King, Donna & Ginns, Ian
(2015)
Implementing a context-based environmental science unit in the middle years: Teaching and learning at the creek.
Teaching Science, *61*(3), pp. 26-36.

Implementing a context-based environmental science unit in the middle years: Teaching and learning at the creek

Donna King and Ian Ginns

Queensland University of Technology

Abstract

Engaging middle-school students in science continues to be a challenge in Australian schools. One initiative that has been tried in the senior years but is a more recent development in the middle years is the context-based approach. In this ethnographic study, we researched the teaching and learning transactions that occurred in one 9th grade science class studying a context-based Environmental Science unit that included visits to the local creek for 11 weeks. Data were derived from field notes, audio and video recorded conversations, interviews, student journals and classroom documents with a particular focus on two selected groups of students. This paper presents two assertions that highlight pedagogical approaches that contributed to learning. Firstly, spontaneous teaching episodes created opportunities for in-the-moment questioning by the teacher that led to students' awareness of environmental issues and the scientific method; secondly, group work using flip cameras afforded opportunities for students to connect the science concepts with the context. Furthermore, students reported positively about the unit and expressed their appreciation for the opportunity to visit the creek frequently. This findings from this study should encourage teachers to take students into the real-world field for valuable teaching and learning experiences that are not available in the formal classroom.

Introduction

Middle school students (i.e., Years 6-9) are disengaging from science (Logan & Skamp, 2008) and choosing not to study science in the senior years. While a greater range of subject choices in the senior school is the most significant factor for the decline in senior science enrolments, one other contributing factor is the lack of engagement in science experienced by a wide range of students (Lyons & Quinn, 2010). A positive experience of science may encourage students to pursue science in the senior years as well as contribute to a longer-term interest in science. This study attempted to address this concern through a context-based science unit in the middle years (see King, Winner, & Ginns, 2011 for full outline of the unit) where students were afforded opportunities to learn about the ecological and environmental features of their local creek (i.e., Spring Creek). In this unit, students conducted a teacher-guided research project on environmental conditions that may be impacting the health of the creek and surrounding flora and fauna. Two themes emerged from the data analysis highlighting the teacher's pedagogical approach and students' learning at the creek. Such pedagogical approaches may spark students' interest and create opportunities for learning about science in their out-of-classroom lives.

Literature

Context-based teaching and learning

Teaching science through a context-based approach occurs when the learning is "meaningful" for students (Gilbert, 2006). Applying Gilbert's (2006) perspective, "meaningful" learning occurs when students connect the canonical science concepts with a real-world context. This may be achieved when the "context" or "application of the science to a real-world situation" is central to the teaching of science and content is taught on a "need-to-know" basis (King & Ritchie, 2013). One way to achieve this is to immerse students in the context through frequent visits e.g., to the local creek. In this study, visits to the local creek afforded students opportunities for learning through teacher-student and student-student interactions.

Another way to view context-based learning is through the theoretical perspective of “situated” learning. Such a perspective emphasizes how knowing and learning cannot occur unrelated to the environment in which it occurs (Lave & Wenger, 1991). Furthermore, this perspective argues that it is the participation of learners within the community that forms their environment and contributes to their learning. In this case, students were situated in the real-world context of the creek while learning about environmental science within the community of their class.

A body of research has been conducted on context-based approaches to teaching science (see King, 2012 for a full summary), predominantly in the senior science, chemistry. The main outcomes of this research reveals that students can make fluid transitions between the concepts and context when taught through a context-based approach (King & Ritchie, 2013); students’ enjoyment of science lessons and their interest in science is generally increased when they engage in context-based courses (Barber, 2000; Gutwill-Wise, 2001; Parchmann et al., 2006; Ramsden, 1997); and students learn chemistry equally as well as students who are taught through a traditional approach (Barber, 2000; Smith & Bitner, 1993). Furthermore, students studying through a context-based approach demonstrate a deeper understanding of concepts than students following more conventional courses (Barker & Millar, 1999; Gutwill-Wise, 2001; Lange & Parchmann, 2003; Sutman & Bruce, 1992). However, two studies found that students were unable to transfer their learning of chemical concepts to situations beyond the context in which they were learned (Hart, Fry, & Vignouli, 2002; Wilkinson, 1999). This contrasted with a more recent study by King, Bellocchi, & Ritchie, (2008) who found evidence that students can make connections between concepts and context in senior chemistry. Most of the research on context-based approaches has been conducted in senior science classrooms where students make connections with contexts while working outside of the real-world field. This study addresses a gap in the research where students are immersed in the real-world context while learning science.

Environmental Education

Environmental education generally refers to curriculum and programs, which aim to teach people about the natural world and the ways in which ecosystems work (Jenkins, 2003). In Western-style environmental education, the focus is mostly on understanding ways in which humans and human systems impact on the environment and non-human natural systems (e.g., local waterways, endangered species). Previous research on environmental education has shown that outdoor projects such as creek activities afford opportunities for scientific literacy to emerge as a collective property; that is, students who are involved in community-based projects may continue to participate in the activities beyond the classroom (e.g., through community volunteer groups) sharing science knowledge to a broader group (Roth & Lee, 2002). Also, participation in the community prepares students for “lifelong participation in and learning of science-related issues” (Roth & Lee, 2002, p. 263). One study conducted in Spain found that by focusing on positive human-environment relationships in environmental science within rural settings afforded students opportunities to see how such relationships can be used to stimulate the interactions between humans and the environment (Dopico & Garcia-Vazquez, 2011). Another study by Eaton (2000) found that junior-level students who attended a half-day program in ecology in an outdoor centre “made a greater contribution to cognitive learning compared to the classroom program” (p. iii). Furthermore, Rennie (2007) argues out-of-school community projects such as environmental science projects, are valuable for students providing opportunities for rich learning, however, “science concepts enshrined in current traditional curricula” need to be sacrificed to provide the time and space for students to develop their own investigable questions about matters that are important to them (Rennie, 2007, p. 25). In this study, students were given some freedom to focus on environmental aspects of the creek of interest to them.

Research Method

An interpretive methodology using ethnographic techniques (Erickson, 1998) was used over a three-month term (April to June) in a ninth grade science class at Spring Hill State High School in Queensland, Australia. Situated in a suburb of a major metropolitan city, the students were predominantly from middle class families. There were eight boys and eighteen girls in the class. A single case study design was used to explore the transactions that occurred in the classroom and at the creek and to develop a deep understanding of teacher-student and student-student interactions that contributed to learning (Stake, 1994).

The authors collected data during an 11-week teaching period, which consisted of 33 lessons, and nine visits to Spring Creek. Two groups of students were selected as case studies by the teacher based on academic results and friendship groups so that they represented a full range of abilities across the class. There were five students in each focus group. Data sources included classroom documents, student journals, interviews with the teacher and students, audio recordings of the teacher and students and detailed field notes. Our analytic process began with categorization of lessons (see King, Winner, & Ginns, 2011) followed by the transcription of interviews and flip cam recordings. Students created the flip cam recordings as they collected their data at the creek with some students choosing to create a "mocumentary".

Analysis

Themes were identified initially highlighting patterns of coherence and contradictions that were emerging from the data (Tobin, 2006). Tentative assertions were constructed and modified as we revisited the data to search for confirming and disconfirming evidence. What emerged through the analysis of video data at the creek was the way the teacher interacted with the students that contributed to their understanding of science concepts and the scientific process. From the transcriptions of nine lessons at the creek we identified many occasions where the teacher capitalized on informal and unstructured "in-the moment" opportunities that were "natural and often sudden" that not only probed students' understanding but also contributed to students' generation of "bright ideas." We define these interactions as *spontaneous teaching episodes* or in-the-moment opportunities where the teacher engaged in a conversation with students about a visible aspect of the creek environment that advanced their understanding of canonical science concepts. Since these episodes occurred in the real-world field, we have narrowed our definition to the teaching episodes that occurred during the eight creek visits. These spontaneous interactions included unexpected observations, relevant comments, conjectures that occurred "without a lot of thought or planning" but seemed "enjoyable and worth doing" at the time (Field Notes, p. 10). The researchers determined which parts of the lessons were considered "spontaneous teaching episodes" as defined through observation and listening to the transcripts that agreed with our definition. These conversations stood out as "teachable moments" and highlighted to us the importance of the teacher's role when in the real-world field for connecting students' learning with the scientific concepts and the scientific process. Furthermore, through the analysis of student-student and teacher-student interactions recorded on the flip cameras, we identified conversations where students connected the canonical science concepts with the context.

The environmental science unit

The environmental science unit was centralized around the community's local creek that meandered through the school property. Using a teacher-guided inquiry approach, opportunities were created for students to assess the health of the creek. The teacher in this study was committed to "letting go" of traditional teaching approaches to allow students to conduct the investigation. Fortunately, the Head of Science who supported the research project allowed the teacher to work with researchers to design the creek project for one term. The teacher gave students ownership of the investigations as expressed by the teacher at the end of lesson two: “You guys are the directors of the study” (Field Notes, p. 2).

Students collected data about the water quality, flora and fauna species and pollution at the creek on three separate sections of the creek (Sites 1, 2 and 3) and they were to compare their results for the three sites. These primary data were analysed and students consulted secondary data for comparisons. A final report was submitted as the assessment for the unit communicating the health of the creek to local government authorities. Students worked in groups that rotated through the various activities and each group was assigned a different task for the purposes of conducting investigations at the creek. The activities are summarized in the table below:

Table 1: Rotational Activities

Activity Number	Activity Name	Description
1	Water sampling	Students wore boots or waders to walk into the three different sites to collect water samples. They submerged white sample bottles and filled them with water samples.
2	Water testing	Students tested the water samples collected in activity 1 using water quality data probes for flow rate (ft/s), dissolved Oxygen (mg/L), turbidity, temperature (^{o}C), conductivity (µs/cm).
3	Count and identify insect/animal population	Students counted the population of the animals and insects in each of the three sites. Groups were encouraged to identify as many different types of living animals or insects as possible (classification resources were provided).
4	Plant population	In each of the three sites students observed, counted and identified as many different types of plants as possible (classification resources were provided).
5	Environmental analysis	Students recorded their observations of the creek’s surrounding environment (e.g., dead trees, vegetation, litter etc..). Each group drew a “birds-eye-view” site map of the three sites.
6	Litter count	Students counted and recorded all the litter that was present on the three sites. This data were then graphed.

Results

Assertion One: *Spontaneous teaching episodes consisting of teacher-led questioning introduced environmental science concepts and highlighted the relevance of the data collected*

The teacher led the students to the creek on nine occasions over an 11-week term. As salient features of the creek’s ecosystem appeared, the teacher would stop the class along the bank of the creek at relevant locations to discuss observations before they began their group work. We found these teaching episodes were important because they consisted of a pattern of questioning that was different to the questions asked in the formal classroom and contributed to students’ understanding of environmental science concepts. We defined these teacher-led interactions as *spontaneous teaching episodes* or in-the-moment opportunities that were natural and often sudden where the teacher questioned students about a visible aspect of the creek environment. Importantly, the episodes highlighted an environmental science concept or aspects of the scientific method to be completed in the group activities. Over the nine creek visits, the analysis revealed many environmental science ideas discussed in this way including: habitats, the difference between living and non-living species, water quality, adaptations of animals, food chains, population of species, native plants and non-native plants, plant reproduction, conditions for growth of plants, pollution, identification of plant species, the erosion of creek banks and sustainability of the local creek environment. We have chosen "habitat" as one representative example to demonstrate these whole-class question-answer dialogues between the teacher and students, which occurred on the first creek visit:

Excerpt One: Habitats

01 Teacher: Ok, guys, what do we notice about the whole area? Have we found much in the way of bugs?
02 Student (A): Yes.
03 Student (B – quiet voice): Water bugs.
04 Teacher: Water bugs.
05 Student (C): Skimmers. Those that walk on the water.
06 Teacher: What about non-aquatic animals?
07 Student (D): I just saw something
08 Student (E): Dragonflies.
09 Teacher: Dragonflies.
10 Student (F): Yeah.
11 Student (G): And something catching fish
12 Teacher: What about larger animals?
13 Student (H): Yeah, we're going to look for fish.
14 Teacher: Look for fish. Do you reckon fish would even like this area?
15 Student (I): No.
16 Teacher: Why not, Mattie?
17 Student (I): It's not clean
18 Teacher: Ok, pollution may be a factor - may be something that you want to investigate a bit later on, is what sort of **habitats** do fish enjoy around this area?
19 Student (J): Oh, rocks, hide behind rocks, and they could hide along there (pointing with finger.)
20 Teacher: What else could they hide along with regards to this area?
21 Student (K) (along with student(J)): The weeds. (Also pointing with finger)
22 Teacher: The weeds, yep. What else? What about along the edges?
23 Student (K): plants in the creek (Motioning with hand)
24 Teacher: Good, plants that hang in the creek could be a good spot for animals like that, so perhaps that may be an area to have a look at, particularly when you are along the edges. Probably looking for small animals living around the edges hiding among the vegetation. When you get the waders next time, you'll be able to walk and have a look at the area as well. So, don't forget to have a look up into the actual vegetation itself. Things just don't live in the water; they live in the area around it and above it. (Video recording, Creek Visit 1)

This excerpt was typical of the spontaneous question-answer dialogue between the teacher and students at the creek. In this example, the teacher probed for ideas about suitable habitats for small animals through nine questions, which engaged 11 different students. The natural and fluid conversations afforded students opportunities to survey the creek environment for evidence of animals in response to the questions. After brainstorming the types of bugs (turns 1-10) that may live in the creek environment, the teacher probed students when he asked, "do you reckon fish would even like this area?" (turn 14). In such a way, he was guiding students to consider the conditions suitable for fish to live in the creek. This led to the introduction of the term "habitats" when he asked, "what sort of habitats do fish enjoy around this area?" (turn 18). In turn 19 student J responded with "Oh, rocks, hide behind rocks, and they could hide along there" as she pointed to the area with her finger. At this point, student J made her first comment when she connected the science concept of habitat for fish with the rocks she could see. The teacher used student J's response to capitalise on the teachable moment when he probed further by asking "what else could they hide along with regards to this area?" and student K responded in turn 25 in unison with student J "The weeds." Through the structure of teacher-student questioning, students were afforded the opportunity to connect the real-world context (creek) with the science concept of habitat that is a suitable environment for fish to live. Unfortunately, the teacher missed an opportunity to reinforce the term "camouflage" in this excerpt when students began to discuss the fish "hiding". The advantage of the creek visits is that it enabled the teacher to capitalize on opportunities where his in-the-moment questioning helped students apply science concepts (e.g., habitat) to the context.

On many occasions at the creek, we observed the teacher work with groups of students supporting them with their data collection while using the opportunity to teach students about the environmental impacts that may affect their results. In a follow-up interview, the teacher expressed the importance for students to think about the data they were collecting while in the real-world context:

> Author One: Do you think that the students are making sense of the data as they collect it?
> Teacher: Yeah, absolutely. Specially, when, I mean, when they've got the probes [i.e., part of data logging equipment used for recording flow rate, temperature, dissolved Oxygen etc..] and stuff in their hands as they're doing their testing. They have to think about what's the difference between these sites and what do you see? How does that translate to what you're bringing back in terms of data? (Follow-up Interview)

The teacher encouraged students to use the data logging equipment to collect water quality measurements and discuss their significance. One representative example occurred in the following excerpt when the teacher was helping focus group one who were collecting data on dissolved Oxygen and temperature readings at various sites. In this *spontaneous teaching episode*, the teacher's questioning reinforced the conditions that impacted on the amount of dissolved Oxygen present in the water.

Excerpt Two: Dissolved Oxygen and Temperature

01 Teacher: What are some of the things that dissolved Oxygen was dependent on? (pause)
02 Teacher: Do you remember at all?
03 Melissa: Pollution?
04 Teacher: No, there's something else. What else could have impacted it? (referring to dissolved Oxygen concentrations)
05 Robert: Is it…flow rate?
06 Teacher: One of them was flow rate. What else? Do we remember?
07 Robert: Temperature
08 Teacher: All right, the dissolved Oxygen was dependent on temperature and flow rate. When it comes to our flow rate, which one had the lowest flow rate?
09 Mary: Site 3
10 Teacher: And, good. So it had the lowest flow rate and lowest dissolved Oxygen, yes?
11 Students: Yes (several students)
12 Teacher: What about temperature? Which one (site) had the highest temperature?
13 Melissa: I think, that one (pointing to results on prac book)
14 Teacher: That one there (referring to Site 2)
15 Janine: Because it's in the Sun, it keeps that one warm
16 Teacher: I probably agree, a bit more sunny….That one over there is very well shaded (referring to Site 3). So, the temperature can vary a bit between the sites.

In this excerpt the teacher used the opportunity to teach students about the relevance of their data; for example, in turn 08 he explained how dissolved Oxygen is dependent on flow rate and temperature. He then asked students to compare the flow rates between the three sites explaining that the site with the lowest flow rate will have the lowest amount of dissolved Oxygen. He missed an opportunity here to question students about why the lowest flow rate will have the least amount of dissolved Oxygen (i.e., Oxygen enters the water mostly via diffusion at the water-air interface) and why dissolved Oxygen is dependent on Temperature (i.e., Oxygen's solubility in water decreases as water temperature increases). However, these explanations were discussed in previous lessons in the classroom. In turn 12 he then asked them about the temperature readings they had found and in turn 15 Janine explained that one site has a higher temperature due to its exposure to sunlight. The teacher agreed with the students' conclusions in turn 16 that the temperature can vary depending on the site, shade and exposure to sunlight. In this excerpt the teacher questioned students to help them make sense of their data while reinforcing the purpose of water quality parameters such as dissolved Oxygen, flow rate and temperature. We observed many occasions when the teacher capitalized on such teaching episodes to support students' sense making of the scientific data collected at the creek. Such teaching episodes were salient for the connections between environmental science concepts and context as well as for interpreting water quality data for the three sites.

Assertion Two: *Group work using flip cams afforded opportunities for students to connect environmental science concepts with the context*

We transcribed and analysed the two focus group's flip cam recordings used to record their observations. The analysis revealed that through the student-student and teacher-student conversations, students were connecting environmental science concepts with their observations while at the creek. Connections between concepts and context have been found in teacher-student and student-student interactions in the secondary science classroom (see e.g., King, Bellocchi & Ritchie; King, 2009), however, such connections have not been found when students are working in the real-world context. Students made canonically accurate connections between the context and concept for the following environmental science concepts: habitat, camouflage, non-native plants, erosion, turbidity, flow rate, pH, dissolved Oxygen, temperature, effect of depth on fish population, growth of plants, seed dispersal of plants, pollution, choking of plants by weeds and identification of plants. We have provided a representative example of students' conversations demonstrating the connections recorded on the flip cams in Table Two (below), including the number of times the concept was used correctly:

Table Two: Examples of connections between concepts and context in conversations at the creek (pseudonyms used for focus group students)

Concept	Example of focus group students' conversations connecting the science concept with the creek environment	Frequency (as counted in flip camera transcripts of focus group students)
Habitat	**Lily**: Must be a lot of fish in here. **Barbara:** Must be a good habitat for the animals **Lily**: And we could say there must be fish here because I think ducks eat fish **Teacher**: So why do you think it is a good habitat for the animals? **Barbara**: There's heaps of like vegetation around there, which would be good. It's not murky and not polluted. **Lily**: And the temperature is right **Barbara**: Yeah, and the water is not freezing or anything **Teacher**: So it's got the right conditions for them to live in **Lily**: Except there is some litter and stuff but it's clean	10
Camouflage	**Lily**: The fish would blend in with the water because we can hardly see them **Teacher:** Yes they camouflage	3
Non-Native plants	**Melissa**: This is known as Singapore Daisy. It is not part of the natural… **Charmaine**: It is imported from Singapore which makes this not a natural piece of the creek **Melissa:** It's known as a weed which is obviously not good **Charmaine:** It is choking up the creek beds as well	4
Erosion	**Riley:** What can you see? **Student C**: Lots of erosion about the trees and banks and like everything **Teacher:** Where's the erosion? **Lily:** Through here **Riley:** On the edge **Teacher:** On the edge there, right that's good	2
Water quality parameters		
Turbidity/clarity	**Charlie:** The water is dirty..yeh it's not that clear… **Barbara:** Yeah, there's a lot of stuff through it, through the water **Charlie:** Yeah, and there won't be as much food for the fish	10
Flow rate	**Teacher:** So, the flow rate might contribute to the amount of dissolved Oxygen?	3

	Robert: The flow rate might contribute in a way. Well, mainly because it's falling on top of the water in the river.	
pH	**Robert:** 7.6, 7.7 **Teacher:** So, what does that tell you about the.. **Robert:** The pH is basically the same in all of them **Teacher:** All right, and, is it acidic, basic, neutral? **Robert:** More alkaline than.. because the lower it is the more acidic, so, 7 that's pretty good. It's almost drinking water, if it was clean, yes. That's in a fairly healthy range, if you filter it, it should be fine.	2
Dissolved Oxygen	**Robert:** Ok site 2 was, had the most dissolved Oxygen and highest flow rate. And, Site 3 had no flow rate and barely any dissolved Oxygen. And, Site 1 was the middle one.	1
Temperature	**Barbara:** There's heaps of vegetation around there which would be good. It's not murky and not polluted. **Lily:** And the temperature is right **Barbara:** Yeah, and like the water is not like freezing or anything	1
Depth	**Student C**: There's not many fish. We may have disturbed them because of the movement. They might be around here because of the deep water.	3
Other ecological concepts		
Growth of plants	**Student A**: Yeah, and they're sort of trying to bend over because you know how plants like grow upwards to be in the sun in rainforests	3
Seed dispersal of plants	**Student A:** Or the seed, or their seeds have been carried and they've just happened to be dropped and they've just multiplied. **Student B**: And they're all weeds **Student A**: They multiply like crazy	1
Pollution	**Student A**: There's like, oh look, there's like wooden logs floating, There's golf balls and there's wooden logs floating around here, which means debris. There's lots of moss, and the water is quite murky. Oh, and there's like a barrel or something in the water over there.	22
Choking of plants by weeds	**Student A**: Weeds, everywhere. 'Cause they are everywhere. There's too many to count **Teacher**: So how might that affect the creek? **Student A**: Well, they could be taking the places of the native plants	1
Identification of plants by name e.g., Singapore Daisy	**Charlie**: And, there's more of this weed stuff. Oh Singapore Daisy is its common name **Lily**: So there is heaps and heaps of this plant **Barbara**: And there's just so much Singapore Daisy, and it just keeps going	3

*Student A, B, C is used when it was difficult to identify the student speaking in the focus groups

Interestingly, the three concepts that were used most frequently in the conversations were habitat, clarity of water and pollution. The large number of comments about the pollution present at the creek (i.e., 22) represented the students' ongoing concern about the sustainability of the creek environment. This was present in students' final reports as shown in the following representative examples:

Charlie: Pollution is increasing the risk of ecological deaths, causing low flow rate which is affecting the overall environment (Final Report).

Robert: I found the creek environment quite beautiful, however I didn't like the fact that some people even thought about littering and someone went far enough to put a fridge there to rust (Final Report).

Students' perspectives

Author One and Two were afforded opportunities to interview the focus groups on two occasions, half-way through the unit and at the end of the unit. Since at least one of the authors was present at each lesson, we would often talk to the students about their experiences and how this unit compared with previous science units. From the analysis, it became apparent that students were positive about the unit and expressed their appreciation for the opportunity to visit the creek. Furthermore, students commented on the opportunity to see the creek from their own perspective, the value of doing the hands-on work themselves and the importance of collecting authentic data. Three representative examples from the interview data are below:

Example 1: Seeing the creek from their own perspective (Focus Group One: Melissa, Charmaine, Mary, Janine, Robert)

> Author One: Does going down to the creek, how does that make you understand what the unit is about?
> Melissa: Because we get to see, like, what's down there, what it looks like, what the clean bit looks like, and the gross bit looks like
> Author One: OK
> Charmaine: Like, rather than being explained what it looks like, we actually get to experience it
> Author One: So do you have a preference for which way you would prefer to do science, like..
> Mary: Going to the creek!
> Charmaine: Like seeing it close up and being explained
> Author One: You like seeing, Why do you like seeing, yourself?
> Melissa: Because, you get your own view. Everyone sees it differently. But, when the teacher explains it, you all sort of get the same…..
> Janine: You get to see it the way the teacher sees it, not the way you see it, and also sometimes when you're just in the classroom talking it can be difficult to concentrate. When, you're actually down at the creek, it's actually something fun to do and you can walk around and it's interesting. (Follow-up Interview)

In this interview above, the students highlighted the importance of seeing the creek "up close" and from their own perspective rather than from the teacher's perspective. They also referred to the creek visits as "fun" and "interesting."

Example 2: The value of doing the hands-on work yourself (Focus Group Two: Charlie, Riley, Barbara, Lily, Julie)

> Lily: I like going down to the creek because like its really fun there, and like..
> Barbara: And it's like hands on… I like hands on
> Julie: and you get to do stuff
> Author One: And, why do you like hands on?
> Barbara: It's like we enjoy it more
> Julie: Instead of like sitting in the classroom writing stuff down we can be like be out there doing something
> Lily: You don't remember what you're doing. Because you did it yourself, you're not watching someone else do it all the time, you get to actually do it yourself, so you remember what you are doing. (Follow-up Interview)

The students in this focus group explained the value of "doing it yourself" which helped them to remember the experience.

Example 3: The value of real-world data

Later in the interview with focus group two, Lily expressed the importance of the creek visits for collecting real-world data:

> Lily: And it helps because when we go down to the creek, we can actually like see it for ourselves and that will help us for the assignment with evidence because we've actually seen it with our own eyes, whereas like if we were watching like a video it wouldn't like, like you wouldn't know. It's not the same as the creek (Follow-up Interview).

The teacher supported the students' comments when he referred to their enjoyment of science in this unit compared to previous science units:

> Teacher: Yeah, and in terms of other general feedback throughout the term as well as, when I'd see them around the school whatever, it was a keenness outside, [they would say] "oh, yeah are we doing science, what are we doing today?" There's more a keen[ness] to get to know what we are doing, what's going on.

> So, I think they definitely gained a greater enjoyment for science because it was very much different to what they had experienced in the past (Teacher interview).

Conclusion

The teacher's pedagogical approach included two main strategies that were salient for student learning at the creek. Firstly, the spontaneous teaching episodes enabled environmental science concepts to be discussed in-the-moment as the teacher saw a stimulus for teaching the concept. Carefully scaffolded questioning and probing drew out key features that afforded students learning opportunities that were spontaneous and natural. Secondly, opportunities for students to work in groups using flip cams as a resource, enabled connections between concepts and context to occur at the creek. Furthermore, students valued the opportunity to visit the creek frequently and appreciated the hands-on aspects of the inquiry for collecting authentic data. The findings from this study supports previous work that found by changing well-established classroom structures (such as going to the real-world field in this case), new forms of action (agency) are created that are not available in the classroom itself (Goulart & Roth, 2006). In other words, taking students to the creek for weekly visits enabled spontaneous teaching episodes about the creek environment that were salient to their science learning and data collection. The creek visits were supported by classroom lessons that provided canonical science knowledge, and the assessment outcome for students was a written report on the health of the local creek. For all students in the study, the assessment task was completed to a satisfactory standard or higher.

This study has shown that context-based approaches can be used in the middle years for learning about real-world environmental science concepts. More specifically, we have demonstrated the important role of the teacher for facilitating students' learning while in the real-world context and the use of flip cams as a tool for learning.

Acknowledgements:

Thank you to the teacher in the study as Spring Hill SHS: Evan Winner.

References

Barber, M. (2000). *A comparison of NEAB and Salters' A-level chemistry students' views and achievements.* Unpublished master's thesis, University of York, York, UK.

Barker, V., & Millar, R. (1999). Students' reasoning about chemical reactions: What changes occur during a context-based post-16 chemistry course? *International Journal of Science Education, 21*(6), 645-665.

Dopico, E., & Garcia-Vazquez, E. (2011). Leaving the classroom: A didactic framework for education in environmental sciences. *Cultural Studies of Science Education, 6*(2), 311-326.

Eaton, D. (2000). Cognitive and affective learning in outdoor education. *Dissertation Abstracts International – Section A: Humanities and Social Sciences, 60*(10-A), 3595.

Erickson, F. (1998). Qualitative research methods for science education. In B. J. Fraser, & K. G. Tobin (Eds.), *International handbook of science education* (pp. 1155-1174). Dordrecht, The Netherlands: Kluwer Academic Press.

Gilbert, J. K. (2006). On the nature of "context" in chemical education. *International Journal of Science Education, 28*(9), 957-976.

Goulart, M. & Roth, W-M. (2006). Margin/centre: Toward a dialectic view of participation. *Journal of Curriculum Studies, 38*(6), 679-700.

Gutwill-Wise, J. (2001). The Impact of active and context-based learning in introductory chemistry courses: An early evaluation of the modular approach. *Journal of Chemical Education, 77*(5), 684-690.

Hart, C., Fry, M., & Vignouli, V. (2002). What does it mean to teach physics "in context"? A second case study. *Australian Science Teachers Journal, 48*(3), 6-13.

Jenkins, E. W. (2003). Environmental education and the public understanding of science. *Frontiers in Ecology and the Environment* **1**: 437–443. http://www.esajournals.org/doi/abs/10.1890/1540-9295%282003%29001%5B0437%3AEEATPU%5D2.0.CO%3B2

Lange, B., & Parchmann, I. (2003). Research to develop subject specific knowledge at students in instruction based on Chemie im Kontext. In A. Pitton (Ed.), *Auberschulisches Lernen in Physik und Chemie Proceedings of the GDCP Meeting 2002* (pp. 269-271). Munster, Germany: LIT Verlag.

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge: Cambridge University Press.

Logan, M. & Skamp, K. (2008). Engaging students in science across the primary secondary interface: Listening to the students' voices. *Research in Science Education, 38,* 501-527.

Lyons, T. & Quinn, F. (2010). *Choosing Science: Understanding the declines in senior high school science enrolments.* Report for the National Centre of Science, ICT and Mathematics Education for Rural and Regional Australia (SiMERR) at the University of New England.

King, D. (2009). Context-based chemistry: Creating opportunities for fluid transitions between concepts and context. *Teaching Science: Journal of the Australian Science Teachers Association, 55*(4), 13-20.

King, D., (2012). New perspectives on context-based chemistry education: Using a dialectical sociocultural approach to view teaching and learning. *Studies in Science Education Journal*, *48*(1), 51-87.

King, D., Bellocchi, A., & Ritchie, S. (2008). Making Connections: Learning and teaching in context. *Research in Science Education, 38*(3), 365-384.

King, D. T. & Ritchie, S. M. (2013). Academic success in context-based chemistry: Demonstrating fluid transitions between concepts and context. *International Journal in Science Education*, 35(7), 1159-1182.

King, D., Winner, E., & Ginns, I. (2011). Outcomes and implications of one teacher's approach to context-based science in the middle years. *Teaching Science*, 57 (2), 15-30.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge, UK: Cambridge University Press.

Parchmann, I., Grasel, C., Baer, A., Nentwig, P., Demuth, R., Ralle, B., et al. (2006). "Chemie im Kontext": A symbiotic implementation of a context-based teaching and learning approach. *International Journal of Science Education, 28*(9), 1041-1062.

Ramsden, J. M. (1997). How does a context-based approach influence understanding of key chemical ideas at 16+? *International Journal of Science Education, 19*(6), 697-710.

Rennie, L. (2007). Blurring the boundary between the classroom and the community: Challenges for teachers' professional knowledge. In D. Corrigan, J. Dillon & R. Gunstone (Eds.), *The professional knowledge base of science teaching* (pp. 13-29). Netherlands: Springer.

Roth, W-M., & Lee, S. (2002). Science education as/for participation in the community. *Science Education. 88*(2), 263-291

Smith, L. A., & Bitner, B. L. (1993, April). *Comparison of formal operations: Students enrolled in ChemCom versus a traditional chemistry course.* Paper presented at the annual meeting of the National Science Teachers' Association, Kansas City, Missouri.

Stake, R.E. (1994). Case Studies. In N. Denzin, & S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 236-247). Thousand Oaks, CA: Sage.

Sutman, F., & Bruce, M. (1992). Chemistry in the community - ChemCom: A five year evaluation. *Journal of Chemical Education, 69*(7), 564-567.

Tobin, K. (2006). Qualitative research in classrooms. In K. Tobin, & J. Kincheloe (Eds.), *Doing educational research* (pp. 15-57). Rotterdam, The Netherlands: Sense Publishers.