"Eeew! There's Dew on My Toes": Common Characteristics of Preservice Elementary Teacher Learning in Environmental Education and Instructional Strategies for Science Teacher Educators

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Introduction

> Thirty pairs of eyes watched me closely. Pausing for effect after several introductory announcements to the elementary school science teaching methods class, I announced, "Let's go outside today!" Smiles broke out, voices rose in something like a cheer and their eyes communicated that my pedagogical decision met with their approval on this sunny spring day. We moved out of the university classroom, down the hall and outside. The excited voices continued as they followed me a few minutes later onto a manicured, weedless lawn glistening in the morning sun. I sensed them slowing down and turned to see many eyes filled with concern. Then I heard one flip flopped paused in mid-stride, exclaim, "Eeew! There's dew on my toes." Her body language suggested that this might be as far as she was going to go.
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> I knew instantly that sound waves had already arrived to the rest of the class. They were assimilating the comment and choosing their complex social group behavior reaction. Would they all refuse to get their toes wet? Confronting me a few feet into the grass loomed a significant reflection-in-action (Schön1983) moment and a pedagogical decision. Do I coax them onto the dewy grass or not? Would forcing them onto the grass reinforce negative outdoor experiences in their minds and reduce the likelihood that they would take their future elementary students outdoors? Should I adapt the planned activities for the dry parking lot nearby? Should I explain how important it is for them to work to overcome their physical discomforts, perceived fears, and biophobias? What should I do? How should I choose?

This chapter explores the pedagogical circumstances described above: How do I as a science teacher educator, a person committed to environmental education (EE), understand the common characteristics of elementary preservice teachers and the pedagogical decisions that foster their increased EE teaching competence? In exploring this question, this chapter seeks to provide science teacher educators with descriptions of preservice teacher characteristics and discussions of science

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methods course instructional strategy suggestions for addressing these common characteristics.

The task before science teacher educators is daunting. In my experience, preservice elementary teachers exhibit five major characteristics that constitute the core of the challenge. First, many preservice elementary teachers exhibit low levels of basic science/environmental content knowledge. Second, an increasingly high percentage of students in my elementary science teaching methods classes exhibit science/bio/ecophobic attitudes and behaviors. Third, substantial numbers of preservice teachers complain about and avoid minor physical discomfort while engaged in EE activities. Fourth, many preservice teachers exhibit low confidence in their ability to successfully engage in mechanical or technological physical manipulations. Fifth, high percentages of preservice elementary teachers desire and often demand what I consider highly structured, prescriptive, detailed procedures for their teaching assignments. I interpret this characteristic to be a symptom from years of indoctrination within an educational system that often rewards passively following directions, accurately memorizing factual details and thinking within discrete disciplinary boundaries. These five characteristics: inadequate content knowledge, ecophobia, avoidance of minor physical discomfort, low confidence with physically manipulating mechanical devices, and a need for highly structured learning environments provide substantial challenges for teacher educators.

In spite of these challenges, every new semester begins with the optimistic hope that redesigned assignments, new class activities, and an increased commitment to providing preservice teachers the highest quality EE experiences possible will result in 30-year teaching careers spent bringing high-quality EE to thousands of school students.

The many pedagogical decisions encountered in an elementary school science teaching methods course are made within a curricular, academic, and professional context. As novice science teacher educators begin to teach elementary science methods courses, my observation has been that they progress along a similar developmental continuum with stages that could be labeled as initial preparation, induction, experienced, and master science teacher educator. I suggest that science teacher educators can engage in pedagogical reflection-in-action moments (Schön 1983, 1987, 1991) with greater depth, sophistication, and success if they have access to discussions of preservice elementary teacher common characteristics in addition to EE-specific instructional strategies. In this chapter, I seek to describe, reflect, and analyze my experiences in teaching EE with approximately 1,500 elementary preservice teachers in more than 50 sections of elementary science teaching methods courses at multiple universities with diverse sizes and geographic locations over 16 years.

My purposes in this chapter are to: (1) synthesize and discuss selected characteristics of preservice elementary teacher learning in EE in preservice science education methods courses and (2) synthesize and discuss science teacher education instructional strategies that are congruent with the learning characteristics of preservice elementary teachers, while developing increased EE pedagogical competence. The intent of the discussion that follows is to illuminate my lived experiences

(van Manen 1990) as a science teacher educator teaching an elementary science methods course through the use of pedagogical practice vignettes and instructional strategies suggestions.

Theoretical Framework

The theoretical framework through which I engage in teaching preservice teachers is based on many influences. First among these, radical constructivism (von Glasersfeld 1989, 1995, 2008) informs my educational approach. This epistemology contributes the idea "that 'knowledge' is the conceptual means to make sense of experience, rather than a 'representation' of something that is supposed to lie beyond it" and "suggest[s] a theory of knowing that draws attention to the knower's responsibility for what the knower constructs" (von Glasersfeld 2008). This emphasis on learner responsibility for actively constructing knowledge that makes sense of their experience is well suited to the teacher educator. As a teacher educator, I strive to understand my learners' sense making. I then design course experiences that emphasize the learner's responsibility for creating understanding of EE pedagogical competence.

Similar to other teaching disciplines, the science teacher educator's pedagogical choices are informed through an understanding of several domains of teacher knowledge such as general content, general pedagogy, pedagogical content knowledge, and knowledge of learners (Shulman 1987). As a teacher educator, I develop pedagogical content knowledge about the nature of my learners (preservice elementary teachers), content (EE), and the instructional strategies that have been effective in teaching EE (Abell et al. 2009). Pedagogical decisions, as Schön (1983, 1987, 1991) described, are filtered through a reflection-in-action and reflection-on-action process that becomes more sophisticated in the way the teacher frames data from the classroom situation as the depth of their understanding in these teacher knowledge domains increases. While many elementary science teacher educators come from a background of doctoral preparation in science teacher education, a surprising number of science teacher educators come from science content areas. This chapter seeks to address knowledge of learner and pedagogical content knowledge deficiencies through emphasis on the nature of the preservice elementary teacher.

This chapter extends the thinking of Driver (1990; Driver et al. 1985, 1996, 1994) who described learners' prior conceptions and suggested that successful instruction depends on first understanding the preconceptions students bring with them into the learning experience. While it is generally accepted that school students have alternative conceptions in science, extending this idea to both preservice elementary teachers and science teacher educators is less commonly discussed. I assert that many science teacher educators operate from a set of conceptions (alternate or naïve or sophisticated) about the characteristics of their preservice teacher learners. This chapter seeks to help teacher educators identify characteristics

and naïve conceptions of preservice elementary teachers, and contemplate instructional strategies that might be useful within their elementary science methods courses.

A high priority for environmental educators is to increase citizens' capacity to engage in social and individual decision-making about their behavior choices, especially as it relates to the relationship between human and natural systems. EE's definition, focus, and objectives have been discussed over many years (Disinger 1983; Hungerford and Volk 1990; Stapp 1969; UNESCO 1977). For the purposes of this chapter, I use an extremely broad conceptualization of EE inclusive of the wide range of conceptualizations. At the core of the many EE definitions is education of citizens about the environment. Research has shown that the state of citizens' understanding on key environmental content and issues is extremely low and has not improved much over the last 30 years (Coyle 2005; NEETF and Roper 2002). This suggests that we need different strategies for educating the next generation of citizens and their teachers.

A key focus area for EE is the development of preservice and practicing public school teachers' ability to teach EE with their students. While studies indicate that 96% of parents think that EE should be taught in schools (Coyle 2005), in practice there are not enough teachers implementing EE effectively in their classrooms. An effectively educated teacher who engages in high-quality EE has the potential to reach many children over many years.

Yet, substantial challenges exist in reaching public school teachers effectively (Ernst 2007). One of these challenges has been how to best go about incorporating EE into teacher education programs. Mckeown-Ice (2000) found that approximately half of teacher education programs surveyed (n = 446) "exposed" preservice teachers to some sort of EE, but it was not institutionalized and quality varied widely. She concluded that, "Preservice teacher education programs are not systematically preparing future teachers to effectively teach about the environment" (p. 10). One approach to require EE in preservice teacher education, where politically possible, has been to mandate EE through state teacher education policies (e.g., Wisconsin). Another approach has been to pass state academic standards that require every school district to teach environment and ecology in classrooms (e.g., Pennsylvania). The North American Association for Environmental Education (NAAEE) developed EE standards for use in teacher education accrediting bodies such as the National Council for Accreditation of Teacher Education (NCATE 2007). Powers (2002) described the challenges that dedicated teacher educators faced in incorporating EE into their preservice teacher methods courses. She found that the barriers to EE implementation are substantial. Not unlike public school teachers, the teacher educators who successfully implemented EE in their courses tended to be dedicated champions of EE and found solutions to their implementation issues.

Despite all these efforts to increase EE in teacher education, the teacher educator faces a basic dilemma: how to include all the worthwhile "needs" of future teachers within the limited credit hours in a typical university education curriculum. How do you encourage more people to become dedicated EE champions in their universities, schools, and classrooms? Do you infuse EE across all courses or require an EE specific course? For many teacher education programs, the elementary science teaching methods course is a common location for EE (Mckeown-Ice 2000).

The following sections describe selected preservice teacher characteristics accompanied by instructional strategies that address these characteristics. Each section begins with a fictionalized vignette based on actual classroom experiences. Each vignette is followed by a discussion of the characteristics and strategies for EE instruction.

Environment/Ecology Content Knowledge

Circulating among the groups, listening to their conversations provided key verbal assessment clues as to how these preservice elementary teachers progressed in their task. I stopped at one table to watch two students open a container of small objects and dump them on their notebooks. They then worked together to sort the objects into two circles they had drawn in the notebooks, one circle labeled "seeds" and one circle labeled "not seeds." We were in the midst of learning about science process skills and the intended instructional outcome was to demonstrate how a first-grade science activity could be used to explicitly deepen observation and classification skills. I listened closely to their conversation.

Student 1: Ummm. (picks up a kidney bean) Is it a seed or not seed?
Student 2: I'm not sure.
Student 1: I guess I'm not sure either. I should know this. Like, isn't this something from elementary school?
Student 1: Yes, we should know this. Oh, my gosh. Is it a seed or not a seed?
Student 2: I'm thinking it's not a seed because it doesn't look like the other seeds (she points to the sunflower and flower seeds). It's bigger than the rest of them.
Student 1: OK. (They put the kidney bean seed in the *not seed* circle and facial clues suggest they are not very sure of their decision.)
Student 2: Wait. Remember Jack and the Bean Stalk? In the book, they plant a bean and it grows into a plant. A bean must be a seed.
Student 1: Ya. But it's bigger than the others (seeds).
Student 2: I think it's a seed. (She moves it to the seed circle. They notice me listening and their faces suggest they want my confirmation that their decision was the right one).

The general science and more specifically the environment, ecology, and natural history content knowledge of many elementary preservice teachers is not much different than the common alternative conceptions held by their elementary students (Bleicher 2006; National Research Council 2007; Krall et al. 2009; Trundle et al. 2006). The preservice teachers illustrated above eventually worked out that a bean was a seed from their memory of a children's literature book. However, their understanding is not much different than the elementary school children they will teach. It is notable that these preservice teachers used a children's literature book for reference rather than their own experiences planting seeds. How is it possible that after 12 years of public schooling and the completion of prerequisite

science content courses in teacher education programs that many preservice teachers' content knowledge does not meet basic proficiency levels?

Many preservice undergraduate elementary teachers dread and often delay scheduling their science teaching methods course because they think of themselves as "science dumb" or unable to understand science. In some cases, students describe poor experiences learning science in the past. As one student explained to me, "science just isn't my thing." This lack of confidence is often fueled by their initial conceptualization of a teacher as someone who knows the answers and tells them to students. They are fearful about the possible situation where a future student asks them a question and they will not know the answer. In a perfect conceptual trap, these future teachers think that they need to know science answers, they perceive themselves to not know the answers, and therefore they reason that they will not be a good teacher of science.

There are several approaches to addressing low content understanding of preservice elementary teachers. Bleicher's (2006) approach employs strategies to help preservice teachers develop content understanding through experiencing for themselves "hands-on, minds-on" in-depth inquiry activities. In my course instruction, I employ strategies to help preservice elementary teachers reconceptualize: (1) their image of teacher as knower and transmitter of science facts; and (2) their view of science as exclusively a body of knowledge to be memorized. EE provides important tools to address these preservice elementary teacher characteristics.

Initially, preservice teachers have a strong conception of teacher as knower of facts. Most likely developed over years of participation in schooling, this conception is deeply imbedded. My instructional approach, rather than to provide the facts they lack (and reinforce their image), is to address their conception of teacher. Incorporating EE activities early in the semester models the teacher's role as a facilitator and not as a knower of all science facts. The preservice teachers participate in outdoor activities, ask questions, and hear me respond with, "That's a great question. Let's look it up in this field guide together so you know how to answer your next question." I use other statements that model teacher as facilitator such as, "You know I have never explored that. Let's set up an experiment to see what happens." In a course activity, I use dichotomous keys with a primary focus on the process of observing tree characteristics (i.e. leaves or needles, opposite or alternate, simple or compound). This engages learners with obtaining content knowledge while engaged in the process of observing the tree. As I model the role of teacher as facilitator and engage learners in EE activities, preservice teachers can begin to broaden their conception of teacher and start to develop confidence in their ability to deepen their content knowledge.

Another way to use EE to help preservice teachers deepen their environmental content knowledge is to focus on inquiry. Emphasizing inquiry and science process skills provides preservice teachers with easier access to content knowledge. For many preservice elementary teachers, it does not cause anxiety to teach about the senses, record scientific observations of animals, or observe their community for signs of spring. Such activities engage preservice teachers with important facets of inquiry and can provide an entry point for additional learning. A focus on inquiry

demonstrates to preservice teachers that they have what it takes to be effective science learners and teachers. Such experiences also lay the foundation for engaging preservice teachers with environmental issue investigations and environmental action projects.

One challenge to using inquiry is that some preservice teachers have a deeply ingrained conception of teacher as knower and disseminator of facts/knowledge that is quite resistant to change. Furthermore, their self-perception of their content knowledge is also low, so many often fail to comprehend that using science process skills may reduce their dependence on needing to know all the facts. To address these beliefs, I use systematic observation nature journals where prospective teachers spend time alone in an outdoor setting to record their observations (Leslie and Roth 2003). I also use a children's literature book critique assignment as a way to reduce anxiety with learning science content. In this assignment, the preservice teachers are given an academic standard related to EE. Next, they select a children's literature book that addresses the standard. Then, they review the book according to a list of quality criteria that includes the nature of science and the accuracy of science content. Since many preservice teachers enjoy children's literature books, this activity provides motivation and interest for learning science content.

In summary, EE provides one mechanism through which preservice teachers can begin to reconceptualize their image of teacher and the nature of science, which reduces the barriers to further developing their content knowledge. In addition, using inquiry-focused activities provides preservice teachers with an entry point for learning environmental science, ecology, and natural history content.

Ecophobia

> "When you go owling you don't need words or warm or anything but hope. That's what Pa says. The kind of hope that flies on silent wings under a shining owl moon" (Yolen 1987, p. 32).
>
> I pause and hold the children's literature book, Owl Moon, by Jane Yolen (1987) still for effect. Slowly I see some heads start to move from their straightforward, attentive positions, which is my signal to move on with directions for our next activity. I ask if anyone has seen an owl in the wild. No one has. After announcing my intentions, I gently produce a great horned owl study skin. Two preservice teachers in the front row physically recoil at the sight of the study skin and their chairs scrape on the floor as they push back from the front of the room. I ask, "Can you describe why you moved backwards?" One responds, "Eeew. Dead things freak me out." The other student asks, "Do I have to stay here?"
>
> "Yes, when you are a teacher you have to learn to be brave." I say, adapting an earlier line in the book.
>
> I ask for volunteers to describe their observations of external owl features that are especially adapted for where they live. Most don't know much about owls but we manage to notice and discuss wing feathers, feathered legs, talons, beak, and eyes. I then say, "Owls eat primarily rodents. They swallow them whole; digest most of the animal and then cough up the fur and bone in a little ball. I have one right here. An owl pellet."

> "Yuck."
> "Eeew."
> "Gross."
> I see one student shiver involuntarily.
> My preservice elementary teachers are predictable. Now comes the real struggle. I pass out the foil wrapped owl pellets, describe how they have been sterilized, and ask that they begin to pull them apart, look for bones, see if they can assemble a full skeleton and collect data on the species in the pellets across the class. Moving group to group I notice that many preservice teachers refuse to touch the owl pellet. Even after I share soothing words and gently model how to proceed, some sit there fearful and defiant.

Whether it is owl pellets, macroinvertebrates, fungi, spiders, snakes, bees, hairless tails, mud, dirt, dead things, or decomposing anything, there are a high percentage of elementary preservice teachers who exhibit a range of phobias about all things gross, gooey, sticky, or creeping. This could be considered ecophobia, the sometimes-primal emotional experience of fear toward the natural world (Sobel 1999). Ecophobia can be considered the opposite of Wilson's (1984) biophilia. Ecophobia can physically manifest itself in ways such as an involuntary shudder at the sight of a snake; a reluctance to use a hand to pick up algae along a river bank or to touch the fur and bones in an owl pellet; panic-stricken swats, screams and sprints from insects; or simply avoiding "dirty" things.

Ecophobia can also mean a more general attitude of fear (mosquito bites, bear attacks, getting lost) toward the outdoors and nature. For example, during one of my outside EE class sessions, several gray squirrels went about their business 20 yards away while I provided directions for our next EE activity. I hardly noticed the squirrels. Habituated to receiving food from passersby, the squirrels all began simultaneously to hop toward our group looking for a handout. Half the class broke our circle and ran letting out a muted scream at the approaching squirrels. "The squirrels are attacking us," one person exclaimed. I took one quick step toward the squirrels and they all scampered up the nearest tree. I then listened to stories about friends or cousins who had bad encounters with squirrels. We discussed the reality of squirrel attacks, natural history, and the impact of feeding squirrels human junk food. In hindsight, a great strategy at that time would have been to engage in conducting behavioral observations of squirrels to enhance my students' comfort level with squirrels.

It is hard to assess where these strong ecophobic emotions come from, how they were created, and how to address them. Each preservice teacher is different. If these fears are socially learned, they can be unlearned. One can imagine a sibling chasing another around with a worm in his or her hand, thus creating a negative earthworm experience. In addition, people are often exposed to movie scenes where serial killers, aliens, and weird neighbors hide outdoors ready to strike the unsuspecting. Even nature shows emphasize the danger of being outdoors to hold viewers' attention.

There are several strategies that could help deal with ecophobia. One instructional strategy engages learners in a desensitization process. Similar to an allergist who administers small doses of an irritant until immunity is built up, preservice teachers with an aversion to "yucky" things can learn to reduce their perceived fears through appropriately phased experiences in a safe supportive environment. (I acknowledge

that there are people with genuine clinical phobias, but I assert that they are rare in my classes.) Another aspect of this same strategy focuses on building extensive positive experiences that reduces the fear by reducing the amount of the unknown. For instance, taking many outdoor walks with a mentor provides the experience to feel comfortable outdoors. Along these lines, adventure education makes use of activities such as rock climbing to help people examine their perceived fears and then develop coping strategies to continue to function in the face of fear (Bacon 1983; Gass 1993; Schoel et al. 1988). Applied to ecophobia, a concentrated effort with preservice teachers to examine their perceived fears and develop coping strategies through positive social group processes could contribute to a reduction of ecophobic behavior. This would necessitate training teacher educators in adventure-based counseling techniques and transferring it to the science methods course context. It would also require voluntary personal commitment from preservice teachers and time frames longer than usually available in a university classroom context. Yet, beginning the process and setting the example are important. Within the university classroom, it is possible to start the process of helping future teachers address these ecophobias in a safe supportive environment through experiences such as modeling appropriate behaviors, structured "safe" activities, and gentle but firm encouragement.

I consistently model appropriate EE behaviors for the preservice teachers in my classes. Modeling is at the heart of teaching and learning, although I have come to believe that its usefulness is limited in my attempts to deal with ecophobia with my preservice teachers since I am perceived as being quite different from them. My appropriate modeling can be dismissed due to how I am perceived. "I could never do that," they say, or "I could never come up with something like that for my lesson." In other words, they attribute to me special characteristics that enable me to do things that the preservice teachers do not perceive themselves to be able to do. Instead of seeing the strength within themselves to become extraordinary environmental educators, they operate within safe self-perceived boundaries. The teacher educator's art is to find the right combination of strategies for each student to unlock their latent strengths and realize their potential as environmental educators.

One verbal strategy involves providing comfort and support for students. The working assumption is that preservice teacher's fear is socially learned and is a perceived fear rather than grounded in real experience. Reassuring words, a positive classroom climate, and acceptance of student attitudes can go a long way toward helping preservice teachers attempt something new within a safe supportive environment. While for some preservice teachers this strategy provides the atmosphere to explore new biophillic behaviors, a safe accepting environment may not provide enough motivation to tip others into cognitive dissonance, face the perceived fear, and attempt new behaviors.

A second verbal strategy points out to the preservice teachers that science and EE is for *all* children and as a teacher they do not have a choice but to learn how to desensitize their fears of nature. For example, I present to my students a scenario such as: "What would you do if a child came up to you on the playground and put an earthworm in your hand? Is it a viable option to scream and run away from your

children? You have to teach yourself how to be brave for those students in your class who need you to help them learn about nature. It's a part of your job as a teacher just like changing a baby's diaper is for a mother." This strategy puts the behavior in the context of a requirement of the teacher's job. Accompanied with stories of other brave preservice teachers who have gone on to do amazing things with their fears sometimes can help provide enough motivation for current preservice teachers to try a new behavior in spite of their fear. Furthermore, another statement can be used: "These are the state standards and you are required to teach them to your students." This statement explains a key aspect of the job. The preservice teachers understand it intellectually, but in my experience this language does not really change behavior for most preservice teachers.

Verbal strategies should be supported by physical strategies to reduce ecophobia. For example, handling animals can be used to slowly desensitize fears through positive animal experiences. The selection of an animal and the progression to other animals is critical. Over the semester, preservice teachers can begin by handling a soft bunny. Holding a hamster is also perceived as a safe experience for many preservice teachers. Progressing to experiences handling birds, reptiles, insects, spiders, or macroinvertebrates are more challenging, but can be supported with a positive classroom atmosphere and gentle encouragement (Campbell, L. M., September 1992, personal communication).

Many people can learn to confront their perceived fears and triumph over them with enough time in a supportive environment. Most people with repeated positive experiences and a careful encouraging mentor can learn to confront their perceived fears. Snakes illustrate a particularly good example for this. Preparing people to touch a snake with strategies such as modeling slow movements and "gentle fingers" help children and adults to begin to confront their fears. Slightly reducing the snake's body temperature by putting it in a cool environment for a short time decreases its body movement and provides a less threatening animal for novices to handle or touch. A single instance of touching a snake will not remove the fear built up over a lifetime. However, incorporating many positive experiences to reduce ecophobia is crucial for preservice teachers to overcome their fears.

It is often easier to address preservice teacher ecophobia in a one-on-one situation rather than in a large social group. One-on-one contact increases the concentration on the desired behaviors, reduces the concern about the potential for embarrassing behavior in front of peers, and provides targeted verbal and physical support based on the preservice teacher's unique needs. Mentoring a student in a one-on-one context reduces their ability to not confront their ecophobia by relying on someone else in the group to touch an owl pellet or pick up an earthworm. Individual attention also allows the teacher educator to provide essential information to the preservice teacher that dispels any myths or fears they may have about the animal or object. The challenge in a typical preservice methods course with over 30 students is to find the time to address individual needs. One promising strategy that addresses both the role model issue and engages positive social peer pressure is to use peer role models to demonstrate appropriate environmental attitudes and behaviors.

The ecophobia characteristic in preservice teachers provides a substantial barrier for some students to participate fully in EE. Teacher educators need to consciously understand and explicitly plan for ecophobia in order to reduce preservice teachers' fears and encourage their participation in EE.

Physical Discomfort Avoidance

As described in the opening vignette, preservice elementary teachers often avoid minor physical discomforts that prevent them from fully engaging in environmental learning. Dew on their toes, rain on their hair, too much exercise for their muscles, insects on their arm, dirt on their clothes, and sun in their eyes are just some of the physical discomforts encountered by preservice teachers in EE. These behaviors either openly voiced as a verbal complaint or demonstrated through quiet noncompliance should be addressed.

One choice open to teacher educators is to move ahead and ignore complaints about physical discomfort. "Ah, come on. It's OK. The dew isn't going to hurt your toes," could be one response. Another choice is to increase the pressure to engage in the activity to the point where preservice teachers feel compelled to participate. The hope being that preservice teachers discover "it isn't as bad as I thought" resulting in a positive experience. This is a sensitive task for the teacher educator. As discussed earlier, providing enough encouragement to extend their perceived physical limitations is necessary without misusing course instructor power over preservice teachers in a way that results in coercion or a negative experience.

Another instructional strategy consists of avoiding physical discomforts by modifying EE activities. This approach assumes that providing learning tasks that take into consideration the comfort level of preservice teachers will develop the capacity for later risk-taking. For instance, playing a simulation game in the parking lot rather than in the wet grass. Another possibility is to reduce the anticipated physical discomfort through extensive prior preparation. Announcing in preceding class periods about the upcoming field trip, outdoor event, or hands-on activity in some cases can reduce issues with physical discomforts; however, in other cases it may serve to raise anxieties. For example, I have found it helpful to emphasize wearing appropriate outdoor clothing in preparation for a field trip to reduce potential complaints about physical discomfort due to weather conditions. Such strategies can be helpful to address issues with regard to preservice teachers' physical discomfort during EE activities.

Mechanical Disinclination

> The sky was blue and clear as I looked at the 30 elementary preservice teachers assembled before me. We held class outdoors to organize our teaching stations for the wetlands festival with a local elementary school. These preservice teachers would be teaching

wetlands-related activities to elementary school children in a few weeks. A non-profit wetlands educator came to class that day as a guest to help explain and organize the teaching stations. She described each station's activity, showed the students the equipment and described the science journal activity at each one that tied the activities together with the overall theme.

One of the stations involved demonstrating a ground water flow model. It consisted of a sealed thin clear plastic container that allowed a view of the underground "soil" and several moving parts such as a water pump. The idea was to pour water into the model and then work the pump, which made the water flow through the ground water system. The model demonstrated the movement of groundwater.

"Who wants to teach the ground water flow model?" the wetlands educator asked.

The pause grew longer.

"It really is very easy. All you have to do is pump the hose."

No hands went up.

Finally, one woman raised her hand, "OK, I'll do it. But I shouldn't do this station. I'm such a klutz when it comes to mechanical things. I usually break stuff."

The class giggled nervously.

I have observed that a high percentage of preservice elementary teachers exhibit low self-confidence and aptitude for manipulating physical objects. They demonstrate reluctance to teach a lesson that requires any sort of mechanical manipulation. There are many factors at work that predispose preservice teachers toward these attitudes and behaviors, which inhibit their confidence leading EE activities. Traditional gender role-based upbringings, media exposure, poor prior experiences, lack of role models, or a lack of opportunity to successfully engage in mechanical manipulations are just a few. Regardless of how these attitudes were formed, this characteristic prevents teachers from feeling confident with physical materials that often accompany EE activities.

One successful strategy I have used involves forming partnerships with local schools to set up structured EE field experiences. Many different possibilities exist for teacher educators to organize actual teaching with small groups of children that result in positive EE instructional experiences. One example of this I found very helpful was an elementary school/science methods course collaboration in which preservice teachers taught wetlands ecology activities at teaching stations during a wetlands festival for elementary school students. The preservice teachers researched their environmental content for the stations and planned their teaching activities. Many of the activities required manipulating nets, buckets, microscopes, magnifiers, models, and other apparatus. The preservice teachers were given opportunities in class through modeling, guided practice, and independent practice to become proficient with their equipment. A local wetlands environmental educator provided extra support to assist preservice teachers with their preparation. Careful coordination with practicing teachers and administrators aligned the activities to state standards. Attention to the logistics permitted the preservice teachers to experience small groups of 8–10 students for their wetland lessons and repeat their teaching with different groups multiple times over the day ensuring success.

On the day of the wetland festival, the nervous preservice teachers began their first lesson and immediately connected with the students. The elementary students displayed much energy and joy typical of children who find themselves outside.

The preservice teachers tentatively began their first lesson and soon were caught up in the children's enthusiasm. As they taught the same lesson again, their confidence improved and their comfort with the equipment grew stronger. By the end of the wetland festival day, the preservice teachers gained much skill and confidence with their equipment. Preservice teachers expressed comments about their increased confidence and understanding of the wetlands content by teaching the same lesson multiple times allowing them to make adjustments. Overall, partnering with schools to create positive EE teaching experiences has substantial benefits. Preservice teachers can grow tremendously in their ability to reduce their mechanical disinclination with prior preparation, modeling, mentoring, and monitoring.

Need for Highly Structured Assignments

> The class had been wonderful. We were outside demonstrating how to make observations using nature journaling techniques. The instructional task was to share ideas and resources for creating a science/nature journal with elementary children. Each preservice teacher had participated in the nature journaling activities, received an 8-page handout and participated in examples of nature journal projects (Leslie and Roth 2003). Formal scientific systematic observation journal formats as well as free-form journal formats were discussed and practiced. I explained that their course assignment was to spend some time outside and create one journal entry. A detailed scoring rubric was provided for the assignment. The students had some questions:
> How many pages does it have to be?
> How much time do I have to spend outside?
> How many sketches do I need?
> Can I draw animals or do you want us to draw plants?
> Does it have to be in a notebook or can I staple paper together?
> What if I can't draw very well, will it affect my grade?

Their unspoken question was, "What do I have to do to get an A?" Their questions revealed concern for the trivial format of the assignment not the instructional intent. These students were focused on getting the assignment done rather than focusing on the learning. They asked questions, very important to them, but sounded to me more like, "What color do you want me to paint my tree?" I would have preferred them to ask, "What drawing activities help elementary children increase their observation skills?" When preservice teachers ask these questions, I patiently explain my expectations, refocus them on the intent of the task, and promise support through the process. Their questions may be a result of a need, accumulated over years of schooling experiences, for knowing specific details for meeting course requirements.

There are several strategies I have used to address this need for structure. Over the years, I have revised assignments over and over to better address their need for detailed, quantified assignment structure. In effect, I increased the specificity and quantifiable aspects of the assignment. In some cases, I provided assignment descriptions that contained so much detail that the assignment essentially became a

prescription for them to follow. While some students feel comfortable with this level of structure, I have come to feel that in the long run, this does not provide the best learning experience. One strategy that successfully challenges the students' need for structure is to provide little, if any, of the detailed quantitative procedures they request. Providing less structure, not more, becomes an effective discrepant event if the teacher educator can provide a supportive environment from which to negotiate through the anxieties of the preservice teachers. They have to trust that their instructor will not hold them accountable to unannounced criteria for their grade.

If we hope to educate teachers who can creatively solve unique curricular dilemmas without clear direction from authority figures, then it follows that we should set up similar situations in their university coursework. Similar to using open inquiry during instruction, preservice teachers initially feel confused and even angry at the lack of specific procedures to follow for their assignment. They say things such as, "What do you want me to do?" My goal of providing practice in self-directed learning conflicts with their image of professor as the knower of all answers and authoritarian prescriber of learning tasks. As an environmental educator, I feel it is an essential skill for citizens to be able to look at their community, assess its needs, and develop multiple approaches for resolving environmental issues. Teachers, in particular, need to experience learning tasks where there are not highly structured pathways to find the correct answers. Such tasks model environmental social decision-making.

Summary

This chapter provides a discussion of my journey as a teacher educator seeking to understand the nature of preservice elementary teachers and the pedagogical content knowledge involved with integrating EE into my elementary science teaching methods courses. Through these phenomenological vignettes, I hope to have illuminated key preservice teacher characteristics in a way that resonates with the elementary science teacher educator. The discussion of EE instructional strategies provides teacher educators with the opportunity to reflect on their own practices that address preservice teacher characteristics. The interdisciplinary nature of EE lends itself well to inclusion in elementary science teaching methods courses. While this chapter focuses on science teacher education, it should be noted that EE can be integrated into other disciplinary areas in the teacher education curriculum.

The challenges faced by teacher educators are substantial. Environmental educators, who are not science teacher educators, often discuss integrating EE into science teacher education as "outsiders," unaware of the constraints and pressures involved in a relatively short 45 contact hour course. As a science teacher educator and an environmental educator, I hope to have provided some insight into several of the dilemmas derived from the nature of the learner. The goal of helping preservice elementary teachers to learn to implement EE in their future classrooms through integrating EE into a science teaching methods course is an important one. The task

requires teacher educators to become dedicated champions of EE, persevere through substantial challenges, and refine instructional strategies that take into account the nature of the preservice elementary teacher.

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