these situations to more carefully align precipitating events and the residue.

I carefully combed the catalog and described in detail the events that I saw reverberate. In describing the events through multiple iterations, I dissected them and studied them from a variety of dimensions and perspectives. I looked at the timing of the events, the flow of the precipitating event, the tools used, touch and smell, and the role of adults in maintaining and sustaining precipitating events. The following matrix, Table 5.4, is an example from the data catalog showing the additional categories I characterized for this third stage of analysis.

Phenomenon	ID	Time into trip	Duration of episode	Moment of Heightened Engagement	# Flip	Student/ Adult initiated	Reverberatio ns	Min	Max	Total who experienced	Whole regrouping	Partial regrouping	Initiation	Number of signals	Kinds of signals	Theorizing	Kinds of observations and theorizing	Living/ Physical	GROSS/NC	Tactile
Dead Bird	**Bio1a**	18:00	390	Yes	4	Student	18	2	13	18	Yes	Yes	Noticing	3	Tell; Yell; Yell	Yes	Mostly unconstrained theorizing, stream of consciousnes s - flow state, but after some closer observation ideas about what happened draw more everyday experiences	Living	Gross	No

Table 5.4. Example of the Data Table from the Third Stage of Analysis.

I bounded the events temporally in 15-second chunks rather than 30-second intervals. This provided greater precision as to the duration and timing of these events.

In addition to more carefully estimating the length of the precipitating events, I included more detailed descriptions about the action. When relevant, I added a short summary of what happened immediately before and after that particular episode because it appeared that there was some continuity from one set of observations to the next. I more carefully characterized the action of the precipitating events as I built the empirical model I was constructing. This meant I looked for who and how these events were initiated and for descriptions of any theorizing that may have ensued. In addition, I examined who congregated. I built on the analysis from the second stage about maximum and minimum group size. I looked to see whether students were regrouping or whether they stayed in their assigned groups. If students did join up with another group, I looked to see whether their whole group regrouped or whether some fraction of the group joined up with another group.

Sight and sound were so common it did not make sense cataloging these modes of interaction. Touch and smell, however, were two modes of interaction I observed playing a roll in a handful of residual events. For example, in class, Lana recalled specific details about the herb garden because she had rubbed the herbs in her hand and smelled them. Olfactory sensations did not prove to be particularly pervasive during the precipitating events. Touch, however, was common. I logged whether student interactions with a phenomenon involved touching it. If a single person touched the object in question during that event, then I counted that as a tactile interaction. For instance, if a student decided to pick up a worm and hold it for others to observe more closely, then that would count as a tactile interaction. Some students only wanted to interact with things if they were wearing heavy latex gloves. So I looked to see whether they were touching things with or without gloves.

Constantly comparing reverberations and potential reverberations helped me to refine my data set. Through this process, I began noticing many more field trip moments about the same kind of phenomenon or with similar sorts of interactions, but for which I did not see any residue. I cataloged these interactions in a dataset. I call this dataset Phase A. For example, there was a moment when Ms. H spotted a small bird in the tree and then announced it to the courtyard. The class came rushing over like a flash mob and with cameras held up, they eagerly searched for the bird. When I looked through the data set, I did not see this bird come up in any discussions after this fairly emotionally charged but fleeting moment in the field. I cataloged 114 candidate events that I excluded from my analysis because they did not leave residue that I saw.

It was the case that some of the precipitating events I did not have in my data even though I was seeing residue from them. I call this catalog Phase B. This means that I was seeing memories of field trip events, but those precipitating events weren't captured by any of the cameras or audio recorders. For example, a pair of students presented in class on the bone meal that they suspected was white mold. I did not see them observing the bone meal in the field. I pulled out this residue and tagged it as a moment for which I have residual data but did not see the precipitating event.

The unit of analysis is the reverberation, including a precipitating event and the residue. This analysis resulted in a total of 82 precipitating events. I captured a total of 242 residual events stemming from these 82 events. In the next section I discuss these precipitating events and the residue they left.

Field Trips Reverberate across Time and Place

In what follows, I unpack the features of a precipitating event and present a model of a precipitating event. Next, I show three examples of precipitating events, and I show the residue that I saw stem from them. Then, I contrast these three events with two examples that for a variety of reasons I did not see reverberate across contexts. I provide summary data about precipitating events and the residue, and conclude this chapter with a brief summary.

Features of a Precipitating Event

To help situate the discussion, I summarize the precipitating event data. This data is grouped by the kind of phenomena and the temporal, social, tactile, and emotional dimensions of the precipitating events. These are the right dimensions to pay attention to because they help to identify what field trip events would be likely candidates to reverberate later on. The following table, Table 5.5, is a summary of this data sorted by field trip.

Field Trip ID	Number of Reverb.	Number of Precip. Events	Kind of Object	Temporal	Social						Tactile	Emotional
			Gross/ Beautiful Precip. Events % Yes	Duration of Precip. Events (mean, s)	Student Initiated	Min Ss	Max Ss	Total Ss	Regroup % Yes	Partial Regroup % Yes	Touch % Yes	Excitement % Yes
Bio1a	87	23	30% (7)	142	69% (16)	1.9	4.6	5.6	65% (15)	48% (11)	52% (12)	30% (7)
Bio1c	23	13	23% (3)	293	62% (8)	6	10.7	13.5	77% (10)	62% (8)	38% (5)	38% (5)
Bio2a	64	22	32% (7)	129	86% (19)	2	3.5	4.2	41% (9)	32% (7)	22% (5)	23% (5)
Bio2b	1	1	0%	210	0%	2	3	3	100% (1)	100% (1)	100% (1)	100% (1)
Bio2c	18	8	38% (3)	536	75% (6)	2.4	6.8	7.4	38% (5)	38% (5)	88% (7)	62% (5)
ES1a	5	2	50% (1)	323	100% (2)	5	5	5	0%	0%	100% (2)	50% (1)
ES1b	38	9	22% (2)	206	22% (2)	9.7	14.1	14.2	22% (2)	11% (1)	44% (4)	33% (3)
ES1c	6	4	50% (2)	246	25% (1)	17	21	21	0%	0%	75% (3)	75% (3)
Total	242	82	30% (25)	Mean = 218	66% (54)	Mea n 4.3	Mean 7.3	Mean 8.3	49% (40)	37% (30)	48% (39)	37% (30)

Table 5.5 A Summary of Precipitating Event Features and Values

Many of the same phenomena were noticed across the field trips. Indeed, many of the exact same phenomena drew attention across groups within a field trip and even across classes and schools who happened to visit the same site. Some precipitating events were about the same kinds of things (e.g., moss, pine trees, statues) or about the exact same thing (e.g., rain barrel, dead bird, hornet's nest). In many cases, however, the kinds of phenomena the reverberated were unique. For example, the category "animals" refers to specific interactions with animals in cages during field trip Bio2c, and the category "turtle" refers to the event when an alligator snapping turtle was encountered during field trip Bio1c. Both schools visited the river, and they saw the same stretch of river. There, they tended to notice many of the same things during these two different field trips. For example, at the river, the splintered tree, the current, rotting animals, trash, and mud were of interest. It is important that there were commonalities in what students noticed and were curious about because it suggests to me that it is possible to anticipate what kinds of things students might find interesting in the field. The following Figure 5.1 is a graph of 82 precipitating events about 43 different phenomena. The length of the bars on the graph represents the number of precipitating events.

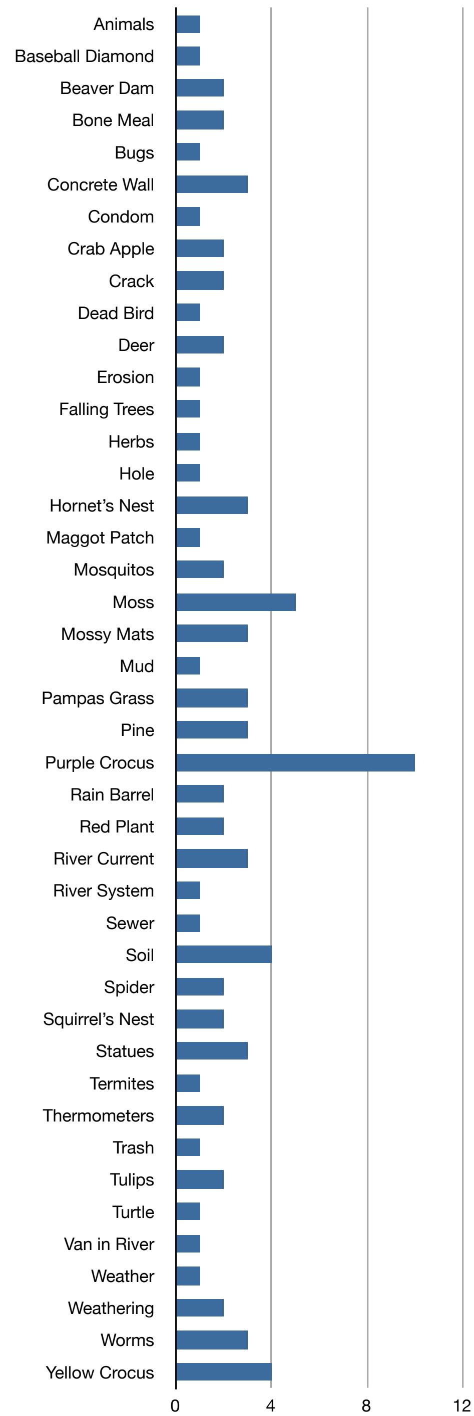

Figure 5.1. 43 Phenomena Led to 82 Different Precipitating Events.

For the most part these 82 precipitating events are primarily about physical phenomena that can be seen and experienced. Other sorts of interactions rarely reverberated, such as storytelling events, for example, when the river guide told a story about the van in the river. One way I sorted precipitating events was according to some conventional categories that emerged from the data. The categories that emerged included plants, animals, nests, dirt, water rock, trash, and a miscellaneous category. Of the 82 total precipitating events, 56% were about either plants or animals. Dirt and rocks was the focus of approximately 20% of the precipitating events. Recall that these 82 events are drawn from analysis of two biology classes and one geology class. For this reason, I expected to see approximately twice as many events about plants and animals as rocks and minerals. This was approximately what I found.

Like plants, nests were also objects of curiosity. They tended to be personally meaningful, such as Flanna talking about the plastic bag caught on the squirrel's nest and her feelings about pollution. They were also socially motivating, such as the lively discussions theorizing about what created the suspected beaver dam. At times, the spotting of a nest created highly engaging situations that caused the whole group to reorganize around it, such as what happened beneath the hornet's nest.

Things such as trash, sewers, and condoms are memorable and fit quite neatly within a "trash" category. On the other hand, some things do not really fit too well in a category. Miscellaneous things such as cracks and bone meal captured students' attention and played a significant part of post-trip discussions.

Despite its centrality to both living systems and geological processes, the category water was just a small focus of talk, accounting for 7% of the precipitating events. The experience of seeing the river and being in the river for the macroinvertebrate hunting activity was emotional and memorable. Residue came through in the written post trip reflections and interviews, even though I did not see much of it reverberate in conversation during classroom discussions. The pie chart in Figure 5.2 is the portion of precipitating events categorized by kinds of things.

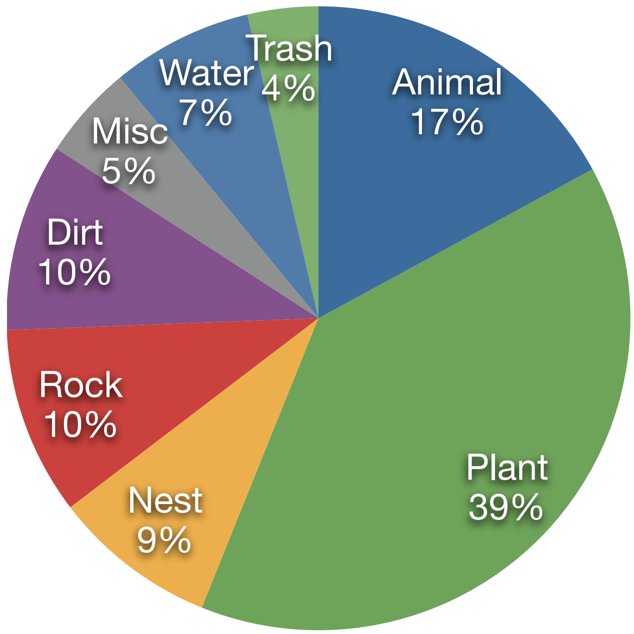

Figure 5.2 Percentage of 82 Precipitating Events Grouped by Different Kinds of Phenomena.

Gross things

Gross things refer to repellent or disgusting things such as rotting animals, condoms, and worms. Approximately one fifth of the 82 precipitating events I categorized were about gross things. Seven of the 16 events flagged as being gross were also highly engaging. Compared to the overall percentage of events about gross things (18%), things that students described as “pretty” or “beautiful” were just 7% of the total.

I categorized precipitating events as either exciting or not. An exciting event was one in which one or more students laughed, yelled, or screamed in response to seeing something. Exciting events were 37% of the total, and nearly two thirds of these exciting events were about gross things, but none were about things the students said were beautiful. This suggests that gross things were exciting to see.

A lurid fascination with gross things invited touch, as 60% of gross events involved students touching the object in question, higher than the overall average of 48%. This is a bit surprising as one might expect gross things to be repellent rather than invite hands-on interaction. Instead they drew interest.

Timing

On average, a precipitating event lasted nearly four minutes. The duration could be a clue into which events were more engaging or memorable than others. In order to calibrate this, I compared these events with ones that did not leave residue, but could have because they looked similar (i.e., Phase A). These events looked similar to precipitating events because they were about the very same phenomena, involved the same students and teachers, and often led to emotionally charged group reorganization. Precipitating events were on average twice as long as ones I did not see reverberate (i.e., 218 seconds for 82 precipitating events compared to 106 seconds for 114 non-reverberating events). It is possible that precipitating events were more memorable than events that looked similar but did not reverberate because they lasted longer, and they lasted longer because they were engaging. This value, of engaging “exhibits” holding attention nearly twice as long as “traditional exhibits,” is comparable to what others have found in similar free choice learning environments (Allen, 2004).

Social interactions

A typical precipitating event was usually social, with many people participating in the act of seeing and experiencing the object in question. The average number of students present ranged from four to seven. The maximum number of students present was double the minimum number, and the total number of students who experienced something that reverberated was typically greater than the maximum number of students who were at an event at a given moment. This means that these were fairly dynamic settings. Students were congregating, coming and going, and reconfiguring and reorganizing in new arrangements in order to see something of interest. Often these moments spontaneously precipitated in a self-organized fashion. During these events, assigned groups would dissolve and new arrangements emerged. The hornets’ nest, dead bird, and pampas grass events are examples of this inter-group mixing phenomenon.

As I saw with the dead bird event, seemingly problematic things motivated many students to self organize in new arrangements and make observations. I found that half the precipitating events involved more than one group coming together, and roughly a third involved partial regrouping. The remaining fraction of events did not involve any regrouping. During these situations, students were busy interacting with one other and with the thing in question. I argue that the mixing and growing of groups is a crucial component of the field trip experience because this was when ideas were shared around something that piqued curiosity.

Usually, amalgamations of lots of students emerged gradually. These situations were subdued and did not necessarily involve a signal like a scream or someone running to see something that would call others over. Approximately 10% of the precipitating events involved a great deal of excitement. These moments emerged quickly and loudly. What vocal volume does tend to reflect is the sheer number of people talking about something exciting at the same place and time, which would in turn enhance excitement and then feed back into a loop of excitement and raised voice volume. This translates to more students experiencing the same thing, which has important implications for creating common shared experiences in the classroom.

Tactile interactions

Approximately half of all the precipitating events I cataloged involved touching physical objects in the environment such as flowers, sticks, insects, and dead animals. I did not count holding a pencil or a camera or touching other people. I noticed many students handled things they found in the field, and certain students did so, but only with latex gloves. My thinking is that physical interactions provide additional information that supports learning.

An Empirical Model Describing a Precipitating Event

When I began to look across the corpus of data, I found a variety of precipitating events that had a similar story. Someone, usually a student, would see something of interest, share this idea by telling others about it, and then many students would relocate to it in order to observe it and see it in person. Questioning, talking, and theorizing about the object in question followed. If what was being seen caused a big stir, there might be several iterations of signaling and congregating with the effect that more people would have heard about it and relocated to see it.

In what follows, I unpack this model of a precipitating event. Figure 5.3 is an empirical model that shows how I think a precipitating event unfolds.

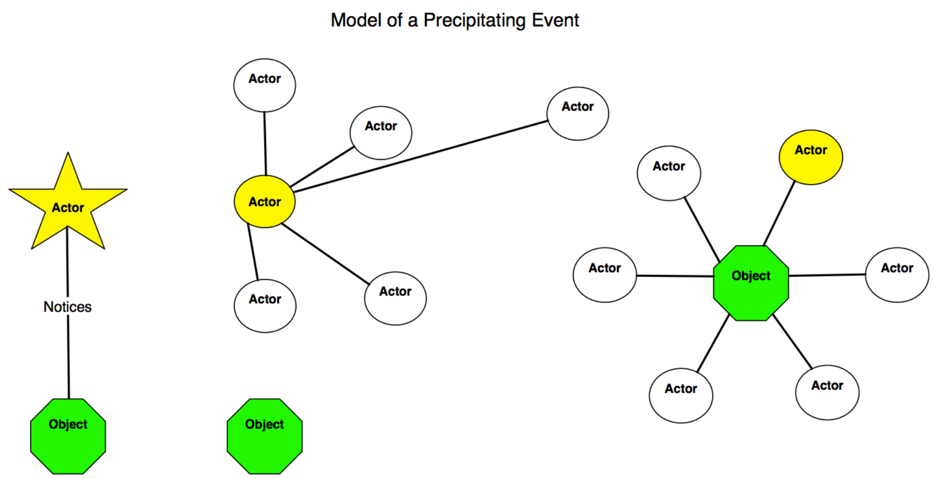

Figure 5.3a. The First Phase of a Precipitating Event Involves Noticing, Signaling, and Congregating.

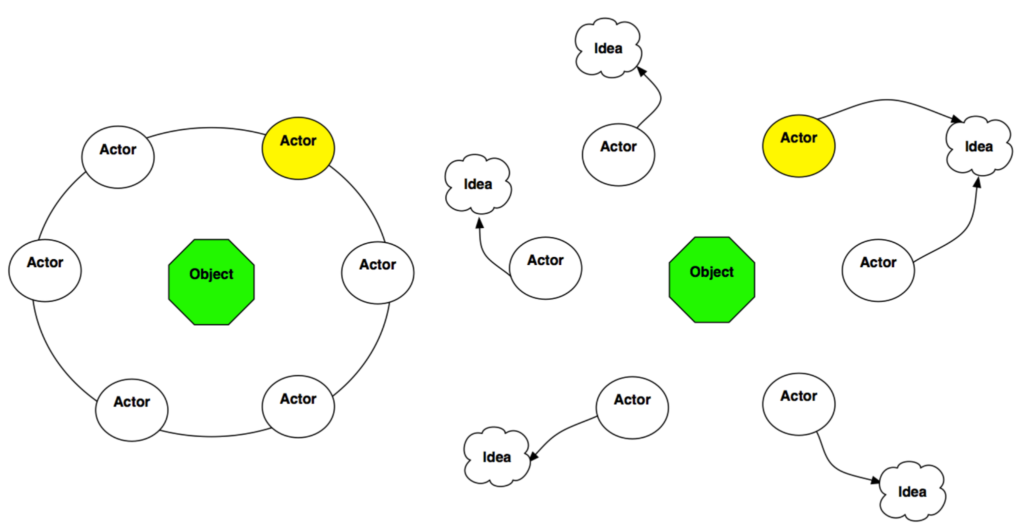

Figure 5.3b. The Second Phase of a Precipitating Event Involves Sharing and Theorizing.

The first part of a precipitating event involves three processes. These are noticing, signaling, and congregating.

Noticing means an individual sees something and initiates interactions with that object. Noticing can be about an object or between an individual and an object. For example, Manuel saw a pair of students observing purple flowers and then invited his group to go with him over to the flowers. On the other hand, Marcy spotted the dead bird and initiated a precipitating event. Just as students can initiate a precipitating event so too can adults. For example, Ms. H noticed the footprint of a hornets' nest and challenged her students to look up high to find something of interest.

From the analysis of the precipitating event data it is clear the students are motivated to find things that are surprising, suspenseful, and novel. The elements of curiosity and surprise, the thrill of making a discovery and seeing something new, weird, unexpected, surprising, or problematic played a role in prompting an episode to initiate.

Once something is noticed, it is shared with another person. This is signaling. A discovery is shared through social cues, either verbally or non verbally. Signaling happens many different ways. Signaling can be subtle by seeing someone move in closely or they could be notified in a much more dramatic fashion such as when a student yells and screams and runs around telling others. Some of the ways people are called to action through signaling include: standing (e.g., comparing, filming, looking closely); instructing (e.g., pointing out, calling attention, teaching); completing the task (e.g., raising a flag, using a microscope, taking a picture; digging); telling a story; yelling and screaming; and questioning.

In the field trip case I presented in Chapter Four, we saw many forms of signaling ranging from seeing others standing beside an object (e.g., the pampas grass event precipitated because some students saw other students handling the stalks of feathers) to screaming loudly in order to notify others about something of interest (e.g., the dead bird event). An event can precipitate through a series of multiple signals. For example, the dead bird was signaled when Marcy quietly told her partner about it. Manuel signaled to the people around him by loudly announcing it. Then Calvin, the third person in their group, ran laps around the courtyard screaming, which had the effect of signaling to the other half of the class to see the dead bird.

Perhaps the most frequent signal was by invitation, for example, by telling or gesturing at their partners to come over and see something. There was often a genuine desire to share in the discovery of something. Telling others about it appeared to be an irresistible and crucial link in this social process of sharing in a discovery.

Congregating means groups of people assemble together. When students would congregate, it tended to involve at least one other assigned group. For example, the pampas grass event started out as an amalgamation of two pairs of students, Marcy and Manuel along with Jebediah and Emogen. Then other students joined up when they saw them handling the feathered stalks of grass. Occasionally, much larger aggregates of students would organize together. For example, the rain barrel, dead bird, and hornets' nest events involved more than half the class. There were partial groups that formed when some of the members of an assigned group would aggregate with other groups. Regrouping is important because it is a precursor to observations and collaboration. Regrouping implies that something meaningful was noticed that is worth seeing in person. If something of high interest and excitement is noticed, there may be multiple signals and stages of congregating, which could also be recursive and have the effect of building enthusiasm, group size, and the likelihood that something would reverberate.

After the event is initiated through noticing, signaling, and congregating, they share in the discovery. The second phase of a precipitating event involves a two-step process: knowledge sharing and theorizing. On many occasions during this second phase of a precipitating event, what was seen was physically interacted with either directly with their hands or indirectly with tools such as cameras and magnifying glasses. Observations during this second phase of a precipitating event could be augmented with the use of tools such as cameras that zoom like a telescope or microscope.

Sharing usually involves talking with others about the object in question. This is often a period of heightened engagement and participation during which the construction of new knowledge and experiences happens. For example, there was a great deal of talk about the dead bird and questions about how it died; the rain barrel involved a long conversation about why the paint was flaking off the outside of the barrel; the purple crocus involved debate about why the flowers appeared ripped; and the hornets' nest invoked emotional responses. It could have been the case that students, once congregated, could have remained quiet and not shared what they were thinking; however, every precipitating event I cataloged involved some sort of talk about an object or process. Sometimes there is harmony in what is being talked about. People take turns and listen to one another, such as the ephemeral disagreement at the purple flowers. Other times there is yelling and a cacophony of commenting, such as beneath the hornets' nest.

Idea sharing during a precipitating event was focused, often involving arguments and debates over alternative explanations and claims about how something came to be. For example, the purple flowers involved sharing multiple ideas about why the flowers appeared ripped. But other times knowledge sharing was wildly unconstrained. For example, the cause of the dead bird's demise appeared somewhat like a group brainstorm, with a fair amount of mutual elaboration.

Sharing can lead to theorizing, closer observations, and to the growth of ideas. An idea can be particular to an individual or constructed among two or more people. For example, the dead bird event evolved from a group brainstorm session to smaller groups theorizing about how the dead bird died. Jebediah and Emogen reasoned from intuitive knowledge about birds crashing into windows at their school as well as from the observation that the bird was beneath a window. Norbert also reasoned from prior experience, but rather than drawing from knowledge derived from the school, he drew from his experiences at home when he remembered birds crashing into windows there. Learners cultivated new ideas by drawing on prior knowledge and accessing available resources such as other people, space, and things to help make sense of what they were seeing and experiencing.

In what follows I dissect and compare three events that reverberated. I first analyze the purple crocus event, then the dead bird event, and finally the concrete wall event as well as two events that I did not see reverberate.

Dissecting Three Reverberations

Three exemplar reverberations comprise the meat of this chapter. In what follows, I show these three precipitating events and trace them across time and place.

The first of the three examples, the Purple Crocus, is an event that did not appear to be especially exciting or involve much intergroup mingling, yet still left residue. The next example, the Dead Bird event, is an example of an event that was very exciting and social, gave rise to a range of ideas and social configurations, and reverberated strongly. The third example is of an event that was not especially exciting, involved minimal regrouping, but still left plenty of residue despite no observational tools being used in the field during the precipitating event.

I sampled these three reverberations because they are representative of the range of reverberations I see in my data and because they provided meaningful comparisons along three dimensions: features of the thing, features of the precipitating event, and features of the residue.

The following table, Table 5.6, summarizes the three examples and some of their defining features.

Precip. Event	Features of the Thing	Features of the Precipitating Event					Features of the Residue	
		Initiator	Tool Use	Students [min, max, total]	Duration [min]	Tactile	Number of Residual Events	Contexts of Residue
Ex. 1: Purple Crocus	Living; Not Gross; Plant	Student	Yes	[2, 5, 5]	2	Yes	3	Classroom; Interview
Ex 2: Dead Bird	Living; Gross; Animal	Student	Yes	[2, 13, 18]	6.5	Yes	18	Classroom; Interview; Field Trip
Ex 3: Rock Wall	Physical; Not gross; Rock	Teacher	No	[16, 16, 16]	1.5	No	2	Field Trip; Interview

Table 5.6 Features of Three Precipitating Events

These three examples of reverberations are about different kinds of things. They were either about plants, animals, or rocks. The dead bird event was widely perceived as gross while the other two were not. The concrete wall was for the most part about a physical entity wearing away by biological weathering, and the other two were about biological organisms and their relationship to other things in their ecosystem.

The two biology events were student initiated while the earth sciences event was teacher initiated. The dead bird event and the purple crocus events involved whole group congregating as well as partial regrouping; whereas the concrete wall event did not involve any regrouping because when the teacher signaled to the group to see something everyone was already together in a group. The dead bird event was a moment of heightened excitement, but the other two events were not. The earth sciences event about the concrete wall did not involve any tools for making observations in the field. In contrast, the biology events that reverberated involved plentiful tool use including digital cameras, clipboards, hand lenses, etc.

Example 1: Purple Crocus (Bio1a, 3/30/2011)

The following example is an account of the purple crocus precipitating event, similar to the narrative of this same event I included in the retelling of field trip Bio1a in Chapter Four. In this example I lifted from the transcript, Manuel decides he wants to make a video of his partner talking about a patch of purple flowers. The data sources for this excerpt are Manuel's audio recorder, JB's researcher camera, and the video clip of the flowers that this group generated with the Flip recorder.

1.	MA[5]	Come on I have to take a video of you guys like talking with each other.
2.	Ma	Like [inaudible] Calvin
3.	MA	Well then I can take a video of just you talking.
4.	MA	Okay.
5.	Ma	Oh look Calvin's coming too
[……………………………………………………….]		
6.	Ma	Okay this, Are we actually going to take a picture? Are you guys almost done?
7.	JE	Yeah, yeah, yeah. Well no. No! What do you mean?
8.	Ma	With this flower because we want [inaudible]
18.	JE	Yeah yeah yeah.
19.	MA	Alright, now, I'm going to take a video of you checking this thing out.
20.	Ma	Ready. Wait Jebediah, why is this…
21.	MA	Wait, Jebediah, could you please go someplace else. I'm about to take a video of her.
22.	JE	Oh my god, dude, it doesn't matter. We're working here.
23.	MA	While she's watching that.
24.	JE	We're working here.
25.	Ma	Hey Calvin, bend down.

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[5] Abbreviations are for the pseudonyms. Two or three capital letters stand for a male student. One capital letter followed by lower case letters stand for a female student. S stands for a single, unidentified student. Ss stands for multiple, unidentified students.

26.	CAL	Okay wait.
27.	MA	Yeah we've got this awesome
28.	Ma	1, 2, 3
29.	MA	I've already started
30.	Ma	Okay. Look at these purple flowers. I bet like something ate it right here because it's all eaten and stuff. Right there.
31.	CAL	Not really
32.	Ma	Yeah
33.	CAL	It bloomed out. See?
34.	MA	Yeah, something probably ate it.
35.	Ma	No no see all these other ones are blooming and then these are sorta like eaten.
36.	CAL	Let's take a picture of them.
37.	Ma	Yeah, okay. Purple flowers.
38.	CAL	Too bloomed.
39.	Ma	Why are they eaten? Probably some little ducks came around and ate them
40.	CAL	How do you know they ate them?
41.	MA	Ducks, really?
42.	Ma	Well, there's a statue of ducks over there.
43.	MA	Geese.
44.	CAL	Okay, let's go guys.
45.	Ma	Why are they eaten? Or maybe some bunnies
46.	CAL	Oh, guys let's do this one.
47.	MA	Let's check these out. Those ones, right there.

This event initiates when Manuel notices from across the courtyard other students standing beside some purple flowers and decides to make a video. Manuel sees there is a pair of students already standing beside this patch of flowers and then signals to his partner several times to go with him to the flowers so he can make a video of her talking to the camera about the flowers. Next, their group congregates around the flower patch, as Calvin joined them. There, beside the flower patch they share their ideas and argue a bit about the state of the flowers. This except is interesting because it follows the flow of how a precipitating event ensues including noticing, signaling, congregating, sharing, and theorizing. It is also interesting because while they were shooting the Flip Video, a variety of claims surface about why the flower looks ripped and wilted. While sharing and theorizing about what they were seeing, a mini argument results about what could have caused the flower to rip.

Residue: field trip Bio1b (4/25/2011) [student audio]

The purple flower precipitating event reverberated in a variety of different contexts. The first time I saw it come up was on the following field trip to the courtyard. On the follow-up field trip, Marcy and Manuel find this patch of purple flowers, except it is just a plant now with apparently no more buds.

1.	MA	Look at these things. Marcy, take a picture of the purple flowers.
2.	Ma	Should we start?
3.	MA	Remember the last time we were here the plants were really small.
4.	Ma	Oh yeah! The purple flowers are gone.
5.	MA	Yeah they are.

This is a relatively unmemorable moment, except they discover that the purple flowers are gone. This event takes place at the exact same spot but the flowers have since disappeared. They see that while the plant is bigger, there are no more flowers. There is no talk about causes like last time; instead they notice that it has changed and they are content to leave it at that. The purple flowers reverberate on this follow up field trip, but weakly.

Residue: post-interview; stimulated recall (5/11/2011) [researcher video]

During the stimulated recall post-interview, Manuel was shown video from the first visit to the courtyard when he made the Flip video of the purple flowers. First he proposes in the video an explanation that the rip was caused by an animal, and then explains in the interview why he was drawn to the flowers.

1.	Video	Yeah we've got this awesome, I already started. "Look at these purple flowers, see all these other ones are blooming and these are sort of like ripped."
2.	MA	That's when we were wondering, like if they had gotten ripped or something like that.
3.	JB	So, do you agree with her?
4.	MA	Yeah something probably did eat them or maybe something hit them and it ripped.
5.	JB	Ok
6.	MA	Yeah that's probably what happened because if something had eaten it why didn't it eat the rest of them.
7.	JB	Hmm and how could you tell that something had eaten them? What did it, what did it?
8.	MA	See right here it is ripped and right here it's ripped [points to screen] and you can see the inside but that doesn't happen on any of the other ones.
[……………………………………………………………]		
9.	JB	Why did you record these flowers?
10.	MA	I mean, because they were in a bunch, they weren't separated like the other plants were.
11.	JB	Ok and that was something that was interesting to...
12.	MA	And there was another group like somewhere way over here.

During the interview it becomes clear why Manuel decided to capture this flower patch. He decided to record this patch of flowers because they were in a bunch (rather than growing separated from one another) and because another group of students was observing it. These are the two reasons these flowers were of interest to Manuel. It wasn't because there was an unusual looking petal that drew his interest, which he could not have seen across the courtyard. While it was still interesting to Manuel that these flowers appeared weird and seemingly growing together in a random place, what drew his attention was the fact that other students were standing next to and observing something curious.

Residue: PowerPoint presentations (5/12/2011) [researcher video synced with external audio microphone; student work products]

During their class presentation, Marcy, Manuel, and Calvin projected a picture of the yellow flowers but they actually talked about the purple flowers, which they saw during the initial visit but not the follow-up visit. The following excerpt is from the classroom discussion.

1.	CAL	[reading] What happened to the flower in the front that is partly ripped/chewed? We think that it might have been eaten by an animal of some sort.
2.	Ss	We can't see.
3.	CAL	Such as a squirrel or rabbit.
[……………………………………………………]		
4.	Ma/MA	Any questions?
5.	CL	Ms. H has a question.
6.	CAL	Ms. H?
7.	Ms. H	Was this the second time you went out or the first.
8.	MA	The first.
9.	Ms. H	So what do they look like the second time you're out there?
10.	Ma	They were bigger.
11.	MA	Ripped.
12.	Ms. H	And what about the one that was malformed?
13.	Ma	That one disappeared.
14.	Ms. H	It has disappeared. Do you. Okay. Do you think sometimes flowers like humans when they're born, when they bloom they don't bloom perfectly. Did it look like, were there smooth edges or jagged like something had eaten it.
15.	Ma	It really looked like something had eaten it.
16.	CAL	Oh and it was a white flower. Never mind
17.	MA	It really looked chewed

Calvin does not appear to disagree with the ripped/chewed hypothesis, even though he did disagree with this idea in the field. He does not offer his idea that they just died of old age, or "bloomed out" as he said. However, during the presentation, they just point out that the flowers had disappeared. The teacher adds a fourth possibility that they were malformed. She makes the analogy to humans who do not “bloom” perfectly. Marcy argues that it looks like something had eaten the flower petal but she does not back her claim up with a warrant. Manuel ends the brief discussion agreeing that it looked chewed. This precipitating event led to a range of competing ideas for why the flowers look the way they do. Consensus is eventually reached among the students and they agree with Marcy’s idea that an animal chewed the flower. Interestingly, the focus here is on the observation about a ripped petal but the bigger picture, that there was a patch of flowers growing with no other flowers around it, did not surface during this discussion. They were focusing on the details while overlooking a much larger observation.

On the top of Figure 5.4 is a photograph of the purple crocuses from their initial visit. It is centered on the ripped/chewed petals. On the bottom is a picture of yellow crocuses that was constructed into a PowerPoint slide during the classroom computer laboratories, and projected to the class during their presentation. Both images were made on the first field trip to the courtyard. For some reason, they chose to include in their PowerPoint slide the image on the bottom slide rather than the image on the top.

Figure 5.4a. Student photograph of purple crocus flowers.

Figure 5.4b. A PowerPoint slide constructed by Manuel, Marcy, and Calvin, depicting blooming yellow crocus flowers. It reads, “Blooming yellow tulips. What happened to the flower in the

front that is partly ripped/chewed? We think that it might have been eaten by an animal of some sort, such as a squirrel or rabbit."

When Manuel, Marcy, and Calvin revisited the flower patch on the subsequent field trip, the purple flowers had since disappeared. Rather than taking pictures of a flowerless plant, they just talked about the fact that the flowers were gone. The idea that stuck was that animals ripped the flowers, an idea initially proposed by Marcy in the field and recorded on the worksheet that she was holding in the field.

Example 2: Dead Bird (Bio1a, 3/30/2011)

The following is an example from the event when a dead bird was found under some bushes. Although the dead bird event was captured on all five student audio microrecorders, three researcher cameras, and four of the five student Flip Video cameras, I present excerpts mainly from Manuel's audio recorder, which was synced with two of the three researcher cameras. What is shown below in this example is the event as captured from Manuel's perspective because he tended to stay close to the dead bird throughout this event.

The dead bird event begins with Marcy feeling bored by plain grass, searching for something not so plain. The simultaneous interactions on the far end of the courtyard when Calvin signals to his peers by screaming about the dead bird are not shown here even though many people recorded this. At one point during the dead bird event Manuel and Marcy decide to go and observe moss growing in a crack in the concrete for a couple for minutes. The moss event within the dead bird incidentally did not reverberate, perhaps because it was overshadowed by the more exciting event of the dead bird. Shortly after checking out the moss, many students including Manuel theorize about how the bird died. This talk is represented as the second part of this event.

1.	Ma	Okay, we're going to find something else. Come on Calvin.
2.	CAL	I'm taking a picture [leaves with camera].
3.	MA	Green.
4.	Ma	No.
5.	MA	Yes. Those are cool. They're cool.
6.	Ma	Way too plain. Let's find something over here.
7.	Mr. D	What are you guys looking for?
8.	MA	Well Ma says that that those green things over there, they're too plain.
9.	Ma	Well, they are plain.
10.	Mr. D	They're too plain?
11.	Ma	Oh, okay. Stay here guys.
12.	MA	What's that? What?
13.	Ma	No, no. Horrible.
14.	Mr. D.	No?
15.	Ma	A dead bird! Perfect!
16.	CAL	Where?!
17.	Ma	Right there!
18.	CAL	We found a dead bird!
19.	Ma	Shut up!!
20.	CAL	Eww. It's tore in half.
21.	MA	Take it take it. Go go go.
22.	Mai	We found a dead bird!
23.	MA	Yeah it's dead.
24.	CAL	I'm going to take a picture.
25.	MA	Go go go.
26.	Ma	Mama Mia a dead bird. Oh there's its skull.
27.	MA	I found its skull.
28.	CAL	Aaaaaahaaaaaahahahahaha.
29.	S	What is it?
30.	MA	It got tore in half, right there and right there. Oh my god we got this dead bird here.
31.	JE	Dead bird.
32.	Ma	That's a bird right here. Oh my god.
33.	MA	Where is it? I don't see it.
34.	Ma	This is not a dead bird, it's a fruit of some sort
35.	BRA	It is no.
36.	MA	That is a dead bird. What are you talking about?
37.	NA	I don't see it.

38. Th This is disgusting.
39. NO Let me get a shot at it.
40. Re You know you could just zoom it.
41. MA That is a dead bird. Oh my god.
42. BRA Oh yeah.
43. Re Eww. That's disgusting.
44. MA You could see its skull.
45. Ma Is anyone writing down the questions?
46. MA/Ma Calvin!
47. MA Calvin, you got to write down the questions! Think up some good questions, like how did it die or something like that. Alright, Calvin's talking care of the that.
[SEVERAL MINUTES LATER NEAR A BENCH]
48. CAL Ooooo. That was disgusting.
49. Emo Disgustingly awesome
50. JE That was awesome! You should totally take a picture of the dead bird over there.
[……………………………………………………….]
51. Mr. D Do you think something killed it or it flew into a window?
52. Emo I think something killed…
53. JE I think it flew into the window because that's where birds always land. If they hit the window they always bounce back.
54. Emo In Ms. F's room we saw a bird just go *schaafffed*.
55. JE Over on that side of the school they hit the window a lot and they end up behind the bushes.
56. Ms. H
57. AR I think I know how it died. I think it probably crashed into the window and then
58. CL Died.
59. AR Died.
60. Mr. D Did someone say it got torn in half?
[INITIATION OF PURPLE CROCUS EVENT AT FAR END OF THE COURTYARD]
61. AR No, the skull is cracked open. But it probably smashed into the window and then died and decayed.
62. CL It probably moved a little bit.
63. AR Birds aren't that smart.
64. Mr. D They're not that smart.
65. AR How did it die? Entire courtyard. Circle that.
66. Mr. D What do you think those white things are?
67. AR Those, those look like pods from a tree.
68. Mr. D Pods?
69. CL Those are the wings.
70. AR Those aren't the wings.
71. Mr. D They're the wings?

72.	CL	No, no, no they're not. But the bird it probably crashed into the window and then it probably wasn't dead as soon as it came down. But it might have walked a little and then it dead, died.

This precipitating event initiates with Marcy seeking something more interesting than just "plain" plants (line 6). She serendipitously spots a dead bird under some bushes (line 15). She tells her partner, Calvin, who then signals to other students near him by stating emphatically what was found (line 18). Within seconds a small group of students congregates beneath the bushes. When Manuel and Marcy's partner Calvin catch wind of the dead bird, he looks it and then while screaming and yelling, runs full speed to the other half of the courtyard where he excitedly tells his peers about the discovery. Once he signals to the other half the class, they run over to the dead bird. A large group congregates, huddled beneath the bushes. Rather than death by natural causes, most of the students seemed to theorize the bird died by a catastrophic event. They believed it flew into the window, died and decayed. Line 58 and 59 we see evidence of convergence on this notion of death and then in line 61 we see evidence of elaboration on this shared idea that the bird died. This idea was solidified by a number of pieces of visible evidence and enthusiastically shared. First, many students had the experience of seeing birds crash into windows outside of school, such as at home or in the movies, as well as at this school while sitting in class. Second, the dead bird was located near a window so it made sense to them that the bird could have crashed into this window. Third, some students noticed a large crack down the center of the skull, which they suspected was evidence of it crashing into the window. Seeing the skull is a key feature of this animal that made it more interesting and exhilarating. Seeing the skull and the decaying corpse may have also helped make this event memorable. The idea that the animal died by crashing into a window reverberated across the classroom and interview contexts.

Residue: PowerPoint construction (4/29/2011) [researcher audio]

In the following excerpt, I walked over to Emogen and Jedidiah who are talking about the dead bird in class while they worked on their PowerPoint presentation.

1.	JB	Tell me about the dead bird since that was on your screen when I walked over here?
2.	JE	Umm the bird was dead when we found it.
3.	JB	How do you know it was a bird?
4.	JE	Umm because it had wings. It had legs. You know how their legs go like this. So lets say my head is facing this way. Its legs go like this.
5.	Emo	I don't think we need that much detail. You write 'it looks like it had been there a month or two because it was decomposing.'
6.	JE	Yeah. It was like rotting and stuff. You could see its skull.
7.	Emo	Yucky.
8.	JB	So did it raise any questions for you?
9.	JE	Um we wondered how it died.
10.	JB	Why?
11.	JE	We really wondered why it dies. We thought we made a guess that it crashed into the window.
12.	Emo/JE	Because every time a bird crashes
13.	JE	Into the window it goes back a couple of feet like boom.
14.	JB	Have you seen that happen here.
15.	JE	Yes. We have.
16.	JB	In the courtyard?
17.	JE	Yes there are many dead birds. One time I saw worms and flies eating the birds' guts.
18.	JB	In the courtyard?
19.	JE	No.
20.	JB	But have you seen birds fly, have you seen that happen before in the courtyard?
21.	Emo/JE	Oh, yeah.
22.	JB	You've seen birds fly into the windows?
23.	Emo/JE	Yeah.
24.	JE	One time I was sitting in class. I can't remember, Ms. T's class and there was a bird that flew into the window.
25.	JB	In class?

26.	JE	Yeah. But he lived though.
27.	Emo	No it was in Ms. P’s room.
28.	JB	Now I'm wondering how do you want to know how it died?
29.	JE	Because, no that wasn't our question. We made a guess that that was possible...
30.	JB	Okay. I'm just trying to understand why it is interesting to you. Why is the dead bird interesting?
31.	JE	Because you don’t see a dead bird with a skull that often.
32.	Emo	Yeah you don’t see a dead bird rotting everyday. Yeah you just don’t see it rotting everyday. Or getting eaten by stuff.
33.	JB	So if you saw one everyday then maybe it wouldn't be so interesting.
34.	JE	Yeah. Yeah. No, no. If you saw one every day then that wouldn't be interesting at all. Maybe your worm would be much bigger. I hope people don't see them everyday. That's bad. That's just mean. Dead birds.
35.	JB	So because it is something kind of unique that is why it is interesting. Were there other things in the courtyard that were like that as well?
36.	Emo	The mats.
37.	JB	Mats?
38.	Emo	Yeah like floor. They were really interesting, yeah. And one of them was really nasty and the one next to it was nothing.

In the excerpt, I probed to learn why the dead bird captivated the students. I wanted to understand why the bird was interesting and what made it memorable. Specifically, I was curious why Emogen thought the bird was “disgustingly awesome.” It became evident that the firsthand experience of seeing birds crash into the windows at school and the location of the bird in proximity to a window were both pieces of evidence that shaped how they understood the cause of death. Clearly, their prior experience of having seen a bird crash into a window at this school was a key principle supporting their thinking. It was drawn upon to link the visible evidence of seeing a dead bird beneath a window and their claim that it flew into the window and died. This event was interesting because it was gross, and memorable in part because Emogen and Jebidiah have had prior experience with a similar situation.

The students believe they know why the bird died because of experiences in school having seen birds fly into windows, as well as the prior experience on the field trip when they saw that the bird was located beneath a window. Like the mossy mat, a decomposing bird was something really "nasty." It is of interest because it is something gross and not something seen "everyday."

Residue: field trip Bio1b (4/25/2011) [narrative summary]

Curiosity drives Arwin to look for the dead bird again, so he walks over to the bushes. He sees that it is gone and assumes the bird decomposed because he knows that is what happens to dead animals. The following excerpt is from my field notes.

> JB notices Arwin walking across the courtyard to the bushes and then follows him. JB asks Arwin what he is looking for and Arwin says "the dead bird." When he was in the area behind the bushes where the bird had been, he notices it is gone and claims rather unenthusiastically, "Oh, what a surprise it decomposed." JB asks him, "How did it decompose?" and he replies, "Dead animals they just disintegrate." JB asks how long it had been since it was last seen and he thinks three weeks. JB asks, "Is that enough time for it to decompose?" He thinks so.
>
> Clay, Arwin's partner, wanders into the bushes where he joins his partner. Clay wonders what Arwin and JB are doing. JB replies, "We are wondering where the dead bird went." Where do you think it went JB asks them?" Clay responded, "They probably threw it away when they did spring cleanup." Arwin says, "Right, that's also another possibility that it got thrown away on Saturday." They are negotiating where to go to next.

Of course there are myriad plausible reasons for why the bird disappeared including getting buried or being eaten by animals. JB gently guided Arwin to question his assumption when the amount of time since they last saw the bird (i.e., just four weeks) is brought to his attention. Yet Arwin still thinks this is enough time to decompose an animal skeleton. When Clay arrives, Clay quickly proposes an alternative idea, which is the bird was thrown away during spring clean up just days before they this second visit. The notion that people moved it then becomes a plausible possibility that Arwin accepts.

Clearly, the dead bird left a strong impression. It is interesting how willing Arwin was to accept Clay's idea that people removed the bird. Clay knew that there was a spring cleanup. He uses this piece of knowledge to link his observation that the bird was no longer there with his claim that people removed the bird. It is unclear whether Arwin still believes that four weeks is enough time to decompose a bird carcass or that Clay's idea is more plausible. Nonetheless, Clay's idea was a logical idea that Arwin agrees with and appears to accept without debate.

<u>Residue: PowerPoint presentations (5/5/2011) [researcher video synced with external audio microphone; student work products]</u>

The dead bird event was represented in many students' PowerPoint presentations. This excerpt is from the classroom discussion surrounding the presentation by Oliver and Minos.

1.	MI	The dead bird.
2.	OL	Yeah. Here lies a dead bird. Questions?
3.	MI	[READING] "The question we want to ask about it is how it died? The question we want to ask about it is that how it died. Minos says that it got struck by lighting or it got hit by a blizzard. Oliver thought that it got too old and died. We will never know."
4.	Ms. H	You know actually could have died in the blizzard. I think that makes sense.
5.	MI	Yeah because it was…
6.	OL	Any questions?
7.	JE	Why were you so far away. You should have gotten closer.
8.	OL	Norbert?
9.	NO	I have two questions. I thought it was impossible for a little bird to get hit by lightning. And also, is it a tulip?
10.	Ms. H	Okay, enough with the tulip jokes.
11.	OL	Flanna?
12.	Fl:	Do you think that like it was knocked out by hitting the window then maybe

		eaten by an animal because it looks pretty messed up?
13.	Ss	[laughing]
14.	OL	I don't know.
15.	Ms. H	Okay what animals have we seen in the courtyard?
16.	Ss	Cougars. Squirrels.
17.	Ms. H	Are squirrels known to eat meat? No. I don't think so.
18.	S.	No. Cougars, tulip, mice.
19.	Ms. H	Okay, A had a question. Jedidiah I don't know what you're doing but you need to stay seated.
20.	AR	If it had been hit by a blizzard wouldn't it have been preserved by the snow?
21.	MI	The snow was gone by the time we got out there.
22.	OL	The answer to all these questions is in the last line. We'll never know.
23.	MI	Yeah, we'll never know.
24.	Ma	Don't they have cameras outside?
25.	Ms. H	I don't think they have cameras in the courtyard.

Like many students in this class, Oliver and Minos wonder how the bird died. What's interesting about this example is this pair poses alternative hypotheses as to the cause of death. They publicly disagree on how this happened. Minos thinks a catastrophic event such as a blizzard or lightning killed the bird. Oliver thinks the bird got old and died. The dead bird event reverberates here, that the bird died by crashing into the window, when Flanna asks whether it could have crashed into the window and died. She also surmises that the carcass looks like wild animals ate it. Arwin picks up on the blizzard notion and the idea about the messed up rather that well-preserved state of the animal. However, he disagrees with the blizzard hypothesis because the bird would have been preserved in his opinion; instead, it appeared decomposed. Minos rebuts that, as the snow from the recent blizzard had melted well before the first field trip to the courtyard. This discussion was the first time the most logical explanation, old age, came up in conversation. The students contrast this explanation with more extreme events such as lightning, blizzards, and wild animals. Oliver cuts short the debate and claims the true cause of death will never be known. Figure 5.5 is the slide they constructed and projected for the class discussion

Figure 5.5. A PowerPoint slide made by Oliver and Minos. It reads “Dead Bird. Here lies a dead bird. The question we want to ask about it is that how it died. Minos says that it got stuck by lighting (sic) or it got hit by a blizzard. Oliver thought that it got too old and died. We will never know.”

Residue: post-interview, free recall (5/11/2011) [researcher video]

Manuel was interviewed about what he recalled from the field trips. I asked him what was a high point from that initial courtyard field trip.

1.	JB	What would you say would be a particularly high point from that day for you?
2.	MA	A high point, well, I think most people would say that finding the dead bird was the high point.
3.	JB	Would say, would you say that for you? Or…
4.	MA	Well most people would say that for them.
5.	JB	Ok, what about for you?
6.	MA	For me, I think was over there [points outside] on that side, uh what side is that?
7.	JB	Um that would be the east.
8.	MA	Yeah that's, on the east side looking at how plants were like, let's say there's some here and then a couple feet down there's some here and I was wondering why they didn't all just grow together.
[………………………………………………………………………]		
9.	JB	And why do you think the dead bird was a high point for, for them?
10.	MA	Because uh most people say that that is interesting. And it is interesting because a lot of people thought of questions like how did it die? How did it get there? What happened to it? Stuff like that. So most, a lot of people got really good questions down on that.
11.	JB	But it wasn't so, it wasn't the highest point for you.
12.	MA	Not the highest, it was a high point but I think that one of the highest points was over there, like I told you.

Manuel initially responds by saying what everyone found interesting, which he suspects is because many good questions emerged about how the bird died. But for Manuel this was not the high point. The high point for Manuel was seeing that plants were growing in separate bunches. In this excerpt, Manuel seems to equate a high point of a field trip with seeing something that raises questions. The dead bird sparked questions about the cause of death, therefore it was a high point for his classmates. Seeing a dead bird was not just memorable but appeared to drive further inquiry.

Residue: river field trip (Bio1c, 6/10/11) [narrative summary]

A bit of residue from the dead bird event spontaneously surfaced during an open-ended whole group observation activity in the woods after a chaperone and a student discovered a flattened possum carcass crawling with maggots. The event that ensues surrounding this animal carcass looks very similar to the dead bird event, as both are about decomposing animals. There are multiple signals, students congregating and regrouping to see the dead animal, and a range of ideas shared and theories generated about what kind of animal it was. The following is an excerpt from my field notes generated from two researcher video cameras that were synced with five student audio microrecorders.

> During the zeitgeist of the moment, Jedidiah comments about field trips in general saying, "there's always a dead thing." I could sense a little exasperation in his voice but also a bit of enthusiasm. Approximately ten minutes later, during a transition to the next activity in a different part of the forest preserve, Manuel walked over to JB and said, "That possum we found is kind of like the dead bird we found in the courtyard." He was very excited about the connection he made and continues to repeat it. "We could see his skull in both of them." JB praised his good thinking. JB asked him "how did you know it was a possum?" "Uh, we didn't but everybody just kept saying it was a possum."

Clearly skulls are of interest to students. Or perhaps there is something much deeper about skulls that drive morbid curiosity. We see images of skulls everywhere in our daily lives. But we do not often see a real skull up close and personal replete with gory details. The magic of field trips in part is that they afford seeing surprising and dramatic things that one can connect to prior life experience.

The dead bird event was a sticky topic. It came up in a range of contexts and in a variety of ways. Like the purple crocus, which was mysterious as to how it looked ripped, the dead bird was also fairly problematic, being about something fairly mysterious. Many competing ideas were heard in the field and in the classroom including the most obvious, that it died of old age. The idea that spread was the one about a bird crashing into a window, which was supported with evidence drawn from everyday and field trip experiences and supported with commonsense reasoning.

Example 3: Concrete Wall (ES1b, 3/29/2011)

The concrete wall event is an interesting example for a variety of reasons. Unlike the other two examples about growth and decomposition, this example is about rock weathering. It occurred during a nature walk at the river rather than at the school. This precipitating event was memorable even without tools such as cameras and maps that could help make ideas visible.

The data sources for this except are John and Mr. R's audio recorders. They were synced with a researcher camera that captured some of this event.

1.	Eme	Look at that wall.
2.	Mr. R	Oh. Is that wall naturally occurring?
3.	S	No.
4.	S	No it's like broken.
5.	S	It looks like we're at the end [of the path].
6.	Mr. R	Alright sixth graders come back here for a sec. Okay so if we look behind us you can see a wall over there.
7.	Ss	[laughing]
8.	Mr. R	So, if we look behind us we see a wall over there.
9.	S	Cool.
10.	Mr. R	Why there of all places?
11.	Mah	Wait wait stop, I want to record this.
12.	Ca	It keeps the river from rising and flooding those houses over there.

13.	Mr. R	There's houses over there, so you think it helps with the rising of the river.
14.	Ca	Well not with the actual rising of the river. It keeps it from when it does rise, it keeps it from flooding the houses.
15.	Mr. R	Okay, so maybe flood prevention. Some other thoughts why there is a wall there and not compared to before?
16.	BRA	Because it's sloped down.
17.	Mr. R	Oh, it's starts to slope down a little bit more. If we look to the corner of the wall, what do we notice is happening there?
18.	Al	It's like falling.
19.	Mr. R	What's causing it to break down and fall.
20.	Mar	The water.
21.	Mr. R	Rain. Water.
22.	Em	The weather.
23.	Mr. R	The weather yeah. Anything else we notice in the corner?
24.	Pa	The tree.
25.	Mr. R	Ah, the tree. There's trees growing out of it aren't there?
26.	S	The roots.
27.	Mr. R	The roots might be like pushing it apart and breaking it up. And then probably like wintertime we can have water going into it and ice breaking it up too. If we look all along the wall we can see trees growing up next to it. What do we think is going to happen to this wall?
28.	Mar	It's gonna break.
29.	S	It's gonna break.

The concrete wall event has a common structure of a precipitating event. An individual initiated it—a student who had seen the wall in line one. Then the teacher, once he was called to its attention, decides to make public this observation. Mr. R initiates the event (line 8) because the object is tied to the curriculum. In this case it was a weathered rock wall that appeared both naturally occurring and man-made. The signaling is not especially strong because everyone was already fairly close together; nonetheless, there is some physical reorganization along the hiking path as the group oriented toward the wall. Then, talk about this object ensues.

Since this object is not too gross it did not cause much yelling and screaming. However, the wall was problematic in that it appeared weird. It raised questions for the group, which added fodder to the discussion. The question from the teacher is whether or not it is naturally occurring, and this is used to initiate the discussion. Then the conversation plunges deeper into the science content when the teacher asks why this wall is there. Next, he has them notice something happening in a particular place and guides them with questions to see how it is breaking down. Finally, Mr. R concludes by probing the students on how long something like this might take to change.

The talk here is gradually tuned toward a specific scientific idea, that roots can break apart rocks, which is evidenced by the observation that trees are growing through the wall and supported with reasoning that the wall preceded the trees and that roots are strong enough to break apart rock. His guided questioning and noticing helps them see the signal through the noise.

Residue: post-trip discussion (3/30/2011) [narrative summary]

This concrete wall event reverberated during the classroom post-trip discussion, the day after the field trip. It came up when Mr. R asked the class if there were any lingering questions.

> During the post visit whole class discussion, Mr. R asked everyone, “What are some questions you still have?” Bharat asked, “How was it that the trees got into the wall at the very end?” Mr. R said, “that’s right at the very end we saw pretty new condos and an older wall that everyone guessed maybe older than 50 years, we saw trees growing out of the wall.” Bharat looked down at the paper and quietly asked “and why are there lots of trees on the ground?”

Bharat wondered how the trees were growing out of the wall and why there were so many trees on the ground. He does not receive an answer, but he was given space to share that he is still thinking about this place and wondering how it could have been changing.

Mr. R does not directly answer the question about how trees could grow through a wall. Instead he restates this idea and refocuses their thinking on the observation that they saw buildings nearby and the presence of those structures could help them constrain their thinking about why there was a wall there in the first place. Mr. R drew their focus away from the condos and toward the trees because in school they were learning about biological weathering rather than flooding.

<u>Residue: field trip ES1c (4/20/2011) [narrative summary]</u>

On a follow-up field trip to the neighborhood to see close-up real examples of weathering and erosion, Brandon and John made a spontaneous connection back to the river field trip (ES1b), which subsequently reverberated throughout field trip ES1c. The following is an excerpt from the field notes I generated from the researcher video synced with John's audio recorder.

> Mr. R now moves closer to the wall to touch it. "So things that were all a solid bridge are breaking down to rocks. Here why don't we move over here so everybody can see it." John quietly says to Bharat, "because there's a lot of trees there." Bharat hears John who is standing next to him and makes a profound connection. Bharat tells Mr. R, "This is like the river place, the Chicago River, there's all these trees growing in the bridge." Mr. R pauses, put his finger to his mouth and appears to have his thinking disrupted. "Hmm," he says. Moments after the group has moved and regrouped where Mr. R has stopped, he says to the group, "Okay, umm. Bharat you had an observation or actually a connection. What was it that you just told me? Bharat smiled and appears shy. "At the Chicago River there was some trees, all these trees. In the bridge thing." Mr. R says, "Okay, what was happening, all those trees growing off of the bridge?" He gestures a hook shape to mean leaning trees. A student says, "They were going through the bridge." Mr. R says "and remember that bridge was broken down in the corner, it looked like it was completely falling apart. Would we say this bridge looks similar to that?" A student replies "Yeah, but there's not a giant tree growing." Mr. R says, "Well [students] had mentioned that there were trees growing up here. He thought that might be a reason the bridge is falling down as well." Someone interrupts and asks, "Is this the train track?" Mr. R says, "The train track is like right up there. The rocks either made by people or naturally occurring start to crumble."

This residual event has a similar structure to the precipitating event. Not only that, but it was this about the same content, biological and physical weathering. Bharat saw similarities across the two field trips shared this idea with his friend, John, who in turn shared this idea with the teacher. The teacher recognizes the importance of this cross-field trip connection and spontaneously makes time to teach the class about this weathering.

What is interesting about this reverberating event is that the big excitement does not happen until after the students were done theorizing about how the wall looks like the bridge they saw on ES1b. Some excitement did come during the initial connection that Bharat and John made, but primarily the moment of heightened engagement happened later, after the direct connection to the rock structure previously seen and experienced on field trip.

Residue: post-interview, stimulated recall (5/16/2011) [researcher video]

The third context I saw the rock wall precipitating event reverberate was during a stimulated recall interview. I showed John a video clip from the neighborhood walk at the crumbling concrete train trestle. He was prompted to describe what was going on in this video clip.

1.	JB	Ok so what's going on here?
2.	John	Well we were watching, we were looking at the side where there was some bricks I think they were like falling, fell down part of the wall in there so then we were, we were pulling out some of the pieces of the wall. And then that, there, maybe uh how long would the, how long [looks over to the left] has that uh building been there, like the wall has been there, and they said maybe 20 years.

In this interview, John remembered handling a crumbling wall on ES1c. Interestingly, he appears to be blending two field trip experiences in his recall of the neighborhood walk. During his recall of handling bits of the wall, he refers to the train trestle as the building, presumably the apartment building they saw at the river. Handling bits of the wall was not possible at the river because a 50-foot-wide river separated the group from the floodwall. In both settings there was a train trestle, and in both settings they reasoned about how long it would take to change over time, which may have contributed to these two events being interwoven in John's retelling of what happened. He appeared to be using his prior experience of being at the river to help constrain his thinking about how the train trestle they saw near the school changes over time.

Teachers help learners see the signal through the noise

On the earth sciences river nature walk, the teacher saw the opportunity in the field to create a teachable moment. Mr. R spontaneously signals by gesturing and calling attention to the floodwall across the river. Then he guides the students to notice that it was weathering because trees were breaking apart the wall. He guides the discussion in a fairly pointed fashion, cutting through the noise of the busy river scene to help the students think about how this wall has been broken down over many years. At this stopping point, the teacher decided to highlight the big idea that tree roots can do the work of breaking rock. Mr. R knows the story of this wall and guides others to discover it. He knows what it is for, roughly how long it's been there, and how it is changing over time. The students had not yet learned this; however, he stopped short of telling them outright how this wall was changing and instead left the interpretation open to the students to construct. The students appear interested in the wall and peered back at it after the teacher said that it was time to move on.

Later on, experiences at this wall reverberated several times in a variety of situations. Many weeks after this field trip, I could still see residue from it. The first time I saw it come up was during a class discussion. Bharat still had lingering questions about the wall and wanted to know why it looked the way it did.

The next time I saw the wall come up it was fodder for a spontaneous moment during the neighborhood walk. Beside the train tracks, the teacher recalled the event at the river to seed a discussion about weathering. Bharat and John made the connection to the other rock wall they saw at the river. This connection motivated Mr. R to draw out ideas about biological weathering.

The third context when I saw the river wall come up was in an interview. What struck me about this interview was when I showed John a clip of video he made on the neighborhood walk, he was reminded of the river rock wall and the apartment building we saw there beside the flood wall. It appears memories constructed in one context cued memories about another. In this case, memory of the precipitating event served as a resource for reasoning about residue.

Nature of the Residue

In the previous chapter I looked at what happens on field trips. I examined field trips and proposed that it was the social and emotional nature of these experiences that contributed to their memorability. In Chapter Five, I follow these memories across time and place to better understand when and why they leave residue. In the following section I discuss the nature of residue. I first examine the range of contexts I saw field trip memories reverberate. Then, I carefully analyze the nature of the full catalog of reverberations.

Residue was visible in several contexts

I saw precipitating events reverberate primarily in three different contexts: during interviews, on subsequent field trips, and during classroom activities.

I saw about the same amount of residue during the interviews (i.e., the free recall and the stimulated recall). What surprised me were the many occasions when students recalled specific events during the free recall. This is significant because it means that without much more than a general question about what happened on the field trip, students could recall specific events that happened.

Another context in which I saw residue was on follow-up field trips. On these subsequent field trips, the students were sometimes reminded of prior field trips. For example, students on follow-up courtyard field trips were tasked with making observations about changes they noticed; with their maps and question logs, they were told to find things they had previously observed. These memories were cued because students were in the same setting seeing the same things weeks later. Other times, however, the students were in new places recalling similar looking things.

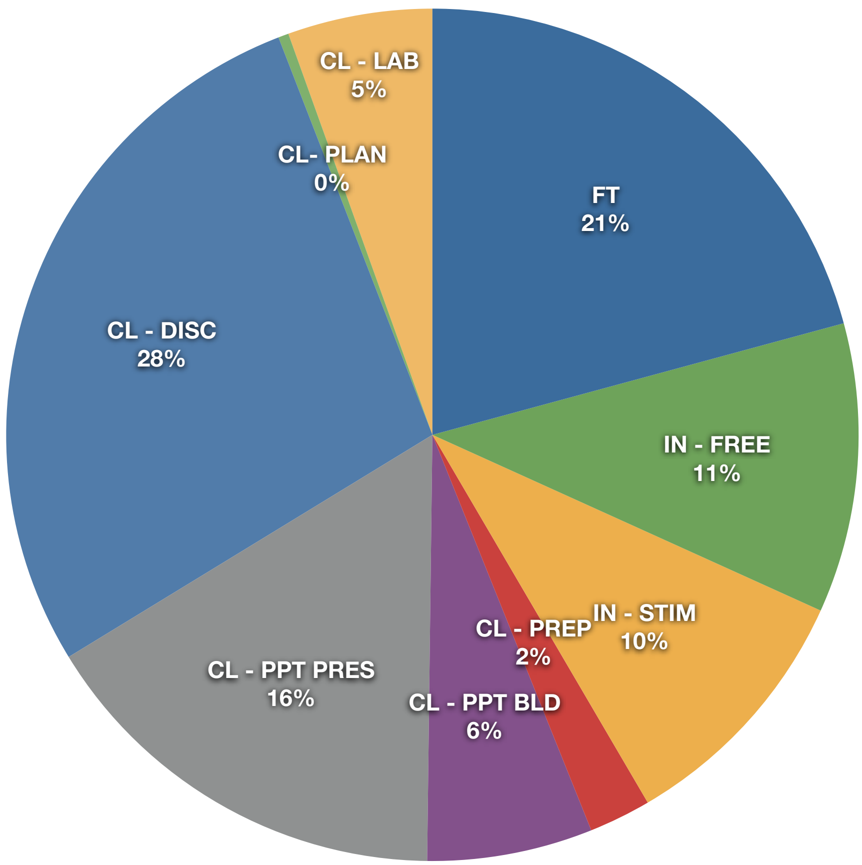


Figure 5.6. Breakdown of nine contexts where I saw residue 242 times.

CL-DISC (classroom discussion), CL-PPTPRES (classroom PowerPoint presentations), CL-PPTBLD (classroom PowerPoint construction), CL-PREP (classroom preparatory activities), CL-LAB (classroom laboratory activities), CL-PLAN (classroom planning sessions), IN-STIM (stimulated recall interview), IN-FREE (free recall interview), FT (subsequent field trip).

I looked at when residue from the field trips came up in the classroom. Approximately half of the classroom residue came up during discussions. These were typically the teacher-led discussions that happened the same day or the next day that were specifically about that field trip. Occasionally, they would discuss the field trips during laboratory activities, at the beginning of a lesson, or during a lesson, but usually they would happen immediately following a field trip.

In addition to the discussions generating a good deal of residue, the PowerPoint presentations generated a significant amount of residue. Approximately 16% of all the reverberations, and nearly a third of the classroom residue came up during the three days I observed the student groups present their slides to the class. These discussions usually were initiated by the teacher, the presenting students, or by a student seated in the classroom. The photos were taken from the courtyard so it is fairly straightforward to identify exactly when and where most of the images were made on the courtyard field trips. This adds to my confidence in aligning the precipitating events with the PowerPoint residue.

A tiny fraction of the residue came up *before* the field trips. One event involving the rain barrel stemmed from planning meetings when Ms. H and I visited the courtyard and talked about objects the students could see that tie to the science content. During the field trip, Ms. H drew from these planning meetings and created a memorable moment in the field for many students.

Figure 5.6 is a breakdown of where I saw the field trips reverberate. Of the 242 reverberations I cataloged, I saw 60% of them in the classroom. Approximately 20% of the reverberations were on subsequent field trips and another 20% I saw in the interviews.

Approximately 10% of what I saw reverberate came up during soil laboratories and computer laboratory activities when students were constructing their slides using PowerPoint.

What I found were memories of the field trips filled a range of contexts. These reverberations were primarily seen in classroom discussions. They were also seen in the interviews about the field trips both as free recall and stimulated recall. It was anticipated that I might see some residue in these two contexts. I did not anticipate I would see as much residue or that it would be so detailed.

All field trips do not precipitate equal amounts of residue

Since I conducted the residue analysis for all the field trips, I am able to compare across the field trips. Bio1a and Bio2a left significantly more residue than the other field trips. There is good reason for this. Even though all the field trips were designed with tasks intended to generate observations and data the students could work with over time, I may have seen more residue from the initial courtyard field trips because they had more interesting stuff to see.

Another reason is there was more time after these two field trips for experiences to reverberate than after the other biology field trips. The field trips near the end of the school year had little time for follow-up discussions and interviews, so it is not surprising that I did not see much residue from them. That said I would have expected to see quite a bit of residue generated from the follow-up courtyard visits, as students would be driven to seek out new and interesting things. Instead, I either saw a significant amount of residue from the initial visit, that is, students attending to the same things they had seen before, or no attention at all was paid to the courtyard environment, at least in terms of thinking about the science learning goals embedded in the field trip activity.

A third reason I saw more residue from these two biology field trips than the other seven I analyzed may be because of what the students were asked to collect. In the earth sciences classroom, most of the residue was in the context of soil samples; the biology students' talk was in the context of digital photographs about the courtyard environment. Even though these two kinds of residue are somewhat similar in that both soil and digital images are authentic artifacts the students generated and carried into the classroom and both appeared to play a role supporting ongoing learning that was specifically related to the field trip, it is possible that there is a substantial difference between the two. The act of making photographs and constructing and presenting digital images may have been more memorable because the nature of the courtyard task was intrinsically more interesting than collecting and analyzing soil samples.

Adult initiated events create lots of residue

In the third stage of my analysis, I looked at how precipitating events were initiated. Was the moment flagged by a teacher, chaperone, or guide—or did it get noticed first by a student? My hunch was what reverberated related to whether it was student or adult initiated. I speculated that if a teacher initiated the event in the field, then that event would be more likely to reverberate because the teacher tended to monitor the classroom discussions. The students rather than adults more often saw something and pointed it out for others to see in comparison to adults. This makes sense because on the field trips, on average, there were roughly five times as many students as adults. Yet, the students initiated two thirds (54 of 82) of the precipitating events. In fact, I found that 90% of the student initiated events stemmed from the biology classroom. Moreover, these 49 student initiated events were 82% of all the precipitating events initiated by both students and adults.

Of the 242 events that reverberated, 60% (n=144) of them stemmed from events initiated by students. Generally speaking, even though adults were relatively few in number on the field trips they were meaningful contributors both in the field and in the classroom. This is not too surprising because students tend to value what teachers notice. It may also be the case that the teachers tend to preferentially give space in the classroom for discussing events they initiated.

Some things reverberated more strongly than others

Certain events reverberated a good deal, while others did not. Figure 5.7 depicts the 43 different kinds of precipitating events and the 242 residual events. The length of the bars on the figure represents the number of reverberating events for a particular kind of precipitating event.

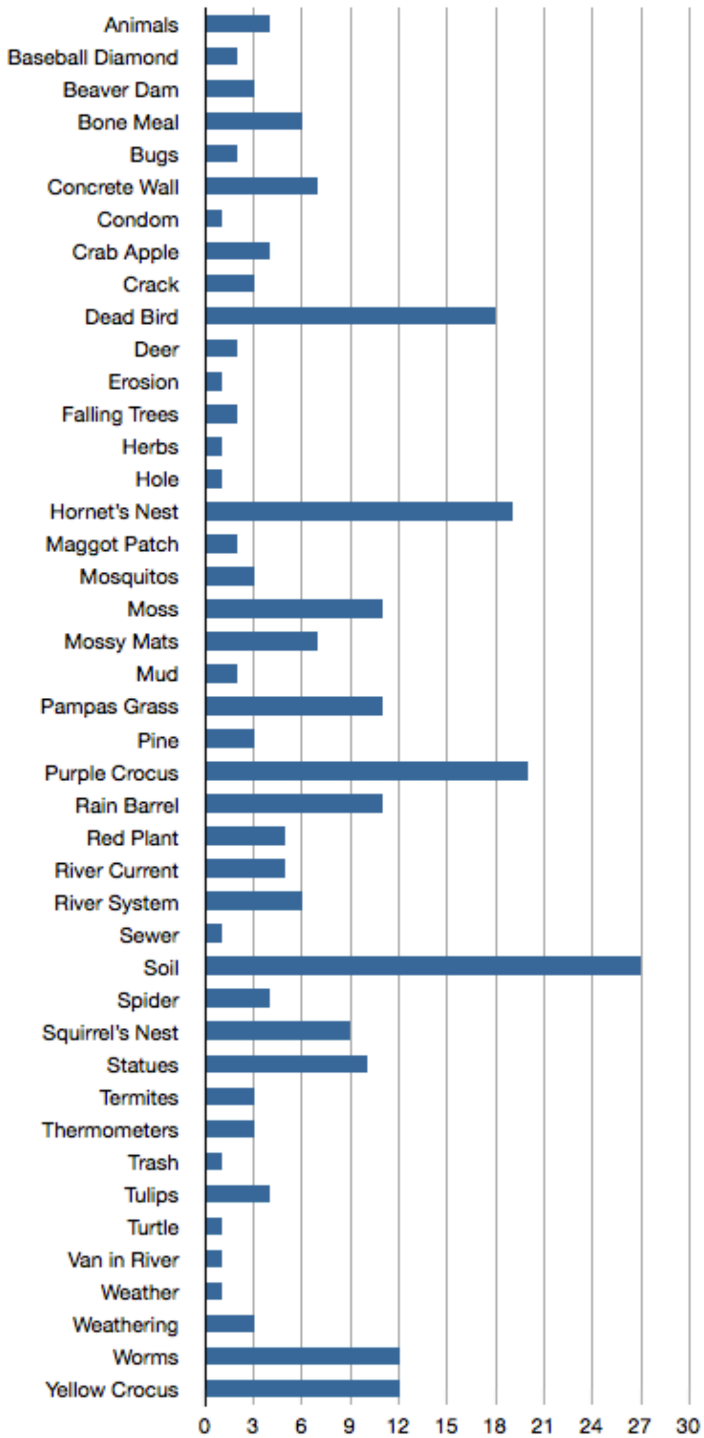


Figure 5.7. Kinds of Precipitating Events and the Quantity of Residue.

The dead bird discovery, the hornet's nest, the squirrel's nest, and soil sampling beside the river in the mud were four precipitating events that generated quite a bit of residue. Together these four precipitating events account for a quarter of the residue I observed. The majority of the precipitating events, however, did not generate much residue. I saw one or two residual conversations for two thirds of the precipitating events. For example, the crab apple, pine tree, purple crocus, and trash are examples of precipitating events that did not come up many times.

Even though what reverberated were conversations about physical things, plants and animals, and processes, the specifics of this list are fairly unpredictable. One might expect this, given that field trips to outdoor places have an air of unpredictability; there is a good deal of uncertainty in exactly what could be seen and experienced. However, there was one clear way to categorize the 82 precipitating events about 43 different things that reverberated 242 times.

One class of precipitating events was especially memorable: gross things, nasty things, and disgusting things. Nearly one quarter of the 82 events I cataloged involved things the students found repelling. These precipitating events were about 12 different phenomena including worms, a worn down bridge, trash, spiders, soil, sewers, the river current, moss, a doormat covered in moss, a maggot-infested possum carcass, a decomposing bird, a condom, and bone meal that appeared to be white mold growing on the soil. Some of the same phenomena stemmed from multiple precipitating events. Worms were usually seen as gross, but not every event about a similar thing was perceived as gross. For example spiders, moss, and soil were only sometimes gross.

Gross things did not always drive students away, as one might imagine. To the contrary, if something was talked about as “nasty” it often cued students to take a closer look. But if something was said to be disgusting, it tended to mean that the experience was repelling and uncomfortable.

The dead bird was an intriguing example because it was simultaneously repellent and inviting. Emogen enthusiastically described it as “disgustingly awesome,” which suggests there is some spectrum in the ways students socially interacted and reacted to gross things. I am hypothesizing that gross things strongly reverberated because they created a big stir.

In contrast to gross things, just a few events were talked about as pretty or “beautiful.” Two of these events were about the river current and one was about the yellow crocus flowers.

The observation that 18% of the precipitating events were about gross things is significant, especially when beautiful things in comparison did not appear to resonate nearly as much as the gross things did. Of the 242 unique conversations that I saw reverberate about the field trip events, 66 of them were in relation to one of these 19 precipitating events that I labeled as gross. In other words, 27% of the residue was about something gross.

Things people see reverberate

The finding that residue is for the most part about physical things is not trivial. Like the purple crocus and the dead bird events, these were conversations about something visible that everyone could see and experience. This means that the students notice and recall physical things rather than stories.

Tools were not needed for the field trips to be memorable. Students could make observations that reverberated without the aid of things like clipboards, cameras, and other devices. Though they may not have had tools in hand, what they did have was a view of the object in question. The concrete wall event was initiated without any tool use and yet still reverberated in follow-up conversations. Although tools may not be necessary for field trip memories to reverberate, phenomena may need to be seen and talked about to reverberate.

Precipitating events tended to be about something physical that could be seen, but not everything that left residue was about something physical that could be seen and experienced in the actual system in which it is embedded. There were two exceptions. The first was an oral history of the forest preserve system given by Mr. H, the river guide, during an introduction at the start of the river field trip. During this event the river was not visible. Using analogies he compared the size of the preserve to the students' homes and conveyed the importance of preservation by relating it to a savings bank. For this precipitating event there was no signaling or a big excitement probably because everyone was already in the same place at the same time. The second exception is similar. Like the introduction it was also a physical phenomena embedded in a story, but the focus of the event was erosion even though what was recalled was an idea embedded in this event. During this interaction a group of approximately 10 students was learning about the effects of erosion. What was recalled was a little story about a van that was driven off the bridge, an example of human-induced erosion couched in this field lesson about erosion. For the most part, what reverberated were actual things that could be seen and felt such as worms, plants, rapids, and rocks. These two exceptions are worth noting because it means that in some instances reverberations can still occur even when the actual thing was never seen in person. Instead, discussing it without actually seeing could have a similar effect as seeing the real thing in person.

What makes residue powerful, as a pedagogic tool, is it was something experienced in the field by many people. There is a collective memory about it. Later on, when these common experiences are accessed during a class discussion a reverberation could serve as a shared touchstone experience around which to organize learning.

An Event that Left No Residue

Worm Discovery (4/25/2011, Bio2a, Narrative summary)

The following example is an event that I did not see reverberate although it could have because it was about a (gross) worm that created a big excitement. It was captured on two researcher cameras, which I synced to Nagel's audio recorder. What is presented below is the narrative summary generated from these multiple, overlapping data sources. Nagel was digging for a worm that he had seen on the first field trip to the courtyard a month prior initiated this event. Once he found a worm to observe, a different event is initiated that created a big excitement.

> Nagel says to her, "Next one is worm. You want to dig?" Renny says she will dig and takes the shovel. "Right now we are getting the worm." He tells others nearby that he is looking for a worm. Then she digs and within seconds they find one. Some students nearby start announcing this discovery. They yell, "Found a worm!" Renny repeats this and says, "Found a worm. Gimee my glove." A few seconds later more students come over including Calvin, who is talking very loud about the worm. A few seconds later, even more students come over. They are talking loudly. "Where is at. Take a picture," Renny states, "Gimee my glove," which she demands because she wants to hold it. She is holding the

worm out on her shovel for others to see. There are eight students gathered around. Clay takes the worm from the shovel and holds it up in front of him. Calvin takes a picture close up. Renny drops the shovel, pushes Arwin out of the way and takes a picture. Calvin says, "Oh, Clay you're in the picture." "Put it on Arwin's tongue. Put it on Arwin's tongue," says Ziva. The students move around with cameras trying to get a closer look. Clay is now holding the worm and saying to the seven other students, "Ooo, it's like doing something." Clay says "it's like flexing." Renny does a little dance move. The worm wiggles and then falls.

Now there are nine students gathered around. Clay observes, "Look! It's bigger on one side." Jedidiah tries to explain, "That is because it is eating. The dirt has to go through its body. That's how it makes soil." Ziva interrupts and jokes, "Ooo it's taking a poopoo." Adara says she wants to see it moving. Clay glances back at the camera and knocks Ziva's palm so the worm comes flying out. The worm falls on the grass. Clay stomps on the worm and then grinds his shoe into the grass and walks away.

While Renny digs for the worm, Nagel looks on over her shoulder, calls out to her, and then they tell their peers nearby about the discovery. They spread this discovery by repeatedly yelling. Then, a group of 10 students congregate on the grass observing this worm. Many had cameras handy and were documenting it and theorizing about it. The students noticed how the worm wiggles as it flexes and they noticed that one end of the worm is larger than the other, which Jedidiah posits has something to do with eating and pooping soil.

I found intriguing how much situational interest this worm generated, surely something all these students have seen up close before. Perhaps the abundance of yelling and signaling raised awareness and excitement.

I was also intrigued by the way Clay abruptly ends the event by knocking the worm from Adara's hand and then stomping on it. It reminded me of the way the dead bird event eventually came to a close when Clay asked Mr. D if he could stomp on the bird's skull to crush it into small pieces.

I did not see residue from this event, which was surprising to me for a two reasons. It had a similar structure as other precipitating events. It was initiated by one student being curious about something in particular, in this case the desire to dig for a worm. Once discovered, through a series of signals, a group of students congregate around the worm. There they observe the worm and enthusiastically share ideas about its anatomy. Another reason why I was surprised I did not see residue from this event was worms had left quite a bit of residue on other field trips, so I would have predicted that this one would have come up in discussion. Considering the number of students who saw this worm and the big excitement it generated I would have expected it to make its way into the classroom.

Reverberating Events are Resources for Learning

When I looked closely at the precipitating events and what happened subsequently in the classroom, during interviews, and on other field trips I found that shared experiences connected these contexts. Precipitating events were initiated with someone noticing something of interest. It is an intriguing feature of the precipitating events that they did seem to follow a similar structure when initiated: initiation, signaling, congregating, sharing and theorizing. This has important implications for the design of field trips because if we see one of these events unfolding, we can flag it by calling attention to it, and then cue this memory later on.

I am making the case that precipitating events are a productive place to focus attention. If we know what kinds of things reverberate, then teachers might be able to predict beforehand what kinds of things would be observed. Furthermore, if we have a sense as to the features of a precipitating event, then teachers can notice them while it unfolds. Knowing what reverberates and seeing an event precipitate in the field will allow for more productive and constructive interactions that are specifically related to the curriculum. It would also provide fodder for follow-up activities that tap these memories.

In the next chapter I present my conclusions. I also discuss limitations with this work and postulate how classrooms and field trips could be best related.

Chapter Six: Conclusion

In this concluding chapter, I first give a brief summary of the findings. Then I discuss limitations, recommendations, and outline potential future directions and implications for the field.

Summary of Findings

The teachers and I were able to carry out the 14 field trips initially planned for, both the ones requiring a bus and the ones close to the school, despite some fairly challenging and unexpected logistical obstacles.

The first research question asked: What happens on field trips? The analysis revealed that on the field trips there is a significant amount of time spent getting to the site and back from it. The special event field trips were particularly time consuming. One-third to one-half the total field trip time was used just for transitioning from place to place. In contrast, the field trips closer to the school took significantly less time to transition to the site and back.

When students are involved in the real work of the field trip, I see groups of students moving independently through a set of tasks in a relatively straightforward way, punctuated by moments of high engagement when groups tend to self-organize around something of interest. When I examined these punctuated moments of high engagement I found them to be especially social and collaborative. During these moments, the students would have their curiosity piqued, signal to others by yelling and screaming, congregate and mix groups, and share ideas and theorize about what they were seeing. I also found that these moments carry forward to other contexts.

The second research question I asked was: What makes some field trip events memorable? In short, the answer to this question is that precipitating events, like those described just above, tended to be remembered. The precipitating events I observed were usually unplanned moments of discovery. For example, the purple crocus event, the dead bird event, and the spontaneous connections made at the rock walls were events that were not anticipated, and which probably *could* not have been anticipated. This means it is hard to know in advance what will be seen and experienced. That said there were patterns in the kinds of things that drew attention. In the outdoor setting, I found that plants, animals, and nests led to vibrant discussions and generated quite a bit of residue. Gross things and more generally things that appeared out of the ordinary sparked a great deal of interest for the students and were especially memorable. This finding has been observed by others, who also find that field trip memories tend to be about things that disrupt expectations (Anderson and Lucas, 1997).

Furthermore, the discoveries of out of the ordinary things would lead students to theorize, to explain something out of the ordinary. We saw this for example with the dead bird when it motivated the students to question how the bird died and propose alternate theories about how it died. We also saw this at the purple crocus flower when conflicting theories about why the petals appeared ripped, torn, eaten or otherwise disturbed. The concrete wall raised a number of questions about why the wall was there in the first place. Upon closer inspection of the wall, the students saw trees growing out of the rocks, which led to a host of theories about how trees grow from rocks and which came first the trees or the wall. It can be argued that out-of-the ordinary observations is what leads to building a congregation, which then provides a resource for collaborative theorizing because there are multiple people with multiple ideas.

Field trips and classrooms are connected by residue, by what is left behind by salient field trip experiences that carry forward to other contexts. I found residue in a variety of contexts: in classroom discussions, laboratories, and presentations as well as during interviews. The reverberations helped create a shared context for other students to chime in and bring in their own experiences. We saw this, for example, with the dead bird and the prior experiences the students drew from as evidence to support their claims about how it died. I found most of the residue in the classroom discussions and activities relative to the other two contexts I observed.

Some field trip events reverberated more than others. This does not necessarily mean these field trip events were more memorable because they generated more residue. Perhaps, I did not see residue stem from some field trip events because there was little time for follow up discussions. Some field trips had months for the field trips to surface in the classroom, while other field trips happened during the last days of the school year before summer vacation. On the other hand, when given space in the classroom to talk about content related to the field trips, the students drew from their field trip experiences. For example, during a classroom discussion following a field trip, when the ripped purple crocus was contrasted with yellow crocus flowers, the question was posed as to why the same flowers appear as different colors. This question expanded into a lengthy 15-minute discussion about genetics and skin color. And although this discussion was slightly a digression from the content learning goals, it shows how a question derived from a precipitating event is traced from the field to the classroom were it is unpacked and deliberated.

The pampas grass is another interesting example when a precipitating event was expanded in the classroom. When it was observed that the “formerly giant plant” was no longer there when the students revisited the courtyard for a second time, the students wondered what had happened to it. Arwin said, “Last time we were here, this was this HUGE plant with seeds everywhere and the seeds flew off it in the breeze. Now, it’s just a series of dead stalks and sticks. Why did people cut it down? We think it’s probably because of the seeds spreading. I mean, that plant is great and all, but it’s huge, and too many of them everywhere would pollute the beauty of the courtyard. It would look terrible. We don’t really know. That’s just our theory. It was in the way.” Ms. H probed, “And what happened when they cut it down? What happened when it was cut down in that right hand picture [referring to the PowerPoint slide image]?” Arwin then surmised, “Oh, more plants could have room to grow.” A student in the class blurted out “because they could see the sun because it's in the same spot.” Ms. H gives space for this discussion by asking the class, “Do you know what kind of plant it is?” She answers her own question as no one spoke up, “It's grass and those [flowers/feathers] are grass seeds and when a plant like that goes to seed is it going to continue, that is what happened. It has gone to seed. Have you ever seen that on your lawn, when it has been really wet or really sunny and you've been on vacation and you haven't cut your lawn as frequently you'll see the actually seed, but this is a giant a giant grass. And when you cut it down it grows back just like grass does. What happens to regular grass that turns brown? Is it dead?” Arwin says, “It's dry.” “Yeah, but what do they tell you?" Oliver says, "The roots are still alive." Yeah, the roots are still alive. Yeah, right," Ms. H validates.

The pampas grass seeds created a big stir, which led students to revisit the same spot when they went to the courtyard for a second visit. There, they noticed that the grass looked different, and this provoked the students to make the observation that the plant was cut down, which they carried into the classroom. A comparison of the grass before and after it was cut sparked a theory that people cut it down to allow other plants to grow (when in fact it was to allow the same plant to grow). This turned into a teachable moment when Ms. H enlightens the class that cutting down grassy plants allows it to grow back more fully because, even though it looks dead and dry, the roots are still alive. The potential to expand on observations in the field, especially ones experienced by many students, is certainly present. The key ingredient is an idea or a theory precipitated on a field trip, which then gets proposed to the class, which in turn can be taken up for further discussion in line with the content learning goals.

I have shown here how the precipitating events actually motivated the students to do some real science in the classroom. These examples of real science are being discussed because they show how field trip experiences carry forward to enrich classroom learning.

There are even examples of students doing real science on the field trips, during precipitating events. For example, a chaperone hoisted up a skull of the maggot-infested possum, and then a large group of students gathered around and questioned what it was. As a group, with the help of the river guide, who recognized the fur, claws, and teeth, they were able to identify the decaying animal. Although doing real science was relatively sparse during the actual precipitating events, with the help of insightful guides and knowledgeable chaperones, it was possible to engage learners in the doing of real science during the field trips.

There are several reasons why I did not see some field trip events come up in class and other contexts. One reason is space may not have been provided for events to be discussed. Another possibility is they did come up but I was not there to see it. Collecting data in two schools meant that I had to make choices as to which classroom I could observe. A third possibility is certain field trip events were not relevant or interesting and were not recalled because they didn't reverberate for the students. Eventually, I plan to know more about the nature of the residue itself, about the form, persistence, and decay of these memories. This could entail a detailed comparison of field trip interactions, classroom discussions, and interviews.

The third research question asked how field trips and classrooms could be best integrated. My position is that increasing reverberations is good because student engagement in the process of science is increased. Students are genuinely interested in participating in the scientific process of making observations, extending from the classroom, expanding in the field, and reverberating back into the classroom. Things people see and talk about tended to reverberate. In fact, residual events did not always require tools, physical artifacts, or specimens to cue memories from the field trips. Although physical tools may not be necessary for field trip memories to reverberate, phenomena may need to be seen and talked about as a congregation in order to reverberate. This suggests that field trip memories are fundamentally socially constructed. Field trips are about seeing things and talking about them. What I saw reverberate in the classrooms and during the interviews were things that were both seen and talked about.

Limitations

I am limited in that my results only extend to the class of field trips I studied and outlined in the opening pages of this thesis. If one studies theatre field trips or graduation trips to the Smithsonian, then these recommendations may not generalize to field trips that are not student directed and situated in the out-of-doors.

One class of limitations is about the data set and methods of data collection. On field trips people are spread out over vast spaces. While my distributed system of coupling audio recorders, Flip Video cameras, and multiple researcher video cameras provided great coverage of the action, it was by no means complete. I do not know what happened for every second for every student and group. I do, however, have a representative sample of the talk and action. The video record and field observations do not offer a complete picture; they are an account of the event, but not the actual event. Much of the richness of the event is lost, but what is gained is a permanent record of a version of the event that can be subjected to continual inspection, viewed and reviewed, and analyzed microscopically, at varying speeds, for the moment-by-moment details of human interaction (vom Lehn, Heath, and Hindmarsh, 2001).

A bigger limitation has to do with the small number of cases I studied. With just two classrooms and 14 field trips, I am limited in the generalizations I can make.

I encountered several challenges collecting data. The Flip Video cameras have poor sound quality, but the bigger difficulty with these pieces of technology was the need to replace the batteries far too often. Even with fresh batteries, the Flip Video cameras ran the batteries down well before the 42-minute class period ended. There were quite a few disruptions just for changing batteries. There was a related limitation to collecting data in this classroom. Overcoming noise issues, as the classrooms echoed, proved challenging as well; conversely, noise was not much of an issue in the field as sound tended to attenuate. Consequently, some of the indoor, small-group work is a little difficult to discern. An additional complication was a handful of students chose not to be filmed or to participate in the study. I avoided recording these students. So for example, during a class discussion, I would not pan the camera over to an area of the classroom that had students who were not consented. This means that I do not always know the speaker. It also means that good portions of the data were not analyzed. On the flipside, the students who were consented comprised a representative sample of the overall gender and ethnicity of the classroom and the school. Lastly, I was only there to observe a fraction of the time the focal units were enacted. Just because I did not see reverberations come up does not mean they were not memorable.

Another set of limitations has to do with the ways the data was analyzed. I placed a strong emphasis on talk rather than on embodied interaction. I did look at the choreography of situations, touch, and other forms of multisensory interaction, but I did not analyze, for example, gestures or the positioning of one’s body in relation to other people. The verbatim record certainly has its affordances because language is thought. At the same time, looking primarily at class discussions and field trip and interview conversations rather than examining the whole situation including the artifacts, gestures, written accounts and sketches, and other non-verbal representations and interactions means I am trading the richness of situation for content.

Lastly, an important limitation is that no reliability tests have been conducted on my analysis. Accordingly, my findings need to be carefully considered.

Recommendations

My analysis took a careful look at what was remembered and recalled because an analysis of field trip events that reverberated could help forecast the kinds of residue to expect. For example, it would be impossible to predict that learners would see a decomposing animal carcass unless it was planted. I may not be able to say the process of decomposition would reverberate because that would depend on whether the students would see a dead or decaying organism. I may be able to say, however, that certain classes of phenomena have a tendency to be pursued, noticed, and remembered. These sorts of events, like the discovery of a decomposing animal could be anticipated, flagged in the field, and subsequently capitalized on or deemed not particularly important.

It might help teachers to know to look for moments of screaming and yelling because these tended to be moments when many people came together to see something. These moments when congregations form might be productive and beneficial for learning rather than off task. This is not to say that these events necessarily leave more residue or are more memorable, but there is reason to believe the events would reverberate, and there is a better chance it could be capitalized on if more people have seen it. It is probably not necessary or even realistic to plan for every minute of the field trip to be conceptually challenging and focused large group activities. If teachers channel talk and give space to students to roam around in small groups, to see things, and to make discoveries, then learning might be enhanced in ways that might not be possible through other means of instruction.

To best integrate classrooms and field trip, moments in the field that create a collaborative situation might need to be channeled rather than dammed. When something out of the ordinary is observed that creates a big stir, notice that groups emerge, listen to the questions posed, and take note of the theories generated. Then, follow these questions into the classroom where they can be reflected on and expanded in line with the science content learning goals.

What I found were that the things students saw and talked about, particularly plants, animals, soil and rocks, nests, and gross, out of the ordinary, things tended to carry forward. In general, mini field lectures did not reverberate. Little moments in the field when guides would tell students about phenomena did not seem to have nearly as lasting an effect as actually seeing that thing in person or when students discovered it for themselves as a large congregation of students. If what could be seen and experienced is a black box and largely unknown, then it is very difficult to design for meaningful experiences. On the other hand, a teacher or field trip guide can't anticipate the actual phenomena that precipitate residue, but it is entirely possible to organize the situation to be responsive to events as they come up. This could look like a spontaneous, guided discussion in the field beside a decomposing animal. Despite the seemingly random and fairly unpredictable nature of the precipitating events, for the field trips I studied there does appear to be patterns in the kinds of things that reverberated.

In terms of design, one could try to rig the field trip so social experiences surrounding out of the ordinary things will tend to happen. For example, a dead bird could be planted in the courtyard. Knowing that it will create a big stir, questions could be anticipated that could channel the students' discussions and theorizing to be more in line with the science content. Alternatively, a teacher could anticipate that out of the ordinary things will be discovered. Once these moments of heightened engagement and participation ensue, the teacher could note the questions and theories (not just the evaluations) and then raise these questions again in a classroom setting where these ideas could be tested and wrestled with.

The richness of the field trip setting creates the challenge of finding a signal through the noise. That is, the task of distilling a great deal of visible information in the field to its relevant science content is a complicated undertaking for learners. Teachers and guides help learners tune to the content if they could know in advance what is of value to students and if they are equipped with tools to observe these things in the field. As a result, field trip and post-trip activities can be designed to maximize these moments of unplanned discovery and high energy. It turned out that student-initiated events were more likely to reverberate than ones the adults initiated. This suggests that the role of adults could be to keep kids on track and focused but not to do the work of making the actual discoveries.

Like teachers, worksheets can function to scaffold learning, to help learners see the signal through the noise (Quintana, Reiser, Davis, et al., 2004; Sherin, Reiser, & Edelson, 2004). Indeed, field trip events are memorable even without inscribing artifacts or making stuff. If no worksheets are provided, then a good teacher or guide can act as a worksheet to capture and enhance experiences that can cue memories later on. The art of teaching (or the function of well-designed worksheets) is to help learners see the relevant content and to progress to new understanding within a productive zone of development (Vygotsky, 1978).

Although I did not often see too many new, profound understandings develop through the field trips, I did see plenty of new connections made and lots of questions posed, questions that were raised again after the field trip ended. However, just because something is memorable does not mean that it holds the potential for deeper understanding. That said the field trips hold the possibility for augmenting curricular content. For example, moments of heightened engagement during events when students signal to each other, mix groups and congregate, share ideas, and raise questions could be flagged and transported back to the classroom where they can be opened up and expanded on further. If teachers could recognize precipitating events, then they could opportunistically plan follow-up activities. If students make discoveries about decomposition, then it might prove productive to provide some scaffolding to capture or record these discoveries in order to help make the connections to the life cycle.

Lastly, in terms of timing, there will be a significant amount of time used for doing things other than science. For example, a significant portion of the field trips, especially the special event bus ride field trips, involve a good deal of time just moving to the site and back again. A recommendation would be to utilize the local environment in order to cut down on time needed for transitioning from place to place. Yet, this raises other questions about the magnitude of a precipitating event in terms of its ability to reverberate. Could it be that more “exotic” locations make a deeper impact?

Future Work

With respect to the data already collected, I have tapped something deep surrounding children's morbid curiosity. I would like to take a magnifying glass to moments that were especially gross, exciting, and engaging and then do a careful comparison with the knowledge drawn upon later.

I would also like to conduct analyses with specific actors in much greater detail than I have done here, looking at interactions across time and place. I would attend to things such as the knowledge the students and teachers draw from, voice prosody, emotions, gestures, artifacts, and processes of constructing the artifacts. I could expand this analysis to look at the full suite of reverberations and compare these moments with interactions that happened in the field. Case studies of focal students and teachers could be generated that would follow them over time. This would be an alternative way to represent the data rather than focusing on the reverberations as the unit of analysis, and it could speak to identity development and learning. It could also add to the conversation of how the objects and individuals' interests in them are related and develop over time.

I have analyzed the Flip video data and there is much to say about what was recorded and how these tools were used. For this thesis I used the Flip Video data to fill in gaps from the researcher cameras. This data set is tremendously rich, and how I used it here only skims the surface. Furthermore, I have quite a bit of additional data such as survey data, written reflections, PowerPoint slides, and other artifacts that have not been analyzed in much detail. I would like to incorporate into the analysis of reverberating events these artifacts, to enrich the data beyond discourse analysis, to account for a more holistic situation. For example, I could connect moments in the field when these artifacts were created with the finished product.

The analysis I carried out was driven by the idea that field trips are memorable. I would like to investigate this idea further. This would entail collecting new data. The best way to carry out this research probably would have been to decide what counts as a precipitating event as the study unfolds. That way I could be tuned to them in the field as they happen rather than months later. This would allow me to interview students about precipitating events the next day to find out just what sticks and what does not.

Another aspect I would like to investigate is the notion of signaling. Part of this could be a design iteration using digital technology that can quickly spread word of a discovery without the need for yelling and screaming, which can be disruptive to other classrooms. Smart phones, which can mark locations, add questions, comments, and audio notes, and geotag locations and photographs, could also be a good way to flag interesting moments in the field and cue memories later on. Smart phones and the use of social networking software such as Twitter could potentially signal to others in the moment about a discovery, particularly when everyone is spread across vast areas. But part of this investigation could test out whether a big excitement can happen without signaling. If signaling is a central process connecting an object and a large number of students, then I want to know how this process works. If signaling were indeed a crucial feature of a precipitating event, then it would mean that reverberations are fundamentally a social phenomenon.

In the long run I want to understand the big picture as to why things reverberate, so I would design the data collection differently. This means I would investigate all kinds of residue, not just specific events related to the science content.

New studies could also aim to discover a more fine-grained resolution of exactly where people went and for how long. Students could wear GPS tracking devices that continuously record their location. Maps could be made that show the flux of people moving across place and over time. Since group dynamics plays a vital role, it would be important to know when and how people move from place to place.

I found that field trips work as touchstone experiences that yield the potential to seed ongoing learning. These touchstone experiences are about real-world phenomena that students can see and experience. It would be interesting to contrast what happens during these kinds of highly engaging situations with comparable ones in the classroom, such as RoomQuake (Moher, Wiley, Jaeger, et al., 2010). One key similarity is the phenomenon is embedded in the actual places where the learning is situated. One important difference is who has ownership over the phenomenon of interest. In the classroom, like in a museum—phenomena have essentially been curated by the instructor—but in the wild, the learners themselves curate their own experiences. In the field, they explore, identify, and construct their own "exhibits." I suspect student directed field trips, like the ones I designed, have a profound effect on how ideas develop and expand over time and place.

Implications for the Field

Perhaps the most significant contribution of this work is the methodological implications. This kind of coupling of audio and video has implications for how data is collected in classrooms as well as in the field, which can both be noisy spaces where the video camera must be positioned many yards from a teacher or student. It also has implications for how we collect data in real-world settings where individuals are spread out over vast stretches of space.

Informal science education is an increasingly predominant theme because of the need to consider learning in contexts beyond traditional classrooms or laboratories (Hofstein & Rosenfeld, 1996; Schauble, Leinhardt, & Martin, 1998; NRC, 2009) and because a great deal of learning happens through participation in human activities that take place outside the “formally prepared educational designs” (Bransford, et al. 2006, p. 35). My research speaks directly to this relationship between informal learning and formal learning environments. I have done some work to map that relationship. I found interesting projections, interesting moments that carry forward from one place to the next, which seem to tap a child’s curiosity for making sense of the world and speak to the benefits of informal education.

Field trips are a meaningful place to begin to develop student interest in science. Memories from precipitating events carry forward to science classrooms and to their lives outside of the classroom. There, they are discussed and occasionally expanded further, with the potential for deep content learning. I believe the kind of student-directed outdoor field trips I investigated are the ideal situation to study a community of learners as they move beyond the classroom to situations that potentially relate more to their personal lives than had they only remained in the classroom to learn the same ideas. In this sense, field trips might be thought of as a “hybrid space” (Gutierrez, Baquedano-Lopez, & Alvarez, 1999; Calabrese-Barton, Tan, & Rivet, 2008), a context that bridges school knowledge and other relevant forms of knowledge to create space for students to hear diverse perspectives and form shared understandings (Moll, Amanti, Neff, et al., 1992). Such an activity space where knowledge is distributed and becomes comingled is an “exceptional informal context in which young people are in control of advancing their own learning…by assembling and coordinating heterogeneous resources” (Bransford, et al., 2006).

References

Allen, S. (2004). Designs for learning: Studying science museum exhibits that do more than entertain. *Science Education*, 88 (Suppl. 1), S17-S33.

Anderson, D. & Lucas, K.B. (1997). The effectiveness of orienting students to the physical features of a science museum prior to visitation. *Research in Science Education*, 27, 485–495.

Anderson, D., Lucas, K., Ginns, I., & Dierking, L. (2000). Development of knowledge about electricity and magnetism during a visit to a science museum and related post-visit activities. *Science Education*, 84, 658–659.

Anderson, D., Kisiel, J., Storkskieck, M., (2006). Understanding teachers' perspectives on field trips: Discovering common ground in three countries. *Curator*, 49, 365-386.

Ash, D. (2003). Dialogic inquiry in live science conversations of family groups in a museum. *Journal of Research in Science Teaching*, 40, 138-162.

Atyeo, H. C., (1939). The excursion as a teaching technique. *Contributions to Education*, No. 761, New York Teacher's College, Columbia University.

Ballantyne, R. & Packer, J. (2002). Nature-based excursions: school students' perceptions of learning in natural environments. *International Research in Geographical and Environmental Education*, 12, 1–19.

Bamberger, Y. & Tal, T. (2008). Multiple outcomes of class visits to natural history museums: The students' view. *Journal of Science Education and Technology*, 17, 274-284.

Becker, H. S. (1972). A school is a lousy place to learn anything in. *American Behavioral Scientist, 16,* 85-105.

Benz, G., (1962). An experimental evaluation of field trips for field trips for achieving informational gains in a unit on earth science in for ninth grade classes. *Science Education*, 46, 43-49.

Birnbaum, S. (2004). Overcoming the limitations of an urban setting through field-based earth systems inquiry. *Journal of Geoscience Education*, 52, 407-410.

Bitgood, S. (1989). Bibliography: School field trips to museums/zoos. *Visitor Behavior,* 412, 11-13.

Bixler, R. D., Carlisle, C. L., Hammitt, W. E., & Floyd, M. F. (1994) Observed fears and discomforts among urban students on field trips to wildland areas. *Journal of Environmental Education*, 26, 24–33.

Bixler, R. D., & Floyd, M. F. (1999) Hands on or hands off? Disgust sensitivity and preference for environmental education activities. *Journal of Environmental Education*, 30, 4–11.

Bouillion, L. M., Gomez, L. M. (2001). Connecting school and community with science learning: Real world problems and school-community partnerships as contextual scaffolds. *Journal of Research in Science Teaching*, 38, 878-898.

Bransford, J., Stevens, R., Schwartz, D., Meltzoff, A., Pea, R. D., Roschelle, J., et al. (2006). Learning theories and education: Toward a decade of synergy. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of Educational Psychology* (pp. 209–244). Mahwah, NJ:Lawrence Erlbaum

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist*, 32, 513-531.

Brown, A. 1992. Design Experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of the Learning Sciences*, 2, 141-178.

Brown, A. L., & Campione, J. C. (1996). Psychological theory and the design of innovative learning environments: On procedures, principles, and systems. In *Innovations in Learning: New Environments for Education* (pp. pp. 289-325). L. Schauble & R. Glaser (Eds.). Mahwah, NJ: Lawrence Erlbaum Associates.

Calabrese Barton, A., Tan, E., & Rivet, A. (2008). Creating hybrid spaces for engaging school science among urban middle school girls. *American Educational Research Journal*, 45, 68-103.

Chamarz, K. (2000). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (2nd ed.) (pp. 509-536). Thousand Oaks, CA: Sage

Chipman, G., Druin, A., Beer, D., Fails, J., Guha, M., & Simms, S. (2006). A case study of tangible flags: a collaborative technology to enhance field trips. Paper presented at the *5th International Conference for Interactive Design and Children* (IDC), Tampere, Finland.

Cobb. P., Confrey. J., diSessa. A., Lehrer, R., & Schauble. L. (2003). Design experiments in educational research. *Educational Researcher*, 32, 9-13.

Cohen, M. R. (1968). The effect of natural small-scale geologic features on the concepts of fluvial geology among fifth and sixth grade children. *Unpublished Dissertation*. Cornell University.

Cole, M., Hood, L., & McDermott, R. (1978). Ecological niche picking: Ecological invalidity as an axiom of experimental cognitive psychology. New York: Rockefeller University, Laboratory of Comparative Human Cognition and Institute for Comparative Human Development.

Cox-Petersen, A., Marsh, D., Kisiel, J., & Melber, L. (2003). Investigation of guided school tours, student learning and science reform: Recommendations at a museum of natural history. *Journal of Research in Science Teaching*, 40, 200 – 218.

Crawford, C. C. (1930). The use of the excursion in teaching commercial geography. *Journal of Geography*, 29, 301-306.

Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F., Goldman, R., et al. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *Journal of the Learning Sciences*, 19, 3-53.

Dewey, J (1922/2002). *Human Nature and Conduct*. Mineola. NY: Dover.

DeWitt, J. & Hohenstein, J. (2010). School trips and classroom lessons: An investigation into teacher–student talk in two settings. *Journal of Research in Science Teaching*, 47, 454-473.

Eaton, D. (1998). Cognitive and affective learning in outdoor education. *Unpublished Dissertation*. University of Toronto.

Edelson, D. C. (2002). Design research: What we learn when we engage in design. *Journal of the Learning Sciences*, 11, 105-121

Edelson, D. C., & Joseph D. (2003). Interest-driven learning: A design framework for motivating active learning (unpublished manuscript, Northwestern University).

Endreny, A. H. (2009). Urban 5th graders conceptions during a place-based inquiry unit on watershed. *Journal of Research in Science Teaching*, 47, 501-517.

Falk, J. (1983). Field trips: A look at environmental effects on learning. *Journal of Biological Education,* 17, 137 - 142.

Falk, J., & Balling, J., (1982). The field trip milieu: Learning and Behavior as a function of contextual events. *The Journal of Educational Research*, 76, 22-28.

Falk, J., & Dierking, L. (1997). School field trips: Assessing their long term impact. *Curator*, 40, 211, 218.

Falk, J., Martin, W., & Balling, J. (1978). The novel field trip phenomena: Adjustments to novel settings interferes with task learning. *Journal of Research in Science Teaching*, 15, 127-134.

Goffman, E. (1981). *Forms of Talk*. Philadelphia: University of Pennsylvania Press.

Gottfried, J. (1979). A naturalistic study of children's behavior during field trips to a free-choice learning environment. *Unpublished dissertation*. Berkeley: University of California.

Gottfried, J. L. (1980). Do children learn on school field trips? *Curator*, 23,165-174.

Griffin, J., & Symington, D. (1997). Moving from task-oriented to learning-oriented strategies on school excursions to museums. *Science Education*, 81, 763–779.

Gutierrez, K., Baquedano-Lopez, P., & Alvarez, H. (1999). A cultural-historical approach to collaboration: Building a culture of collaboration through hybrid language practices. *Theory into Practice*, 38, 87–93.

Gutwill, J. P., & Allen, S. (2011) Deepening students' scientific inquiry skills during a science museum field trip. *Journal of the Learning Sciences*. First posted on: 25 January 2011.

Hall, R. (2000). Videorecording as Theory. In A. E. Kelly and R. Lesh (Eds), *Handbook of*

Research Design in Mathematics and Science Education, Mahwah, NJ: Lawrence Erlbaum Associates, 647- 664.

Harvey, H. (1951). An experimental study of the effect of field trips upon the development of scientific attitudes in a ninth grade general science class. *Science Education*, 35, 242-248.

Hattie, J., Marsh, H. W., Neill, J. T., & Richards, G. E. (1997). Adventure education and Outward Bound: Out-of-class experiences that make a lasting difference. *Review of Educational Researcher*, 67, 43-87.

Heath, S. B. (1996). “It’s about winning: The language of knowledge in baseball.” In L.B. Resnick; J.M. Levine; and S.D. Teasley (Eds.). *Perspectives on socially shared cognition.* Washington, DC: American Psychological Association.

Hidi, S.a& Harackiewicz, J. M. (2000). Motivating the academically unmotivated: a critical issue for the 21st century. *Review of Educational Research*, 70, 151-179.

Hofstein, A., & Rosenfeld, S. (1996). Bridging the gap between informal and formal science learning. *Studies in Science Education*, 28, 87-112.

Hollenbeck, I. (1958). A survey of outdoor science experiences of college freshmen in Oregon. *Science Education*, 42, 219-224.

Hutchins, E. (1995). How a cockpit remembers its speed. *Cognitive Science*, 19, 265- 288.

Jarvis, T., & Pell, A. (2005). Factors influencing elementary school children's attitudes toward science before, during, and after a visit to the UK National Space Centre. *Journal of Research in Science Teaching*, 42, 53-83.

Kern, E.L., & Carpenter, J.R. (1984). Enhancement of student values, interests, and attitudes in earth-science laboratory through a field-oriented approach. *Journal of Geoscience Education*, 32, 299-305.

Kern, E.L., & Carpenter, J.R. (1986). Effect of field activities on student learning, J*ournal of Geoscience Education*, 34, 180-183.

Kisiel, J. (2003). Teachers, museums, and worksheets: a closer look at a learning experience. *Journal of Science Teacher Education*, 14, 3-21.

Kisiel, J. (2005). Understanding elementary teacher motivations for science field trips. *Science Education*, 89, 936–955

Kisiel, J. (2006). An examination of fieldtrip strategies and their implementation within a natural history museum. *Science Education*, 90, 434-452.

Kitts, K., Perry Jr., E., Leal-Bautista, R. M., & Velazquez-Oliman, G. (2009). Geological field experiences in Mexico: An effective and efficient model for enabling middle and high school science teachers to connect with their burgeoning Hispanic populations. In S.J. Whitmer, D.W. Mogk & E.J. Pyle (Eds.), *Field Geology Education: Historical Perspectives and Modern Approaches*. GSA Special Paper 461, 275-289. Boulder, CO: Geological Society of America.

Kuhn, A., Cahill, C., Schmoll, S., Pompe, A., & Quintana, C. (2010). Zydeco: using mobile and web technologies to support seamless inquiry between museum and school contexts. In Proceedings of the 9th International Conference on Interaction Design and Children, *ACM*, 3370-3378.

Lee, C. D. (2008). The centrality of culture to the scientific study of learning and development: How an ecological framework in education research facilitates civic responsibility. *Educational Researcher*, 37, 267-279.

Louv, R. (2006). *Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder*. Algonquin Books: Chapel Hill.

MacKenzie, A. A., & White, R. T. (1982). Fieldwork in geography and long-term memory structures. *American Educational Research Journal*, 19, 623-632.aa

Margulis, S. W., Reiser, B. J., Dombeck, R., Go, V., Kyza, E. A., & Golan, R. (2001). Behavior matters: Involving students in scientific investigations of animal behavior. Paper presented at the annual meeting of the National Association for Research on Science Teaching, St. Louis, MO.

McManus, P. M. (1985). Worksheet-induced behavior in the British Museum. *Journal of Biological Education*, 19, 237-242.

Mason, J. L. (1980). Annotated Bibliography of Field Trip Research, *School Science and Mathematics*, 80, 155-166.

Moher, T., Wiley, J., Jaeger, A., López Silva, B., Novellis, F., (2010). Spatial and Temporal Embedding for Science Inquiry: An Empirical Study of Student Learning. Paper presented at the *Ninth International Conference of the Learning Sciences*, Chicago, Illinois.

Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: A qualitative approach to connect homes and classrooms. *Theory Into Practice*, 31, 132–141.

National Research Council. (1996). *National Science Education Standards*. Washington DC: National Academy Press.

National Research Council. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*. Washington DC: National Academy Press.

Nundy, S. J. (1999). The fieldwork effect: The role and impact of fieldwork in the upper primary school. *International Research in Geographical and Environmental Education*, 8, 190-198.

Orion, N. (1989). Development of a high school geology course based on field trips. *Journal of Geological Education*, 37, 13-17.

Orion, N. (1993). A model for the development and implementation of field trips as an integral part of the science curriculum. *School Science and Mathematics*, 93, 325-331.

Orion. N., & Hofstein, A. (1991). The measurement of students' attitudes towards scientific field trips. *Science Education*, 75, 513-523

Orion, N. & Hofstein, A. (1994). Factors that influence learning during a scientific field trip in a natural environment. *Journal of Research in Science Teaching*, 31, 1097-1119.

Orion, N., Hofstein A., Tamir, P. & Giddings, G. (1997). Development and validation of an instrument for assessing the learning environment of outdoor science activities, *Science Education*, 81, 161-171.

Orr, D. (1994). *What is Education For? Earth in Mind: On Education, Environment, and the Human Prospect*. Washington, D.C., Island Press.

Price, S., & Hein, G. (1991). More than a field trip: science programmes for elementary school groups at museums. *International Journal of Science Education*, 13, 505-519.

Quintana, C., Reiser, B.J., Davis, E.A., Krajcik, J., Fretz, E., Duncan, R.G., Kyza, E., Edelson, D., & Soloway, E. (2004). A scaffolding design framework for software to support science inquiry. *The Journal of the Learning Sciences*. 13, 337-386.

Rennie, L. J. (2007). Learning science outside of school. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of Research on Science education* (pp. 125 – 167). Mahwah, NJ: Erlbaum.

Rennie, L. J., & McClafferty, T. (1995). Using visits to interactive science and technology centers, museums, aquaria, and zoos to promote learning in science. *Journal of Science Teacher Education*, 6, 175-185.

Rogers, Y., Price, S., Fitzpatrick, G., Fleck, R., Harris, E., Smith, H., Randell, C., Muller, H., O'Malley, C., Stanton, D., Thompson, M., & Weal, M. (2004). Ambient Wood:

Designing new forms of digital augmentation for learning outdoors. *In Proceedings of Interaction Design and Children, ACM*, 1-8.

Schauble, L., Leinhardt, G., & Martin, L. (1998). A framework for organizing a cumulative research agenda in informal learning contexts. *Journal of Museum Education,* 22, 3–8.

Schoenfeld, A. H. (1999). Looking toward the 21st Century: Challenges of educational theory and practice. *Educational Researcher*, 28, 4-14.

Schoenfeld, A. H. (2006). Design experiments. In P. B. Elmore, G. Camilli, & J. Green (Eds.), *Handbook of Complementary Methods in Education Research* (pp. 193-206). Washington, DC & Mahwah, NJ: American Educational Research Association and Lawrence Erlbaum Associates.

Sharp, L. B. (1943). Outside the classroom. *The Educational Forum*, 7, 363-368.

Sherin, B., Reiser, B. J., Edelson, D. C., 2004, Scaffolding analysis: Extending the scaffolding metaphor to learning artifacts, *Journal of the Learning Sciences*, 13, 387-421.

Sobel, D. (2004). *Place-Based Education: Connecting Classrooms and Communities.* Great Barrington, MA: The Orion Society.

Sorrentino, A. V., & Bell, P. (1970). A comparison of attributed values with empirically determined values of secondary school science field trips. *Science Education*, 54, 233-236,

Spradley, J. (1980). Participant Observation. Orlando: Holt, Rinehart, & Winston.

Stevens, R., & Hall, R. (1997) Seeing tornado: How VideoTraces mediate visitor understandings of (natural?) phenomena in a science museum. *Science Education*, 81, 735-748.

Stevens, R. & Toro-Martell S. (2003). Leaving a trace: Supporting museum visitor interaction and interpretation with digital media annotation systems. *The Journal of Museum Education*, 28.

Stokes, A. & Boyle, A. (2009). The undergraduate geoscience fieldwork experience: influencing factors and implications for learning. In S.J. Whitmer, D.W. Mogk & E.J. Pyle (Eds.), *Field Geology Education: Historical Perspectives and Modern Approaches*. GSA Special Paper 461, 291-311. Boulder, CO: Geological Society of America.

Tal, T., & Morag, O. (2007). School visits to natural history museums: Teaching or enriching? *Journal of Research in Science Teaching*, 44, 747-769.

Tunnicliffe, S. D., Lucas, A. M., Osborne, J. (1997). School visits to zoos and museums: A missed educational opportunity? *International Journal of Science Education*, 19, 1039-1956.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, 54, 1063-1070.

Wiley, D., & Humphreys, D. W. (1985). The geology field trip in ninth-grade earth science. *Journal of Geoscience Education*, 33, 126-127.

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Appendices

Appendix A: Schoolyard Geology Lesson (ES1a and ES2a)

Field trip purpose

- Be educational and fun experience doing science in everyday places
- Foster understanding about minerals and soil formation phenomenon as part of the rock cycle (weathering of rock into smaller components)
- Interest students in schoolyard history, source of materials at site (rocks, soil)
- Investigate minerals in schoolyard (or neighborhood) by observing, finding describing, collecting rocks and soil (i.e., things made of minerals)

Orienteering

- Pass out maps of schoolyard. Project map on white board using Google earth. Discuss features, boundaries of field site.

Predicting

- What will I find in my schoolyard made of minerals (soil, rock, etc.)?

Task

- In teams of four to six, find different examples of soil and rock samples in the schoolyard (i.e., things containing minerals).
- Make observations about location where sample was found.
- Locate and mark on map.
- Collect some soil and rock samples for analysis in class.
- If different kinds of rock samples are hard to find, then dig down a little bit and collect some soil and rock specimens

Tools

- Clipboards, maps, colored pencils, paper, 4 journals, flip cameras, hand shovels/augers, sample bags, hand lens

Post-Visit Possible Discussion Prompts:

- What do you see?
- How did you feel on the field trip?
- Did anything surprise you? If so, what?
- What did you like or dislike?
- What do you remember?
- What was challenging or frustrating?
- What could have made the trip better?
- What were some questions that came up for you?

- Did you notice any differences in what is living in the forest beside the river with what is living in the banks?
- What was the point of this field trip?
- What is soil?
- Where will you find rocks, minerals, and soil in the schoolyard?
- Where did it come from? Where will it go?

<u>Learning Objectives: From textbook (**bold** are ones connected to this field trip)</u>

- Minerals (How can minerals be separated?)
  - **Explain how to identify minerals by their properties**
  - Classify some common minerals according to their hardness by doing an experiment
- Rocks (How long will rocks remain as they are?)
  - Identify three types of rocks (how are they similar/different)
  - **Explain how one type of rock can change into another**
  - Tell how common each rock type is in the Earth's crust
  - Design a system for classifying rocks in an experiment
- Soil (How is rock related to soil?)
  - **Describe how mechanical weathering breaks down rocks**
  - Explain how chemical weathering breaks down rocks
  - Identify the factors that affect the rate at which weathering occurs
  - Identify variables in an experiment about rust formation
  - **Explain what soil consists of**
  - **Know that surface soil consists of approximately 5-10% organic matter; Explain how the other 90% of soil is comprised of minerals, rocks, air, and water (<u>New learning goal</u>)**
  - **Describe how climate and landforms affect a soils' characteristics**
  - **Recognize how the activities of organisms affect a soil's characteristics**

<u>What students were provided</u>

- To understand how soil is made?
- To see what's in the soil in my schoolyard.
- To observe, collect, locate soil in the schoolyard
- To identify patterns in what's in the soil in my schoolyard and where it is located.

<u>Goal for the schoolyard field trip</u>

- Collect 3 samples of soil from near the surface and at least 1 sample deeper in the ground, noting where you found it on the map.

- Make careful observations and ask questions about the soil, what you see, and the local environment where you found it.
- The soil and your questions and observations will be used in class to help us better understand how soil is formed.
- Use hand shovel and gloves to dig in the earth and collect at least 3 small bags of soil from different places around the schoolyard.
- Collect at least 1 soil sample using the tool that you can push into the ground.
- Mark on a map name and location from where sample was collected
- Label bag with unique sample name.
- Write any questions you have about this soil sample on the bag, before you put anything in the bag
- Describe as best you can what the soil looks and feels like
- Carefully observe the environment where you found the soil
- Carefully observe what you see in the soil

<u>Soil Sample Prompt Questions</u>

- Your mission is to find different kinds of soil in Thordyke's backyard.
- Describe the soil you have found
    - Color
    - Things you see in it
    - Moistness
    - Any living things

- Where did you find it, what was near by?
- How deep did you dig?
- List two questions you have about this soil, write them on the bag.

Thorndyke Academy Schoolyard Map

Appendix B: Courtyard Exploration (Bio1a, Bio2a, Bio3a)

Essential Question

How do things survive and thrive?

Goal

Make careful observations, discuss in pairs, and pose questions together about living things, the courtyard environment, and relationship among living things and between living things and the environment.

The essential question you are trying to understand is how do things in the courtyard survive and thrive. To help you understand this is you will be collecting evidence or information by taking photos, making notes, posing questions and coming up with ideas about living things and their relationship to the environment and to one another.

Examples of environmental factors: Water, Soil, Rock, Light

Organisms include living things or once living things

Task

Your task is to make careful observations about things in the courtyard because these observations will be used in class to help explain how things in the courtyard survive and thrive. With your partner you will make careful observations with all your sense and with the cameras and magnifying glasses. Your observations will be about the environment in the courtyard. You will be making observations and asking questions that will be seeds for discussion in the classroom after the field trip.

To better understand how things survive and thrive, you will be investigating living things and their relationship to the environment.

In pairs, you will be making observations and asking questions about 20 things of your choosing. From these 20 things, you will pick 3 things that you found most interesting, important, or puzzling. You will create a caption for these 3 photographs.

- Stand at either end of the courtyard and take a picture of the entire space. Think about the size, shape, color, and location of things that you see.
- Walk around the courtyard looking very carefully for "organisms" and for "environmental factors."
- When you find something interesting, important, puzzling, inspiring, and about living things and their relationship to the environment:
    - Talk with your partner about why you want to take a picture of what it is that you see.
    - Together, write down at least one thoughtful question about it.
    - Use the numbers on the key ring to take a picture of that number so it matches your question and the photo of what it is that you are capturing.
    - For every picture you take that has a number attached to it, you will need to mark on a map the number corresponding to that picture.

<u>Post-Trip Discussion Sample Prompts</u>

- What was the point of the field trip to the courtyard
- How did you feel on the field trip?
- Did anything surprise you?
- What do you remember?
- What was challenging or frustrating?
- What were some questions that came up for you?

- What did you find? Why did you find it where you did? How are living things in the courtyard surviving and thriving?
- If you could change something to improve your experience what would you do different the next time?

Worksheet Table to Record Observations

Photo #	What it is you observed	Questions
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

PowerPoint Activity

From the 20 photographs and observations you made, choose 3. For each of these 3 sets of observations, write a short statement (in 50 words or less) explaining what you observed and why. These 3 brief statements will be shared with the class during your presentation. Think of them as captions to your photographs.

Photo #	Photo Caption (in 50 words or less)

Follow Up Courtyard Field Trip Activity Revision (Bio1b, Bio2b, Bio3b)

Look all around, up in the sky, in the trees, in cracks, on leaves, in dirt…be very careful observers. See if you can find Look for living things and how they are related to the environment. In your presentation you want to explain either one set of things in the courtyard (Why they are all there) or different parts of the courtyard (and why they are in different places).

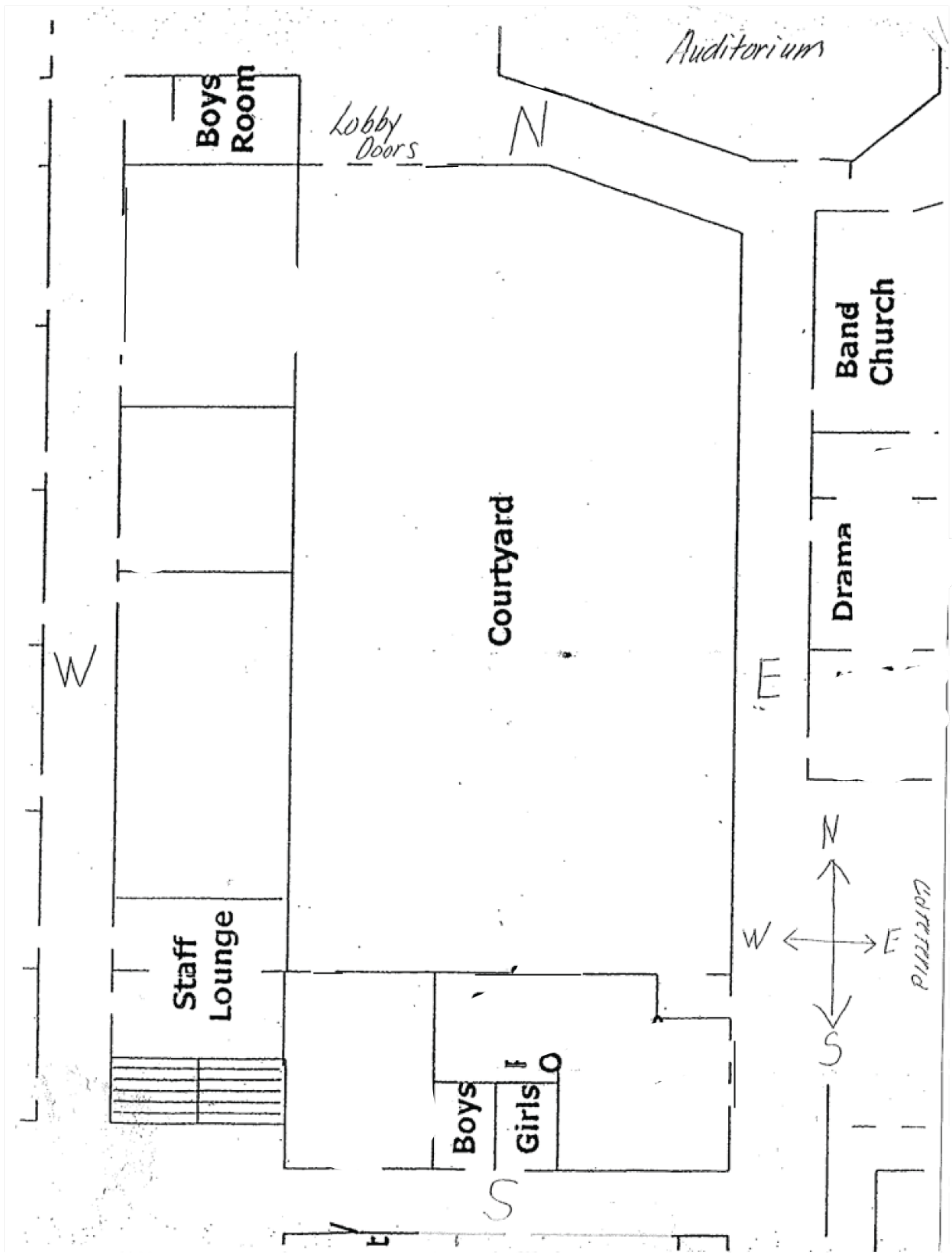
Why does it make sense that you would find this right here? Would you expect to find this anywhere else in the courtyard?

Why would you find this here? Why is this living here? Not thriving here? Relating this to environment.

PowerPoint Activity Revisions for Second Courtyard Visit

Pick 3 pictures from the same place or different places. Write a caption for each one that explains why those things might be found in that area. In your explanation you will need to mention at least one thing in the environment that is related to that living thing. For example, we found flowers mostly in this area because there is better soil and it gets more sun. Additionally, you may choose to put two pictures in your PPT; however, you may only do so if both pictures are related. In your caption you will need to say how they are related.

Courtyard Map



Original Courtyard Exploration Activity Drafted by Ms. H

Team Members ____

COURTYARD EXPLORATION #1

Take photographs to help answer your questions. Use the numbers on the key ring to take a picture of the number that matches your question and the photo you are taking. Then take a photo or photos that document your written answer. You do not need to answer the questions in order. Written documentation for each question and photo must be provided. You may not find the answers to all the questions, but do the best work that you can!

1. Describe the environment in the courtyard. Include descriptions that include size, what manmade things you see, what natural things you see. Stand at either end of the courtyard and take a picture of the entire courtyard.

____
____
____
____
____
____
____
____

2. Find any evidence of a change of seasons. Describe and photograph those changes.

____
____
____
____
____
____

3. What evidence of animal or insect life can you see? Photograph this evidence. Do you see the animals or insects? If so take a picture.

4. What signs of erosion (some destruction of the ground by water – either dirt or concrete) do you see? Describe and photograph the evidence.

5. Photograph a branch and describe what you see in detail.

6. Find a plant that is beginning to sprout. Take a photo, note its location, and describe what you see. You will take a picture of this plant the next time we come out to observe.

7. Find a leaf or needle pattern. Photograph it and describe the pattern below.

8. Find an example of decomposing material. What is it? Photograph and describe it.

9. Find an example of damage to the environment caused by humans. Photograph and describe it.

10. Find an example of damage to the environment not caused by humans. Photograph and describe it.

Appendix C: Chicago River Environments

Learning Objectives

- To carefully observe various river environments (river, banks, forest)
- To compare environments in the river to environments outside the water
- To generate questions and observations about relationships among living things and the environment and about differences between optimal and preferred environments

Activities

Observation and Reflection Station (Whole class)	30 min
Station 1 (Aquatic Habitats): Life in the river (15 students)	45 min
Station 2 (Terrestrial Habitats): Life beside the river (15 students)	45 min

Field Trip Schedule

9:00	Board bus and drive to Forest Preserve
9:30	Introduction from Mr. H about river habitats, Chicago River, objectives of field trip, rules, overview of the days activities
9:45	ACTIVITY 1: Whole class walks to woods for observation and reflection
10:15	Sharing observations as a whole group
10:25	ACTIVITY 2: Group A at Station 1 and Group B at Station 2
11:15	Lunch and Free Play
12:15	ACTIVITY 3: Group A at Station 2 and Group B at Station 1
1:05	Gather and share out observations
1:30	Bus returns to West Elementary
1:50	Arrive at West Elementary

9:00AM. On bus ride ask students to pay attention to where the bus is going. What do they notice about the landscape that is similar and different from the environment right around the school.

9:30 AM. Short introduction to the field site, students will be led to the river where we will have the first activity. Motivate activity to be about becoming careful observers and using senses, intuition and whole bodies

9:45AM Activity 1. Pass out paper, clipboards, pencils, etc. Walk the whole group to the forest. Instruct students that they will be reflecting on the environment by making careful and quiet observations about the river and the river habitat. The two activities planned are about making careful observations because by being a careful observer we can better understand how the world works. This is a mostly individual activity, at least initially. Students are to find a comfortable place to be, no less than 10 feet from someone else. Have the students be perfectly quiet for anywhere from 1 minute to 15 minutes (or more).

Encourage students to stay in the present, to use their senses, and to focus on their feelings (are they feeling peaceful, anxious, happy, sad, etc.). While they are working have them journal, draw, write a letter, or write a poem in their journals about how they are feeling and experiencing the environment. Here is a prompt "...gather your eyes, take a deep breath, and ask yourself: 'What is happening outdoors, this particular season, this time of day, and in this particular place where I live?'...Be very quiet, be still.

After everyone has made some observations in their journal (some students will be wandering a bit by this point), gather everyone together and walk up to the grass by the tree and facilitate a group share out. Ask students to share one observation and/or one question that came up for them.

10:25AM Activity 2. Group A goes to Station 1 and group B to Station 2.

11:15AM Lunch. Eat lunch by trees. Provide sports equipment for students to play.

12:15PM Activity 3. Switch groups, so now B is at Station 1 and A is at station 2

1:05PM. Gather group and facilitate a group share out. Ask: How did you feel on the field trip? Did anything surprise you? What were some questions that came up for you? Did you notice any differences in what is living in the forest beside the river with what is living in the banks and in the water.

1:30PM. Begin to board bus to head to King Lab

Station 1 (Aquatic): The goal of this activity is to see what's living in the banks and under rocks in the river.

In pairs, one student will wear hip waders and use a D net to scoop mud and filter it in the water. Collect organisms and place them into a tray.

Students' task is to find living things in the river, to identify them, and to reason about where they found them (by roots, under rocks, in mud, in the current, etc), and importantly to raise questions about them. Each pair can identify by matching them using the laminated cards Mr. H provides, before returning to the river to collect more specimens. *Students describe where they found the living things and to see if any patterns were found in where these living things were found. Push students to talk about relationships between living things and the physical environment. Ask students where organisms prefer to live and why.* Partway through activity, pairs can switch roles. At the end of the activity all organisms get counted and identified and water quality score for the river assigned. Students interpret meaning of this value and talk about why it's important to determine what quality and what affects it.

Station 2 (Terrestrial): The goal for this station is to make careful observations about a terrestrial ecosystem and to think about how living things survive on land.

Each pair of students gets a 3 foot diameter rope loop, graph paper with a large circle drawn on it, a clipboard, and a bucket of observational tools (colored pencils, hand lens, tape measure, shovel, gloves, sample bags, etc). Instruct students to be very careful observers and not to let any detail go unnoticed.

Students task is as best they can to represent what they see inside the loop using the graph paper. The drawings need to be careful enough so that one of their peers could make sense of the drawing. They can begin by drawing a circle on paper. What they draw and include will need to be careful enough so that another group can use this "map" to make sense of what is inside your loop. Students can include anything they want that is inside rope perimeter.

To begin one student from each pair will close their eyes and gently toss the hoop to a location of their choosing. For the first 20 minutes of the activity students in pairs will be finding and sketching in the circle as many different things they see inside the loop. They will be drawing them and labeling them on their clipboard. They can make a legend if they wish. Explain that they don't have to know the names of the things they see. For example, they can make up names for each type of plant if it makes it easier to tell them apart.

Then, after about 20 minutes of working in pairs, each pair of students will swap clipboards with another pair. They will walk over to this other pair's rope loop and continue making observations at this rope loop with the drawing made by another pair. Using another pair's loop drawing, students try to find the things located in the drawing (careful not to move the rope loop). Students could choose to make revisions, additional, modifications, etc. to that drawing to make the representation better their image of it. If they have questions they can write them down on an additional sheet and then ask them when we regroup.

For last 15 minutes, gather all the students and the clipboard drawings. Lead a short discussion about similarities and differences across groups in terms of what was found and the challenging task of representing it on paper. What did they find the most of, the least of. Were there any major similarities within rope loops and differences across rope loops, if so what? What was hard or easy about using someone else's drawing as a guide to interpret the landscape? What were some strategies students used to identify things they found either on the maps or on the ground and when using someone else's work.

In class discussion following the river field trip (30 minutes)

- After the trip, students will be making sense of their observations and questions. Discussion could begin with some of these possible discussion prompts.
    - How did you feel on the field trip?
    - Did anything surprise you? If so, what?
    - What did you like or dislike?
    - What do you remember?
    - What was challenging or frustrating?
    - What could have made the trip better?
    - What were some questions that came up for you?
    - Did you notice any differences in what is living in the forest beside the river with what is living in the banks?
    - What was the point of this field trip?
    - What will the river environment be like in the future? How will change?
    - If students collected anything from the river, what did they collect, why, and what did they observe?

- What is similar or different about the river environment to the courtyard here at school?
- How are living things in this river environment able to survive and thrive?
- Where do living things in this environment get their food? For plants? For animals?

Appendix D: Focal Student Vignettes

Overview

Of the 25 focal students I observed and interviewed, I narrowed my analysis to eight focal students for whom I have a fairly complete data record. For instance, two cousins missed the last weeks of school because they went to visit family in Ethiopia, so these two focal students were not able to attend the special event field trips or complete the Post-Interviews. I have a nearly complete record from two students from ES1 (John and Judy) and three students from Bio1 (Maddy, Manuel, and Flanna) and Bio2 (Chloe, Evan, Jacob). The following vignettes are snapshots of what these students experienced and remembered about the field trips, which I illustrate with excerpts from the interviews.

John

In class and on the field trips, John was chatty. He primarily interacted with his group mates, four other boys. He regularly participated in whole class discussions, offering ideas and insights. He was an active participant on the field trips, as well. He was given detention when he was talking over the teacher and not on task during a lab. In class, John is soft spoken, playful, and followed directions. He rarely asked questions. He wore an orange Bears hoodie often. John liked going into the water to hunt for bugs. He seemed to grasp that soil was a big focus of field trips.

John recalled the first field trip to the schoolyard, which “was pretty cool. We got to go around and pick up soil and then we brought it back here and we examined it to see if it had any like plants or roots or like little like animals like worms or something.” He thought it was cool “because we really don't get to do that much stuff like that like we don't get to go to field trips and do stuff. Like actually. We just mostly just go to field trips and just look at stuff, but now we go to field trips and do stuff. Like actually examine stuff like that.” He felt that examining the soil went well because they got to “look inside” and “we smashed it up and we like we broke it up into two sections to see like which one, like a pile which is like the one that has plants and stuff in it and the other one that's more soft and another one that is like more grittier. Something that's hard.”

John is a team player. While digging in the schoolyard, he made sure that everyone had a chance to switch jobs and have a chance to dig so the people who weren’t digging “wouldn't feel that bad. So they can actually dig, get a chance to dig.”

Experiencing the difficulty of digging was a memory John used to constrain his thinking about why the soil was different colors. John recalled from this initial field trip that the orangish soil came from the baseball field. He remembered that it was hard to dig deeper and he also remembered that the soil changed color with depth. “Carne was trying to dig it and then it seems like it was more harder to go down maybe because I don't, maybe because it was harder soil because this soil was, it wasn't brown like the other kinds, it was yellowish kind of and it was more soft. Yeah” He observed that the yellowish soil is soft but digging down deeper the soil is brown and hard.

He remembered the second field trip to the river. On that trip John recalled “three things we would do: we would, the first of them was pick up soil just like we did in the school yard so SSS picked up soil near the river and then we came back to compare them to see how different and similarities they were. And then the other section was you would go into the river with these boots on and then you would try to find some insects and bugs or something that you find in there. And then the third group was you would go to uh like uh like where trees are, it's kind of like a little forest or something and then you would get a paper, and then you would write like what you see. And what you smell. What you see, smell, touch, feel, and hear. Yeah.” The day at the river went well for him. “I mean we got to look for bugs and we got to actually go inside the river and walk in it.” He especially liked “looking for bugs because I didn't really think there would be that many bugs in the river and how there'd be rolly pollies in the river. I would just think they would just drown. Some of them didn't.”

He saw the reason for the first and second field trips “to just see how different soils there are and see, yeah see how different soils are because we got like uh three soil bags and then we got three soils and we just like looked at them and then some of them were different colors, just to see how different they were.” He wasn’t sure what was the point of the field trip around the neighborhood.

The third field trip to the neighborhood, John remembered it as a time “when we walked on the trains.” He also remembered “We went around the neighborhood of the school and then we saw different cracks on the on the sidewalk and we tried to uh predict what, what might have happened to the sidewalk because the sidewalks went straight and part of it was kind of upwards like that [hand motions up] so we predicted how that happened. And then and then we went underneath the train tracks and then we, there was water coming down from part of the train tracks where the metal parts or something, they would keep the trains from coming down, that, why was it leaking maybe? And then we predicted uh how, how um, how the sediments and we went up this hill where there's uh rocks and something. And then we predicted how could it move, how could the rocks come from on top all the way to the bottom. And then we, we predicted that maybe it was the weather, maybe the rain like just went on it and then it just fell down the river all the way to the bottom. And that's all we did."

At one point on the neighborhood field trip John played a critical role in helping make a profound connection. He noticed trees growing out of the side of the train tracks and was reminded of the trees he saw growing out the concrete flood wall at the river. When he told his friend about it, his friend shared this connection with the teacher, who in turn prompted a spontaneous teaching moment. Immediately following this discussion about how rocks break apart, John and several other students walked up to the concrete wall and they enjoyed messing around with these bits of flaking rock.

Judy

Judy is fairly talkative in class and participated often. She likes doing laboratory activities in science class. She says she learns better by doing, talking, and experiencing things in person rather than just by listening or looking at pictures. She wore stylish clothes. On the field trip to the river she brought her own boots, which afforded her extra time in the water, yet these thin boots also caused discomfort. She complained a lot on the field trips, particular about getting dirty and feeling cold. She joked a lot about catching “hypothermia.” She was especially cold on the trip to the schoolyard. When the wind picked up she shared her knowledge of wind chill and helped motivate her group to hang out inside a playhouse where she thought they would feel warmer. Judy often described things she saw as nasty, disgusting, and gross. Sometimes she was critical of her peers, for example, the time when John was curiously touching the rock wall on the third field trip she mumbled to her friend that John was acting like a five year old boy. After Spring break Judy was not back at school because she was on an extended holiday in Mexico.

When asked about the first field trip, Judy recalled the fall trip the sixth graders took to the Museum of Science and Industry. She said she could remember all the field trips but just not the order they were in. When guided toward the schoolyard field trip, she remembered “collecting soil samples...and then we studied them and compared them from which places they came so. We did labs on them and that was basically it.” The video stimulated her memory of a worm that they had found on the field trip. “We found a worm in the soil and they were grossed out about it. Because it was a worm and it was living. And I thought they were killing it...because you know soil is, the worm is surrounded by soil all day. And I didn't really think it needed air I'm not really an expert on worms but um yeah I didn't think they were killing it, um I don't know it was dead later. It was kind of nasty.” She recalled working with the soil in the lab. When they opened up the soil sample and “checked up on it again after like 3 or 4 days,” they discovered it had died because “worms eat soil to survive.” She deduced that the soil in the bag was not sufficient for it to live. Later in the interview, Judy shared her observation that they tended to find more worms deeper in the soil, where the soil was moister.

Judy thought the field trip to the river was “fun” because it was a special experience and because she learned new things. “Well normally you don't go to the river. We don't normally do that so that was special. I didn't even know it existed. That area um...I thought I only knew the part of the Chicago River that went through downtown Chicago. I'd never thought that it went anywhere else. And um well it was fun to go in the river and um and like scoop out the animals um. And I liked the nature hike where we saw the weathering rocks and stuff. So that was fun yeah.” When she elaborated as to why it was fun she said “because “it was just different from school because it's a lot less boring. School is pretty boring and that was not...[in school] we do basically the same thing everyday just sitting in our desks and working on paper. We don't do as many labs as I wish we could so.” She said the difference between a river field trip and learning in a classroom is “I actually work better when I talk because I get very distracted when I'm not talking and I start looking at things around the room and don't do my work.” She thinks being silent is boring. That said, she doesn’t think that in Mr. R’s classes she had to be silent.

There was particularly high or low point on the schoolyard trip. Judy enjoyed going into the river, but didn’t like “working on worksheets in nature because they were too hard, they were extremely hard because I had to find too many examples that I couldn't find with different things.” This reflection activity made her feel “confused” which was a low point. The kinds of things she was looking for but didn’t find were “different animals...dead trees, a couple leaves, and some dirt. Since she “didn't see any animals or anything so it was just plain and boring.”

Judy understood the point of the first trip two field trips “to collect soil samples so that we could study them.” She was studying them to “look for animals, living things, we were looking for um you know how the location affects their moisture or what type they are if you know color, how it's related to other things in soil. So we were looking at what causes what to happen with soil. What causes its properties and stuff." She elaborated a bit on the second field trip to the river, which had the added purposed of collecting "a lot of different samples because there's not that many different ones there but, um, and also we could look at living things and we could look at weathering on the second trip. Uh so like um rocks in the water that had you know like weathered down walls that were broken up, so we could look at examples of that." Judy said looking at these examples "helped me understand, um I don't know you don't really realize that normally and uh when you look at, when you can really see why it helps...to see stuff. To help me understand it more than just reading about it. Reading that water weathers down rocks or water weathers down rocks but if you go and you see that the rocks and the weather in the water are much smoother than the rocks not in it. It just helps me understand it more."

Judy thought that what happened on the second and third field trips were similar. On the third field trip, "We were looking at weathering under the bridge where water had you know poured down and washed away some of the rocks and there were like stuff like it looked like barnacles, but um, growing on the bridge which had been there for a long time. So that was that. I don't think I really remember much else about that except um how the tree roots could break the sidewalk, because they would grow and the sidewalk would crack." She remembered walking around and making "inferences as to why it would happen and there were no real right answers or anything, it was just ideas." She recalled Mr. R doing most of the talking "but then he would let us share our ideas." This "was a short field trip, so it wasn't as fun as long field trips.

But it was better than being in class." Long field trips are better "because you get to do more stuff." She learned on this field trip that rocks weather faster in windy and wet areas. She remembered the "nasty" underside of the bridge, which had water dripping down. It was "ugly" to her because "like it had the holes in it and it was rusting and there was like stuff growing on it like, like a barnacles like I said. Um it just looks really gross. Like you don't want to be walking under it." She didn't think that bridge would have looked like it was breaking apart if it were inside because it would not have as affected by water and wind.

From her experiences in the field and in the classroom, Judy learned quite a bit. When she examined a soil sample collected from a low lying area around home plate on the "kickball field" she discovered that this sample was particularly moist. She suspected it was more moist because it was lower lying and had been patted down by people walking on it, creating a space for water to pool. Judy also observed different colored soil. She learned that the different colors are due to there being "different minerals." She said "I remember that from the textbook there's different ingredients like more of one mineral in a different type of soil might make it redder um or maybe more water would make it darker. I don't remember exactly but something about the contents of the soil definitely changes it." Although she didn't know exactly which minerals they were she knew "when there's more plants in an area it's uh, when it has more organic matter it will be darker."

Maddy

Maddy is an observer and imaginative. She identified with her video camera and took care of it like a baby, even naming it Gigi and keeping it warm. During the dead bird episode she observed it but then stood on the sidelines and commented on her peers who found it interesting. In the interviews about the field trips she recalled experiencing quite a few technical problems and also remembered being freezing and asking lots of questions. She field interviewed others because that was what she thought she was supposed to do.

Maddy was unclear about content goals of the field trip. She used because "the gloves [were] for stuff there was something that we had to pick up we put the gloves on and make like like (inaudible) kind of and then we had shovels so we could dig the dirt to see what was in the dirt" That said, she recalled the second courtyard trip to be about "looking for change. The second time we went out there me and Luise were kind of just observing what, the changes happened. Some of the flowers bloomed and died and then we saw that the rug was gone and then we saw that that little statute was rusted on the top of it and it was like before we went out there the first day it was not rusted. She remembered learning about the seasonal changes in the environment "I learned that um [points out window] that flowers usually bloom in the spring and kind of die in the summer and some bloom in the winter and then the grass that was growing really tall and was yellow, I didn't know that was grass I thought that was like a flower because it had little spiky things on the end of them, some of them. And so I thought that was like flower, but it was grass." She had fun this day because "it was nice outside" and because "me and Luise got to see changes that had that we didn't see before when we went out the first time and then we got to take other pictures of flowers that bloomed." When pushed to expand on what about the experience was fun she explained, "I just like taking pictures of things. It's fun. Well I like holding things and pressing buttons so it was fun to take the pictures and we got to see what pictures that we took before that was like the grass that was dead. We took a picture of that and then when we came back it was grass, regular grass and dirt." Making observations mediated with camera technology was a hook for Maddy that also reinforced her learning by helping her see changes.

She also "learned how um the bone meal would work with the flowers. Well first when we did Garden Club I didn't understand what the bone meal was doing for the flowers but then when we found the bone meal bag she was saying that someone left it out and it was to help the flowers grow stronger roots." She remembered this connection that adding certain things to flowers can help them grow.

For Maise, a low point was not understanding, "Why we had a [mossy] rug there in the first place because we have carpet right there."..."because I was I didn't understand why it was there and it was there and then also what why it was mossy.... Me and Luise were kind of. We were going to take a picture but then we thought it was a waste and then we were kind of wondering why it was there and why it had so much moss on it, but when we did the slide show it answered our question."

Maddy identifies with Garden Club. Her involvement with this after school club guided what she engaged with in the in field. She involved herself in identifying plants because she had this knowledge, which she found interesting and empowered to help others figure it out. "I was drawn to the bucket "because garden club had planted flowers in there and they didn't start growing until now and um that and what I thought was interesting was that Jeremiah and Emily were trying to figure out why and since they're not in garden club they wouldn't know that we planted those."

Manuel

Manuel loves media video games and YouTube movies. He remembers well ones about violent, grotesque things or incorporate scenes from video games such as Call of Duty. He also likes Harry Potter that he drew on different times as evidence to support his reasoning. On the field trips Manuel was drawn to dead things and gross things. He enjoyed getting a reaction out of his peers by saying and doing provocative things with the dead objects. Manuel has an argumentative relationship with his dad because his dad doesn't appreciate his sharp tongue. Manuel is bright and has a keen memory. In class, Manuel is pretty quiet but on the field trips Manuel would not stop talking to the point that his peers kept telling him to be quiet and stop annoying them. He would repeat things over and over, such as lines verbatim from YouTube movies that he thought were funny. He has quite a bit knowledge and much of is specific (such about the big riverboat disaster in the Chicago river or about how and where moss grows) that he uses to constrain his thinking as well as to pose new conflicts, such as orientation of moss growth. Manuel believes that "Ms. H isn't usually wrong."

In the courtyard "we just went around looking around looking at stuff...So we looked at that and then we looked at all these other flowers and stuff like that that we hadn't really had time to actually look closely at in our other times we've been to the courtyard. Like, you know, for parties and stuff like that. We haven't actually had time to look closely at any of these things. Like we've just been running around playing.... But we haven't actually had time, so it was interesting to see all the little pieces of the courtyard like the red flowers and the yellow flowers and the white flowers.... And we saw this...I don't really know if it could be called a tree but it was a weird plant that wasn't small enough to be a flower but it wasn't big enough to be a tree. But it was right there [points out window] it looked kind of like a bush. And it had all this white fluffy stuff that Marta started throwing at everyone." He liked having the chance to look closely at things, which he did. He drew some interesting analogies to everything objects like streetlamps. "I just think it's interesting to be able to look at things. Like really closely. When you've seen them just like, really general other times like usually on the other times you just looked around and say, Oh look at all those cool stuff, but this time we've had things, we've had time and uh we were supposed to look at it like really closely to actually look at all the different pieces of everything.... Yah it's like like looking at your hand under a microscope. You see what you wouldn't usually see if you just went like that [waves hand in front of face]. For Manuel, it is more than just looking at something new, but it is seeing in a new ways in a new light.

An example of constraining his theorizing involved noticing plant spacing "they were just separated out. I think that was pretty cool and that happened with a lot of the plants. Like not just one of two plants. That happened with different kinds of plants like there was purple plants that were all separated and then there was these green plants that were all separated and then there was yellow plants that were all separated. So it wasn't just one kind, one type of plant that was separated."

He was especially interested in the pampas grass that was touched. From his physical interaction with this plant he learned that "It's just that like when you rubbed it one way it went all flat and when you rubbed it the other way it like it's like everything was laying that way like when you took off little branches of it [lots of motioning with hands] everything was laying that way. So when you rubbed on it, it was just flat. When you rubbed this way you lifted everything up. Manuel also liked the moss that he observed growing in many places. Manuel knew that moss can help with navigation. He gave a confused explanation about why moss grows where it does by invoking the seasons; his explanation involved the idea about the sun moving around the earth.

The second time in the courtyard, Manuel made some observations about the changes he saw. "So the dead bird was gone, the second time we went. It wasn't there anymore and since the water barrel had been moved, the first time it was kind of empty but the second time you could move it and you could hear the water going around, (but) there was a lot more water since we moved it. So it was catching more water. And now, the second time we went uh the separated plants weren't as interesting as the first time we saw them. They were still interesting, but not as interesting as the first time we saw them because it's like, you know, like in Kindergarten the first time you ever come to (inaudible) it's like whoa this place is so cool, but after a couple of years it's not as interesting because you've been there a lot. It's like, right now I know basically all my whole way around this school. And the first day of Kindergarten I probably didn't."

Flanna

Flanna is cheery and energetic. She often wore sandals and did not hesitate to wade in the river. She is environmentally minded, loves living things, and is concerned about things like pollution. She persisted through a difficult partnership with an uncooperative and obstinate partner. Flanna is seen as a leader by other students because she has lots of knowledge. Flanna missed the last day of school because she went on summer vacation with her family to Wisconsin.

On the first field trip “me and Zion, that's my partner, we went outside and we looked at everything and everything looked either dead or brown. And there weren't really any plants sprouting out and it was just very dull and grey...we took pictures of uh things we noticed that like we don't usually see around you know. Like we took pictures of the hornets nest and the dead plants and all that stuff so that later we could see all the living stuff later.” She saw the purpose to “see the changes that an environment or different weather can change on something.” Flanna wasn’t too psyched because it wasn't very nice outside and you know you wouldn't really get to be like playing around and stuff but it turned out to be a really fun project. We got to be in the fresh air and we go to see a lot of fun stuff. And it was just fun to be outside and be with your friends while doing something in school so.

Flanna likes the outdoors. “Um going outside is fun because you get to be in the fresh air and you get to experience a lot diff of different stuff you get to when you're just sitting in a classroom you get to actually see like the things you might have seen in pictures and actually see like how these plants or animals might get their water might get their food, stuff like that.” She continued “Being outside I think gives you a sense of what's not, like you're not cooped up and gives you a sense of what you're hidden from like if you're hidden from bees and you're obviously going to be afraid of them because you don't know what they are. So I guess being outside gives you more knowledge on what's out there.... Well you can't really keep as many wild plants and stuff inside and animals and stuff you can't keep them cooped up inside. But then inside also you kind of have a sense of safety also. Like you know there's not as stuff so I, I me personally I like the outdoors better. I think there's more stuff to do and all that. But I guess inside or outside you learn just about as much." She elaborated on her comparison between the indoors and outdoors. "Inside you're mostly seeing pictures and you're looking, writing stuff down but outside you actually get to touch something or you get to see with your own eyes. It's really different. Um when you get to actually experience something it seems like it might stay in your memory and you know you'll learn it easier because you actually like, you can connect your thoughts to it easier. Well at least I can but inside um I feel like you don't really have a real sense of what it actually is, you have a two-dimensional sense of what it is. I think 3-D is better."

Flanna likes going outside and sees an interesting distinction between pictures and the real thing. "Seeing a picture is way different than actually seeing it with your own eyes. 'Cause looking at a picture it's like seeing a copy of the real thing. When you act...like when you go to a concert, it's better to go actually to a concert than to see it on TV, right? Or to go to a real basketball game instead of just see it on TV. It's like the experience. Being there, actually seeing that, being in the same area, stuff like that. You know? ...When you're inside you can uh look at pictures or you can act....like you can grow little plants, well you can do a lot of different stuff. You can experience if they need more light or not because you can actually control that. Outside you couldn't control that as easier. Usually they'll just grow near the light, you know?" Flanna sees "the purpose of the outdoors, well for a lot of things it's there home, it's there life, it's there environment, there ecosystem, it's there biome, everything."

Flanna's perspective on learning is fairly profound for a fifth grade student. "When you see things and you ask questions that's how you learn. Well at least that's how I learn."

Flanna thinks that becoming familiar with fearful things is good. "When we went to camp Timberlee everyone was like, 'Oh I'm afraid of snakes and stuff,' and then we when they were um introduced and stuff some of the girls who were hiding outside actually came in the room and held one so. That was good."

A low point on the first field trips was when "Me and Ziva weren't really getting along but on the first trip it was mostly just the weather." The second field trip was not seen as a low point "The second time? Um, it was a good experience. It was really productive. We got a lot of stuff done also. Interestingly, her and partner got very little done the second time. In fact they were having major interpersonal issues. The first time out the got along fairly well and were quite productive. Another low point the first time out "there weren't actually that many green things so it wasn't very nice to see all the still like, I mean I don't know if they were dead because maybe the roots were still alive but all the brown things. It was kind of sad...Well to see everything so sick or sleeping, you know? I don't know. I don't really like the color brown. [hesitant laugh]…I was just looking at all because this was our first experience I was just looking at all the sleeping or I called it dead, at the time. All the plants that were brown and then I saw some of these buds like in this picture it showed some of the things that were just popping up underneath the things."

Dead animals aren't especially interesting or unusual to Flanna because "dead animals I see them a lot because I have two cats and a dog. So, I always wonder was it my dog or my cat that killed this."

Flanna is environmental minded. "I don't I don't like polluting, I don't believe in it because I'm a big animal person and I like outdoors like I said earlier so polluting I think just ruins it. It kind of, it kind of uh destroys the purpose of the outdoors, you know?"

Chloe

Chloe is a positive, confident, happy go lucky African American girl. She loves flowers. She also enjoys finding dead things. For example, she was curious to find a dead bird, which she may have learned about from the field trip preparation several days before or from other students who found the dead bird in Bio1 (she never did find the dead bird).

Chloe enjoys taking photographs. "I liked taking pictures of things like I don't want to be a photographer when I grow up though but I like taking pictures of things like that are real. I don't why it's just fun, it's like really amazing. And it was fun because we got to walk everywhere, we got like, we get to walk everywhere and we get to discover like um unusual things like when we were in garden club we go out there but we do specific stuff and we don't get to like walk around and take pictures of things. We like plant or build something so it's kind of fun walking around knowing everything that's in our courtyard."

Chloe felt good about the second field trip to the courtyard. "That was even more amazing, everything was green, it was like a really big difference, it seemed like a really long time after we went out. So everything was green and there were new flowers and then we looked back on our board where we marked the things at, we went back to those spots and then the thing that used to be there was gone or it was um with like something else." When shown a clip of she made of the hornets' nest and asked to speculate about why she decided to capture it she said, "I decided to record it because it was kind of weird so like weird things you just have to record them."

<u>Evan</u>

The teacher described Even as a genius because he is enrolled in math at a local high school. He loved using the Flip cameras and would sometimes get a little crazy and out of control. He was very savvy with the laptop computers and made some very creative PowerPoint slides. He has a strong vocabulary, loves animals, and for some reason was drawn to the lone crab shriveled crab apple, the weird faces on the clay plaques, and stone duck statues in the courtyard. His best friend he said was Oliver so he took great offense when Grady called racist against black people. Evan was one of the few students who seemed to really be able to connect the field trip task and the curricular learning goals. "I am an animal person."

He felt the point of the first field trip was "To find what others hadn't. It was fun to look for um some of the plants that were thriving because we would probably, we would, because there weren't many. It was almost like hide and seek with plants. Because um there weren't many plants so if you found one it was kind of, like um, a big discovery. Um we found a couple flowers but they were ones that people really had found. There was one tree that um, like that one [points outside] I think like that one kind of closest. That you can see like the whole thing of. It had like, it was like a cherry or a crab apple and there was only one, so we took a picture of that because it was, um like almost everyone did, because it was a um, there was only one there so we questioned why there was only one? It was kind of cold though so it discouraged us a little bit."

Evan didn't like the second field trip as much "Because um we, well first of all we didn't have much time to and second of all, we kind of um. We were, we're not that, I guess into this stuff where we would be able to know that only one grew and like, and if we do figure out then it'd be like. Another question would come up like, why is there only one and why, and if one could survive, then why can't others?" He liked the second trip "because it was warmer and um there were much more flowers there was much more stuff to take pictures of and I guess we didn't take as many pictures because it was kind of, since it was warmer, people were running around a little bit because we have short recesses so we needed to be outside kind of. So, we didn't take as many pictures. It was really nice out and there were a lot of plants.

Evan was interested in the patch of purple flowers. "We found like ten crocuses sitting there and somehow they were surviving really well. Uh I probably, like on the brim of thriving, but they were definitely surviving.... there weren't that many other plants that we found and there were ten right there. So, it was kind of weird how ten could be right there."

Evan believes we need to be outside because "our bodies need fresh air because the air in here isn't as good, I guess....sometimes like outside there's a cool breeze and it like, if you breathe it in, at least to me it feels really good and in here there are no breezes. Unless the air conditioning vents break."

Evan routinely made inferences about survival and often reasoned at about ecosystems not just about organisms; he connected physical factors, which he called “environmental factors” and organisms. “We were taking pictures of the clay plaques that um probably um seventh or eighth graders did and they put them in the courtyard and they were environmental factors because they, I mean they're there in the environment but like a squirrel might store nuts in one of their, one of them was like out in 3-D and it's mouth was open so a squirrel might store nuts in there or um a bird could hide dead worms in there.” He understood an environmental factor to be “something in the environment that affects the environment and affects the living things in the environment” “The plaque could be somewhere for a small creature could hide like a bug could hide for a weird reason there was a frog and there, a mosquito or a fly could hide in one of them…The ducks are an environmental factor because if something was on, if the duck is right here [hand motions] and there's, and something, and something could, let's say just random there's a pencil chasing a piece of paper that's small and the piece of paper could hide behind a duck while the pencil's looking for it, they could hide behind them (for or) against the predators.

When asked about why he felt he was gutsy for opening up a sewer cover manhole he explained, “Because um nobody had, was, had was willing to open it because it some kids thought we were going to get in trouble if we did but I just figured I want to look inside and see if there's something in there, so I opened it.

<u>Jacob</u>

Jacob is a happy go lucky and charismatic, friendly individual. He is great helper. He is more of a follower than a leader. He meets with a speech coach for help with his diction. He has a pet bearded dragon that he adores and often brings it up, occasionally inviting students over to his house or sharing insights about this reptile.

Jacob liked the field trips “it just seemed more you know more interesting. Because you know I see dead plants all the time around my backyard but I didn't, I barely don't see a wasp hive so, it's pretty interesting.” In fact much of what he experienced he found to be interesting. “That was, it was really interesting we saw a wasp hive that's like right over there [points outside] and it was really deserted so we thought it was really interesting and we, and me and Elvis's question was are they ever return or sometime or did, did something happen and now the wasps can't support life. That's kind of my answer. He remembered dead stuff and the crab apples, which were also interesting objects. It was interesting because it was different.

Jacob was a follower; his partner bossed him around and directed what he should attend to and video record. Jacob smiled and laughed often and appeared to have no problem being told what do to. Together they used the flip cameras to make an adventure movie about the courtyard. Jacob sees a speech therapist at school. He has a bearded dragon that he talked about on several occasions in the field. He used this pet as something of status to lure others to his house to play. He talked about his mom and brother a fair amount on the field trips.

For Jacob, the regularity of stuff to see in the courtyard was a low point. “A low point I think it would probably be the trees because you know we always see the trees without leaves in the winter and yeah you know they just look exactly the same and we see them every once a year and they're just always around, like trees are all around this planet and you know, we see them all the time. Once you get to barely, if you see something that you barely see you get more excitement and you go, "Ooo what is that?" You know, you have a lot of questions, you get a lot of excitement, you get, that's what I, what I explained.” In contrast to more ordinary things, more out of the ordinary stuff piqued his interest. The second time out Jacob noticed that everything sprung back to life except the wasp hive.

He remembers seeing a squirrel, even though that didn’t happen. “There's this tree over there [points outside] and there was this nest I saw and then it was climbing up on the tree to get some acorns. I saw it climbing on the tree it was like, like this [spreads arms out on the table] and it was, it was going really fast to try to get to that branch full of acorns.”

What he liked most about the field trip was the exploratory nature. “I love adventures because there's always exciting stuff all around. I really love adventures, like adventures are so much to learn about and when, and when you learn it then you mostly know what it's all about and then the more we know, the more we can take care of the earth and then the earth will be a better place. And so I like adventures because they're a good way of learning because adventures you learn a lot.” He expanded on this idea “I thought it was a really great adventure. I thought, I thought it was and adventure of how plants do all, like all around the four seasons. Winter, spring, summer, fall. And what I, what I just knew was that plants are great in the spring and the summer and in fall they die but now I know but now I know why because there's some parts of, some parts of the time in earth we can't survive and you, and you just can't stay, you have, you get to go or die and I thought that wasn't really a big deal but when I realized you, because when I realized I thought when I looked at all those things that I thought, it came, it came hitting me like saying this is more, um, important stuff and we should take care of the world more. And that's what I've been planning to do. I have been um been working on my garden, on our garden in our backyard and we've been making sure that Ted [pet dog] doesn't dig because that's just bad. Jacob thinks having adventures is a good way to learn. Through adventure type field trips, “We've learned how, what our, what plant’s life are like and we see it in front of our eyes so and it's really cool and we get to see what's happen, what's happening and what's going on with the plant or trees or bushes or any places where wild life live.

Jacob thinks he has adventures in the classroom “because um sometimes we um, you know sometimes Ms. H talks to us about science which is pretty much the whole, about the whole entire universe and what's part of science is the environment and also when we learn about the environment we can look up on a computer or book for information about what happens at any place on earth. Deserts, Savannah, Rainforests, Deciduous Rainforest, I forget the other rainforest though, sorry. But they say pretty much, actually there are plants that in the desert that can actually survive for a long time. Cactuses for instance. They only need like a couple [sic] of water.

One of the most striking moments for me was a short piece he and his partner recorded while walking up the stairs at the end of the field trip. Jacob’s partner said “C'mon get outside, explore the environment around you, you might discover something new and get a lot of money. Well that's not the point, the point of discovering something new is so that you can give other people knowledge." We watched this clip in the interview and Jacob reflected on it saying “So we were telling, we were trying to give people a reason why we don't just have to sit and watch TV like there's something, there could be something incredible outside happening in your missing all of it, which is the environment, and so when you see that it's actually more cool than just watching TV. You know what I mean." He think that outside "Maybe we would discover new like, we could probably see a squirrel having a baby, because I never saw a squirrel having a baby before. Maybe we could see that or maybe we could see birds hatch out of their eggs. Well, I've seen like you know in TV shows how like some birds hatch but that's not how it's exactly like. I mean you got to, you got to, you don't learn by just watching TV, you have to, you have to go outside and you may, may be impatient but in life, it takes time."

For Jacob seeing and experiencing something for the first time is interesting but repeated viewing are not as interesting. He used the courtyard as an example to contextualize his observation. It's interesting to me that he found things of interest the first time even though he had been there many times.

Appendix E: Pre and Post Semi-Structured Student Interview Protocol

Introduction to the interview

My name is …. I'm a researcher from Northwestern University. Today I want to ask you some questions about field trips and science. Some of these questions may be about things that you've haven't learned yet. So you might not be very sure about many of the answers. That's okay. I'm really just interested in how you think about these things; I'm not really interested in whether you get answers right or wrong. So, I'm hoping you'll tell me as much as you can about what you think about the questions that I'm going to ask. Just talk and work together and I'll listen and ask questions.

Field Trips (5-7 min)

a. What do you think a field trip is?
b. Can you remember any field trips you've been on?
    a. If yes, when was it? Where did you go? Who were you with? Do you remember learning anything?
c. Do you like field trips?
    a. Why, why not?
d. Have there been field trips you haven't liked?
    a. Why or why not?
e. Why do you think your teacher takes you on field trips?

Science (Ecosystems) (5-7 min)

a. What would happen if we brought a polar bear to a forest?
b. Can you think of something that lives in the desert?
    a. What do you think would happen if we brought it to the courtyard?
c. What do living things need to survive? To thrive?
    a. Do all living things need the same things?
    b. If they recognize that plants and animals need different things, then ask about X (X environmental factor that stands for sunlight, soil, water, etc.) in order to get at relationships among environment & living things
d. Where do living things get the food they need?
    a. For plants? For animals?
e. Have you noticed that some trees stay green during the winter?
    a. If, no then direct attention to evergreen outside window.
    b. Then, ask why some trees go bare during the winter while others stay green?

Appendix F: Follow up Semi-Structured Student Interview Protocol

PART 1 (10 min)

Free Recall: What happened on the first field trip to the courtyard (6 min)

- Can you tell me a little bit about what you did that day?

Guided: Everyone was in the courtyard with clipboards, cameras, buckets of stuff to work with, etc. *(to help stimulate recollection of what happened, if needed).*

- *Probing questions*
  How did that go for you?

What do you remember doing?
How did you feel that day being out there?
What was a particularly HI (positive) point for you that day? LO (negative) point?
Repeat free recall interview questions for second field trip (4 min)
(additional questions)

- When was the second field trip, do you remember? And when was the first one?
- If you were to go to the courtyard in another few weeks, what do you think you would see?

PART 2 (14 min)

I'm going to show you four video clips, one at a time, which you recorded with a Flip camera, and then ask about them.
Show 4 clips (ea. 15 sec. to ~2 min duration)

2 HI and 2 LO (or if episode moves from LO-> HI or HI->LO then show these two clips as one clip)
HI/LO Dimensions include: Scientific thinking (e.g., about organisms, environmental factors, worms/birds, pollution, death/life cycle); Communication; Collaboration; Unexpected events /Surprise; Plausibility of ideas; Group Dynamics; Video technology; On-task/Off-task;

BIO (5th graders) -4 clips from courtyard (taken in different areas of courtyard and/or over time).
ES (6th graders) – 1 to 2 clips ea. from different field trips (Schoolyard, Neighborhood, River)

- Can you tell me what was happening here in this clip?
- Why did you record this?

Then ask follow up questions specific to clip; see Excel workbook for specific prompts for each HI/LO Flip clips sampled, for example

- What were you going to when the camera stopped recording?
- What things were puzzling for you here?
- What did you mean when you said X?
- What was buddy (partner, peer, teacher, etc) saying here?
- Does that [idea] make sense to you?

Appendix G: Follow up Semi-Structured Teacher Interview Protocol

General Questions

Background

- Why do you go to the trouble of taking kids on FT?

Students

- What do you think the students get out of field trips?
- What changes if any have you noticed in particular students? For community?
- What did kids tell you about trips?

Practice

- In terms of instruction, are there things you felt you had to sacrifice for these field trips?
- Do you think your teaching style and approach to teaching has changed this year. If so, what's changed and why.
- What do you plan to do next year?

Specific Questions

Asked set of questions for each of the field trips that happened (sequentially)

Field trips

- What happened on the field trip? (your story of that field trip)
    - What did you take away from it?
    - What went right/what went wrong? What were some snags? Workarounds?
    - What did the students learn?

Optional Probing Questions

- I understand that you didn't get a chance to see all the different groups on all the field trips, from what you did see what were some meaningful/memorable experiences? Why did you pick these moments?

- How much structure do you need to provide on field trips?
    - If a teacher is preoccupied with safety/control then they can miss moments. So for example, chaperones/teacher aides are resources on field trips to help keep a structure in place. What kind of support do the chaperones/teacher aides provide on field trips? In class room? For you? For students? For each other?

- What would happen if you didn't provide worksheet or guiding activities? What's the purpose of these worksheets? How does it help learning?

Appendix H: Positive and Negative Affect Survey (PANAS)

(from Watson, Clark, & Tellegen, 1988)

NAME______________________________________Date__________________

The words listed below describe different feelings and emotions.
Please mark each word with a number indicating how strongly you have felt this emotion today.
Make sure you write a number beside each and every word.

1	2	3	4	5
very slightly	a little	moderately	quite a bit	extremely or not at all

____interested	_____irritable	
	____distressed	_____alert
	____excited	_____ashamed
	____upset	_____inspired
	____strong	_____nervous
	____guilty	_____determined
	____scared	_____attentive
	____hostile	_____jittery
	____enthusiastic	_____active
	____proud	_____afraid

Appendix I: Recruitment and Contact Information Sheet

Field Trip Project Northwestern University

Overview
This project explores using “field trips” to support learning of science. Rather than view field trips as enrichment activities that are no more than a day off from school, we believe field trips can be educational experiences that fit in with your existing science curriculum goals.

With you, we hope to plan two or three field trips to places we can get to by foot or by bus. We also hope to observe students in the classroom before and after the field trip to get a better handle on how field trips support learning science.

Fall:
Observe any field trips you may already have planned
Pilot technology for data collection
Pilot technology for students to use on future field trips
Possibly observe and videotape day before and after field trip

Winter/Spring:
Carry out 2-3 field trips away from school property, ideally within a single science unit
At least one will be an all-day field trip
1-2 will take place within walking distance
Ongoing videotaped classroom observations

Collaboration will involve:
Distribute and collect consent forms from students
Participate in initial 30 minute meeting to discuss your science curriculum
Identify focal unit
Collaborate with Jon on field trip planning

Administer pre & post questionnaire about science learning and field trips to students
Possibly administer brief weekly survey about science attitudes (during focal unit)
Identify 8 focal students to participate in interviews with Jon
Interviews will take place during school hours
Interviews will take place at the beginning and end of focal unit
Allow Jon to copy student work relevant to field trips and focal unit

Thank you!
Participating teachers will receive a stipend of $250 at the end of the project