



A look into Preparing Secondary Science Teachers with Citizen Science

Um olhar para a formação de professores de ciências da escola secundária com a Ciência Cidadã

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Abstract

Ecojustice philosophy is an exciting approach for science education that can increase student and community interactions while promoting awareness of culture, science, and learning. The research presented here was collected over one semester of a secondary science teacher preparation course that utilized ecojustice philosophy and citizen science as a framework for instruction. Highlighted in this article are expectations of the professor and university, assignments and daily course activities, the location of courses as they serve as exemplars of enacting ecojustice philosophy, and perspectives from preservice teachers on what they were learning. This research shares that when pre-service teachers are allowed to participate in philosophical and pedagogical approaches to science instruction that contradict the familiar, they express discomfort. However, these learning opportunities have long-term potential benefits. By forcing preservice teachers to step outside of their comfortable spaces and into class being held in the rain, their perceptions of teaching and learning were defied. In turn, these related experiences encouraged them to alter their teaching practices to co-exist alongside a new framework of ecojustice philosophy, a philosophy that highlights the benefit to challenging assumptions and promoting diversity in thought and action. The ability to consider alternative perspectives, at least for these preservice teachers, provided rewards that may be felt by their students, such as a deeper appreciation for and involvement within the local community.

Keywords: ecojustice; teacher preparation; ethnography; collaboration; citizen science.

Resumo

A filosofia da ecojustiça é uma abordagem interessante para a educação em ciências que pode aumentar as interações dos alunos e da comunidade ao promover a consciência da cultura, da ciência e da aprendizagem. A pesquisa aqui apresentada foi conduzida ao longo de um semestre de um curso de formação de professor de ciências, que utilizou filosofia da ecojustiça e a ciência cidadã como um referencial para o ensino. Destaque neste artigo são as expectativas do professor e da universidade, as tarefas e as atividades diárias do curso, a localização dos cursos e como esses servem de exemplares de promulgação da filosofia da ecojustiça, e as percepções dos professores em formação sobre o que eles aprenderam. Essa pesquisa partilha que quando os professores em formação inicial são permitidos a participar de abordagens filosóficas e pedagógicas para o ensino de ciências que contradizem o familiar, eles expressam desconforto. No entanto, essas oportunidades de aprendizagem têm benefícios em potenciais no longo prazo. Ao forçar os professores em formação a saírem de suas salas confortáveis e ministrarem aulas na chuva, suas percepções de ensino e aprendizagem foram desafiadas. Por sua vez, essas experiências encorajou-os a alterarem as suas práticas de ensino a coexistir ao lado de uma abordagem da filosofia da ecojustiça, uma filosofia que enfatiza o benefício das hipóteses desafiadoras e a promoção da diversidade de pensamentos e ações. A capacidade de considerar perspectivas diferentes, pelo menos para estes professores em formação, resultou em recompensas que puderam ser sentidas pelos seus alunos, como uma profunda apreciação e envolvimento na comunidade local.

Palavras-chave: ecojustiça; formação de professores; etnografia; colaboração; ciência cidadã.

Introduction

While research into secondary teacher preparation courses are common (CONCANNON; BROWN, 2013; SAUNDERS; CAMPERELL, 1994), what may be uncommon is the way in which the classroom in this study was framed and in the very nature of opacity that took place in discussions between the professor and the researcher. This paper moves beyond the past examples of research in teacher training to share the unique framing ideas, activities, and understandings which served to promote learning and interaction within one secondary science teacher preparation course that was structured with ecojustice as the guiding philosophy. When ecojustice philosophy, and in this case citizen science pedagogy, is used as the guiding framework for science teacher preparation, future teachers are provided with opportunities to incorporate environmental issues with their own ideas of what science teaching and learning could look like, within their own classroom.

This research took place in and around one fall semester of the 'Methods of Science Teaching' course taught at a major southeastern university in the United States; the course was one of three which were required, that semester, for teacher certification. The schedule allocated 8:00 am – 11:00 am on Monday, Wednesday, and Friday with time shared equally between two of the three separate courses; specific meeting dates were included on the syllabus. The researcher was a graduate student at the time and served as a participant observer for the course (with no grading authority). The professor of the course ("Morgan"), and a primary participant, had been teaching in this location for less than three years,

coming to the university with a background in middle school science, focusing primarily on life and earth sciences. Preservice teacher participants included Bernie, Paul, Rose, and Sarah (pseudonyms were given for all participants). Each of the four primary student participants were selected based on their content background (physics, chemistry, and biology) with an even ration of male-female. Three of these students possessed undergraduate degrees in their content area and were currently working towards a masters in teaching; the fourth was an undergraduate student pursuing a degree in her content area with teacher certification. What follows is the result of this semester-long qualitative research study, with descriptions from the participant observer researcher, the four future teachers, and the professor.

Theories guiding the course structure

Ecojustice

Ecojustice philosophy represents a connection between environmental and social concerns, presenting a platform for increased awareness at the community and global level for both habitat and culture (BOWERS, 2001; 2002; SACHS, 1995; TIPPINS et al., 2010). Ecojustice provides an opportunity for focusing on the interconnectedness of both earth and social systems. The use of this philosophical lens encourages change by promoting consideration of the relationship which often exists between areas of environmental degradation and impoverished social groups (Bowers, 2001). Specifically of interest for this course was the focus on how we, within groups and as individuals, interact with the environment and subsequently to challenge future teachers to consider the direction they intend to take as science educators. Ecojustice philosophy can unfold in a variety of ways; the pedagogical approach used in this secondary preservice teacher classroom was citizen science.

Citizen Science

The principles of citizen science reflect learning and doing science in the community by discovering concerns that exist, working to solve problems through the inclusion of local resources, and fostering an appreciation and awareness for all types of knowledge (BROSSARD; BONNEY, 2005; TRUMBULL et al., 2000). Citizen science provides the pedagogical framework for encouraging individual involvement in scientific issues in life science, physical science, and earth science, with independent projects established by the community or larger endeavors that are led by research scientists (BRITTON; TIPPINS, in press; COOPER et al., 2007; RADDICK et al., 2009).

Research Methodology

The intent of this research was to gain an understanding of what took place in a pre-service secondary science teacher preparation course organized around the tenets of citizen science. Hermeneutic ethnography provided a guide for understanding the interactions that occur either between individuals and/or with an individual and the environment; context then becomes an essential component to making sense of these encounters (Geertz, 1973). According to Hammersley and Atkinson (1983), ethnography allows for extensive time spent

with the participants, getting to know their personalities and interests. It is a common occurrence in ethnographic research for a relationship to develop between the researcher and participant (WOLCOTT, 1999). Undeniably, the relationships developed between the researcher and all participants allowed for more interactions with the pre-service teachers in the class, thereby helping to establish a better basis for understanding. Additionally, time spent interacting with the participants outside of the classroom setting aided in making better sense of how they were identifying with the content and structure of the class. As indicated in table 1, there were a minimum of 18 formal meetings with the participants, in addition to the formal interviews and informal conversations that took place over the semester.

Data collection

Data used to inform this research included participant observation, interviews, focus groups, and artifact analysis with observations and interviews serving as the predominant sources of information utilized in this article. The five primary participants were interviewed three times each, using a predesigned interview protocol, and field notes were collected during scheduled class interactions. Additionally, the researcher was given access to classroom artifacts which were completed during the semester; these artifacts included assignments and opinion pieces written at the end of class or in conjunction with a class activity. In an effort to add transparency to observed actions and responses, and to enhance understanding, the course professor participated in after class discussions with the participant researcher; several of these discussions took place through back and forth emailing. Additionally, a reflective journal was kept during the research process and used to identify emerging questions and themes, researcher biases, and others areas where special attention may have been needed. The data in Table 1 were collected and used to inform the descriptions of the course in an effort to resolve the research question: What happens when citizen science is used as a pedagogical framework for secondary science teacher preparation?

Table 1: Inventory of collected data.

| Data source | Total occurrence | Description |
|--|---------------------------------------|--|
| Field notes | 18 meetings/class events | |
| Interview with professor | 3 over the semester | <i>Formal</i> interview protocol utilized |
| Interview with four pre-service teachers | (12) 3 per student, over the semester | <i>Formal</i> interview protocol utilized |
| After class debriefing with professor | 7 Face to face, 3 via email | <i>Informal</i> Questions and discussion regarding issues from class |
| Classroom artifacts | 6-10 | Individual assignments done for class; anonymous writings completed in class. |
| Personal research journal | | Varied times over the semester – as issues arose and thoughts needed to be hashed out. |
| Peer-debriefing to discuss unfolding research | 6 | Discussion of research journal, issues on bias, questions on making sense of the process |

Data analysis

Data analysis was conducted through the lens of hermeneutics and required constant self-reflection as to the meaning of actions and how the researcher may or may not have influenced the perceived understandings. The premise of hermeneutics indicates that *true* understanding is not possible, as we are incapable of completely understanding that which is not our own thought or action (MICHIRINA; RICHARDS, 1996; GOODALL, 2003). Bauman (1978) encourages data presentation in such a way that the reader is encouraged to take in the descriptions, make sense of the depicted scenarios, and filter out what is most logical for their own attempt at sense-making. Larger themes were identified, but these are not the intended focus of this discussion. While the data was studied extensively, the intent of this paper is to share a detailed picture of the assignments, expectations, and interactions that unfolded over the semester in this citizen science-based course.

Why was the course unique?

The facets common to teacher training courses are the same characteristics which add to the uniqueness of this class. The specific expectations, as outlined in the syllabus and by the professor, will be discussed in relation to their influence on the student understanding of citizen science pedagogy and ecojustice philosophy. The location and type of activities that took place, along with the existence and role of the co-educators, helped to further the ideals of a democratic classroom which are espoused within ecojustice philosophy.

Goals of the class

True to most university courses, a syllabus includes a class description, expectations, and an outline of events and assignments. In this case, the 'university' description emphasized a focus on methods, while Morgan (the course professor) tended toward a different approach. When confronted with the university description of the course, Morgan responded "it does say methods, but it is illogical to think that it is a philosophy class...for me [presenting the course as something illogical] makes sense. [The course, for me] is about developing their philosophy. They can look at any method then and frame it [...] (Interview-K)." Within the course syllabus, the expectations presented by Morgan are descriptive and more closely align with his purported framework of ecojustice philosophy:

What pedagogical tools and instructional strategies will equip new teachers to teach in rich, academically rigorous, multicultural and environmentally sensitive ways? This course emphasizes science teaching methods, teaching issues, multiculturalism, the role of the local communities and environments in science teaching ...engaging in community and environmentally-centered projects through science education for community development. This course is also unique in that you will be asked to critically analyze environmental literacy resources related to science teaching and further develop your understandings of teaching investigation, writing, nature journaling and observation, safety and ethics. This course emphasizes how teachers work with students to foster sustained scientific interests, and become informed such that they will have greater access to *environmental decision-making*. (Fall 2009 syllabus)

The practicality of focusing a methods course on philosophy proved challenging for the participants, but provided an opportunity to represent a key construct of ecojustice. The idea of defying currently held assumptions requires an individual to think critically in the face of uncommon experiences. While taking part in science instruction that many times contrasted with those more familiar to the pre-service teachers (and researcher) allowed an opportunity to safely experience change and begin a personal journey for understanding how teaching in this way could restructure the scope of science education.

In the 'classroom'

Over the course of eighteen weeks, the time-span of one college semester, classes met at the Piedmont Arboretum, a local farm cooperative, a traditional university classroom and laboratory, and at the University environmental complex. The Piedmont Arboretum, the location of five class meetings, has hardwood forests, engineered gardens, and both paved and natural trails which encompass a vast array of habitats. Every class meeting held at the arboretum had some outdoor component, with the students outside for the entire class period on many occasions. The University environmental complex provided a non-traditional classroom for fire-safety instruction and a same-day field-component for the students to take part in fire suppression, under the supervision of two university firefighters. Participants met in a large, carpeted room with tables arranged facing a projector screen for the initial safety presentation. Once completed, we moved to an over-sized garage with fire equipment and a rolling door that opened to a grassy area designated for starting and extinguishing fires. Luna Farms, a local farming cooperative, served as the field-site for another class meeting, one that allowed the students to observe activities occurring on a working farm which is designed around sustainable agricultural practices.

Table 2. Location of scheduled class meetings (Pseudonyms used for all locations).

| Location | Number of meetings |
|-----------------------|---------------------------|
| Piedmont Arboretum | 5 |
| Luna Farms | 1 |
| Environmental Complex | 1 |
| Ecology laboratory | 1 |
| Traditional classroom | 8 |

One class meeting began in the traditional, on-campus classroom with students then walking to laboratories located in the Ecology building on the main campus for the final portion of class. During this meeting, students worked with microscopes, gloves, and other identification equipment in a science laboratory which also contained monarch enclosures and live butterflies. The remaining eight class meetings were held in a traditional classroom in Lafayette Hall, on the main university campus. The traditional classroom design included windows along one wall with black lab counters underneath as well as on the opposite wall; black lab tables were situated in the middle for seating of two to four students.

It is extremely important in this case to note that all class meetings were held in their originally scheduled locations, regardless of weather. The fall in which this course took place was unusually rainy, with more than half of the outdoor classes taking place in the mud and wet conditions. Rose, one of the primary participants, felt especially strongly about these outdoor conditions and shared that many of her classmates complained at the expectation

of being outside during the rain; “they were not very outdoorsy people”. She emphasized to me that she shared with her peers that “this was a good representation of what classrooms could look like, that having to do things that make you uncomfortable help you become a better teacher”. Her belief that changing perceptions related to comfort and science instruction are in alignment with ecojustice philosophy and suggest the need to further promote opportunities for acknowledging the relationship between humans and the environment. Increased awareness for varied environmental conditions, and direct experiences within them, could potentially enable preservice teachers to be more prepared for classroom encounters which are uncomfortable for their own students.

Daily assignments and activities

Classroom assignments provide opportunities for students to express what they understood and how they were progressing in terms of understanding core ideas presented in the course. Assessment of pre-service teacher integration and understanding of ideas, both at the individual and group level, happened daily in the methods class and involved both graded and non-graded activities. Paul shared in his reflective essay, an early graded assignment, one perspective of science education that seems to align with the goals shared by the course professor and emphasized within the constructs of citizen science.

[...] the purpose of public education [...] it should prepare students to become citizens capable of fulfilling their responsibilities. With a society increasingly dependent on technology and science, and a nation continually facing issues where an understanding of science is necessary to make a decision, citizens need to develop some basic understanding of what science is and what it says. (Paul CA1)

This was one of many assignments that allowed the pre-service teachers time to share their personal beliefs of what science education means to them. Opportunities to develop a personal stance prepares a foundation for allowing deeply held beliefs to be challenged; this was done through both graded and daily activities. Further supporting the constructs of ecojustice philosophy was the emphasis on becoming familiar with the natural habitat and how it could be utilized in science instruction. Several classes were organized around outdoor learning, with instruction focusing on citizen science and the role of students as stakeholders. By integrating the processes of doing science into daily classroom learning, regardless of the location, pre-service teachers were encouraged to make sense of how they could repeat this instruction with secondary students.

Two meetings particularly emphasized the value in nature as a potential classroom, and further supported the philosophical underpinnings of ecojustice. Nature journaling was a subsidiary focus of one class meeting held at the arboretum, an experience in which the pre-service teachers were instructed to find something of interest and write the story from the perspective of an organism found in that space. The activity was suggested as a follow-up to an ‘in-classroom’ community mapping project that helped foster a personal level of awareness for specific features of the ‘human’ community, i.e. resource availability and location, transportation, and methods of sustainability (terminology used by Morgan). A second classroom activity that was especially relevant for different science disciplines involved learning about Monarch migration and how classrooms can get involved in tagging, identification, and tracking of the butterfly. Through this activity, the students were given

time to interact with scientists currently studying monarchs, to learn about the culture of people who typically collect tags in Central America, and to consider ways that this research could be effectively modified for the secondary classroom. An after-class discussion with Sarah underscored the potential value in this activity for the pre-service teachers, 'this could be done in my chemistry class by focusing on the toxins within the milkweed that make the caterpillars and butterflies bitter for birds'.

Educational collaboration

Co-educators for the course included invited guests and department-assigned assistants; these collaborators typically taught while Morgan participated in the class alongside the pre-service teachers. Additionally, nature was considered as equitable to the physical instructors in educating the pre-service teachers. According to Morgan, these collaborations increased the diversity of instruction while encouraging dialogue between individuals with vastly different strengths and knowledge-sets. Morgan described the anticipated relationships developing with co-educators as having a two-fold purpose. The multiple collaborators aided in encouraging community development and secondly, helped to foster an understanding that everyone has a valuable role in the course as both student and teacher.

The pre-service teachers expressed appreciation for the diversity in the instruction they received, as a result of the collaborative and geographically varied experiences; these were emphasized as having altered their perceptions of learning and classroom instruction. Bernie shared his beliefs about using citizen science, as he saw it unfolding in the course, "the relation to the community is important because it lends itself to learning more on a deeper level, a more sustainable meaningful learning experience" (Bernie 3). The following statement further elaborate Bernie's perspective; the additional discussion from his fellow preservice teacher expresses value of being allowed to 'see' the diversity among her classmates, as she directly references watching Bernie during the Luna Farm visit.

[...] once I get plugged into a school and kind of get a feel for the community and things that are important to people [using citizen science] will be a bit more easy to work out about how to do it. I think it could be a very effective...you know...aspect of teaching. (Bernie 1)

[...] he [Bernie] probably [would've] been like a kid at Christmas if [he] had gotten to touch one of those baby pigs. It kind of help[ed] to remind me that these people did not grow up seeing things I saw and that is part of the reason why they don't understand things like I do... I have learned that we are all pretty unique. (Sarah 2)

Additionally, the level of interaction with many of the co-educators was a very positive experience, with Rose explaining how communication was encouraged between pre-service teachers and the other educators in ways that made her more confident in both content and teaching. The chance to "openly talk to all of the instructors encouraged a level of comfort" and prevented her from becoming overly stressed about her ability to succeed as a teacher. Collaborators brought, to the preservice teacher classroom, a wealth of experiences and information that far exceeded what one person would be able to offer. The inclusion of multiple facilitators allowed the pre-service teachers to become more aware of how to incorporate 'field experts' into their own classroom, and provided additional

foundation in content knowledge. Furthermore, the ideology of ecojustice encourages awareness for the value of multiple stakeholders who share their expertise through similar community endeavors.

Conclusion

Getting [the students] to know and help out...learning about people that live in another culture, [or] about the people that live around your community...the problems in your environment and how you can help fix that...some students really want to be a part of something, [and] giving them that chance to do [citizen science] helps bring out that creative side and it gets them to learn concepts in a much deeper understanding besides terms and memorization. (Final interview with Rose)

A prevailing theme shared across these experiences was how participants were challenged with facing personal comfort and negotiating their personal expectations in ways that encouraged them to think 'outside of the box'. The students in this course were given opportunities to experience philosophical challenges that will always remain part of their teaching repertoire. The pre-service teachers in this study were confronted with making sense of ecojustice philosophy and citizen science, and emerged with a deeper appreciation of how their teaching could potentially be altered. They transitioned into teachers who possess diverse views and individual beliefs regarding what should be valued in the classroom and how they will proceed to enact their philosophy. In this situation, ecojustice was demonstrated as a viable option for establishing a connection between the community and science in ways that were more concrete and relevant to the unique school environment each preservice teacher will encounter. Rather than approaching science instruction that may not meet the needs of all students, these preservice teachers left with an understanding of how citizen science and ecojustice can serve a community of learners. The challenges and rewards to teacher preparation within a framework of ecojustice philosophy are limitless and represent an approach to science education that is necessary for successfully preparing individuals who are aware of the cultural and environmental impacts they have on the world.

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Submetido em outubro de 2013, aceito para publicação abril de 2014.