Assessing Teacher Self-Efficacy through an Outdoor Professional Development Experience

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Abstract

Teachers' self-efficacy and outcome expectancy have been consistently associated with student achievement. This research examines changes in these constructs for K-12 inservice teachers who participated in a two-week summer professional development experience designed to promote the use of outdoor spaces for environmental science instruction. The investigators used the Science Teaching Efficacy Belief Instrument, version A (STEBI-A) (Riggs & Enochs, 1990), which was modified to include statements about outdoor science teaching. Pre- and post-assessment results for the 22 teachers who completed both assessments indicate significant increases in outcome expectancy scores for classroom and outdoor science teaching, as well as self-efficacy scores for outdoor science teaching, from pre- to post-test. An unexpected observation was the reported decrease in self-efficacy for traditional science teaching over the same period. The results are examined further and explained using supporting data from the professional development, specifically, assessments on participants' beliefs about outdoor instruction, audio taped small group discussions, reflective journal entries, and researcher notes from classroom observations. Recommendations for PD planning and future research on teacher self-efficacy and outcome expectancy are presented.

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Over the past several decades, environmental studies (ES) have become an increasingly important component of the public school curriculum in the United States, primarily in science and social studies (American Association for the Advancement of Science, 1993; Connell, 1999; Hicks & Bord, 2001; National Research Council, 1995; North American Association for Environmental Education, 2004). Researchers have linked a thorough understanding of science-related ES topics with more positive attitudes and beliefs about the environment which may, in turn, result in appreciation and concern about the planet's resources and may eventually lead to actions such as living more sustainably and repairing environmental damage (Eagles & Demare, 1999; Fisman, 2005; Semken & Freeman, 2007). By contrast, others (Bloom & Holden, 2011) posit that, because knowledge alone does not lead to behavioral change, educators should instead approach environmental education with the idea that a "sense of agency and control lead

to the knowledge of issues and action strategies, which lead to an intention to act" (Sobel, 2007, p. 16). Regardless of the anticipated or actual outcome, teachers (and subsequently, their students) struggle with comprehending the complexity of Earth's systems and interrelationships, in addition to the sociocultural, ethical, and (ultimately) emotional aspects of many environmental issues (Sobel, 2007). Outdoor spaces, such as school grounds, parks, and native land naturally lend themselves to the study of these topics. Outdoor learning experiences provide a meaningful context for students to better understand connections between humans and their environment (Connell, 1999; Littledyke, 2008), and have the potential for additional benefits, such as greater understanding and appreciation of nature through direct interaction, general physical and emotional health, and opportunities for project-based community learning (Corcoran, 1999; Louv, 2003; Sobel, 2004).

Unfortunately, students' exposure to the natural world has become increasingly limited in the U.S. for a number of reasons: parents' concerns about their children's safety, the overwhelming popularity of technology-based entertainment, and the shortening – or phasing out entirely – of recess in many parts of the country, particularly in urban, high-minority, high-poverty areas (Center for Public Education, 2008). In addition, curricular frameworks do not often support the use of outdoor spaces for science instruction. Many school administrators and teachers also have concerns about cost, liability, student safety, and the lack of academic benefits associated with many types of outdoor activities compared to the efforts expended (Bloom, Holden, Sawey, & Weinburgh, 2010).

So how can teachers improve their understanding of the multiple disciplines comprising ES, and learn both indoor and outdoor pedagogical strategies to meaningfully and effectively help their students construct this knowledge? In recent years, opportunities for teacher professional development in this area have expanded beyond traditional district-led workshops to include experiences in informal settings (science museums and nature centers) and outdoor spaces (school grounds, parks, native land), as well as opportunities to participate in legitimate science research (National Earth Science Teachers Association, 2010; National Institutes of Health, 2010; National Science Teachers Association, 2010; Vanderbilt Center for Science Outreach, 2010) and community service projects (Almeida, Bombaugh, & Mal, 2006; Jung & Tonso, 2006; Kenney, Militana, & Donohue, 2003). However, despite the means available to prospective outdoor educators for developing appropriate competencies, many teachers continue to encounter challenges in implementing outdoor ES instruction. The source of these challenges can be internal (such as lack of experience and content knowledge) or external (logistics, administrative support) (Bloom et al., 2010). Any number of these factors can affect teachers' sense of self-efficacy. Self-efficacy beliefs - individuals' judgments of their competence to execute a particular task - are thought to be one of the strongest predictors of human motivation and behavior (Bandura, 1986) and have been helpful to teacher educators in better understanding the role these beliefs play in teacher development and practice (Pajares, 1992).

The research described herein is part of a larger study undertaken by the investigators as part of a year-long professional development (PD) program developed to

inform K-12 teachers in the use of outdoor spaces for ES instruction. The overall PD objectives follow: 1) to provide integrated instruction on environmental systems and issues to complement participants' existing science content knowledge; 2) to model the use of outdoor environments for instruction to help teachers improve their pedagogical skills for teaching ES in unique ways; and 3) to provide guidance in aligning content and learning experiences with state science standards (which is measured by the Texas Assessment of Knowledge and Skills, or TAKS) – as well as national standards - to fulfill school district curriculum requirements. We anticipated that meeting the goals of the PD program would result in improvements in pedagogical content knowledge (PCK), science teaching self-efficacy, and the ability to use the outdoors for ES instruction. Shulman (1986) introduced the concept of PCK by arguing that, because subject matter knowledge and general pedagogical strategies are neither mutually exclusive nor sufficient for capturing the construct of teacher knowledge, the two are accessed simultaneously as teachers interpret a subject in a way that makes it accessible to learners.

Literature Review

Teacher self-efficacy has been an integral sub-discipline of educational research since researchers first defined the construct in the mid-1970s (Berman & McLaughlin, 1977; Labone, 2004). Believed to be a strong predictor of motivation and behavior (Bandura, 1977), teacher self-efficacy has been consistently correlated with teacher learning and practice, as well as student attitudes and achievement (Ashton & Webb, 1986; Goddard, Hoy & Woolfolk-Hoy, 2000; Moore & Esselman, 1992; Tschannen-Moran & Hoy, 2007). Based upon an integrated theoretical framework proposed by Bandura (1977), one may conceptualize the construct as having two distinct components: *personal efficacy*, the level of confidence about one's own abilities and effectiveness as a teacher, and *outcome expectancy*, the belief about how much student learning depends on teacher effectiveness in general (as opposed to other factors over which teachers have less direct influence). Bandura (1977) also argues that four sources of personal information –performance accomplishment, vicarious experience, verbal persuasion, and emotional arousal—strongly influence these types of beliefs.

Early research on efficacy in education defined the construct as a primary influence on teacher expectations (for oneself and one's students), teacher classroom practice and ultimately, student achievement (Gibson & Dembo, 1985; Huitt, 2000; Tschannen-Moran & Hoy, 2001). Ashton (1990) subsequently addressed teacher efficacy as an important element of teacher education and professional development. Perhaps not surprisingly, one of the strongest antecedents to self-efficacy is teaching experience (Hebert, Lee, & Williamson, 1998; Tschannen-Moran & Hoy, 2007). Preservice and novice teachers, lacking the mastery experiences of veteran teachers, typically must rely more heavily on other factors, such as available teaching resources and internal support (what Bandura [1977] termed "verbal persuasion"). However, with an increasing number of years of experience, perceived self-efficacy often improves (Brand & Wilkins, 2007; Sodak & Podell, 1997). In addition, preservice teachers perceived active, rather than passive instructional development strategies to be more important for increasing personal teaching efficacy (Mosley, Huss, & Utley, 2010)

Collective efficacy relates to the "culture" of schools, which may be influenced by teachers' administrative support, influence on policy, and control of their own classrooms. This form of efficacy is an equally important factor in teachers' attitudes and self-efficacy, as well as teachers' sense of professionalism and retention (Barrett, 2007; Goddard, Hoy, & Hoy, 2004; Hoy, Sweetland, & Smith, 2002; Ware & Kitsantas, 2007). Although collective efficacy was not measured directly as part of this study, it is still considered relevant because many of the teacher participants from the same schools and/or science departments had significantly different (and in some cases, more positive) experiences with this PD than those who attended on their own.

Regarding science teaching specifically, some researchers have found a high correlation between teacher efficacy and the quantity and quality of teacher's early school science experiences, educational level, number of science courses taken during college, amount of time per week devoted to science instruction, and number of days in the school year (Bleicher, 2004; Shireen-Desouza, Boone, & Yilmaz, 2004; Tshannen-Moran & Hoy, 2007).

During the past decade, advances in theoretical grounding and improved measurement techniques have helped to address several difficulties identified in the research on teacher self-efficacy, such as the construct's definition, conceptualization, and validation (Henson, 2002; Pajares, 1992). Another criticism of the use of this construct is the contextual nature of any given response on an efficacy belief instrument (Raudenbush, Rowan, & Cheong, 1992), the complexity of individuals' belief-structures that go into making self-judgments, and the challenges inherent in understanding both of these enough to meaningfully improve teacher practice (Pajares, 1992). Much of the efficacy research in education conducted to date has established a strong positive correlation between teachers' perceived self-efficacy and teachers' educational beliefs, instructional decisions, curricular planning, and classroom practices (Labone, 2004). However, existing quantitative instruments do not sufficiently capture factors we believe to be highly relevant to this type of educational research, namely how teachers' educational belief-systems develop over time and with experience, as well as the context-specific nature of self-efficacy judgments made during any given efficacy measurement (including the Likert survey used in this study). Therefore, proposed changes to research on teacher efficacy should include a qualitative component (Hebert et al., 1998; Henson, 2002), measurement instruments that better reflect the context in which teachers make self-efficacy assessments (Wheatley, 2005), and a broader definition of efficacy beyond the "traditional" dimensions of teaching, such as social awareness, the building and value of relationships with others, and empathic action (Labone, 2004).

Methodology

Context

The present study examines changes in self-efficacy and outcome expectancy as a result of teacher participation in a two-week, field-intensive PD experience designed to increase PCK (Schulman, 1986), improve general science teaching ability, and help participants find ways to use outdoor spaces for ES instruction. The investigators

conducted the PD from late July through early August 2008. The PD's science component emphasized local biodiversity, abiotic factors related to diversity (i.e., geology, soil, and topography), and field sampling techniques. Participants first received an introduction to ES instruction using the university's campus grounds, then moved to a botanic garden, and finally spent two overnights at the local school district's Outdoor Learning Center (OLC), a 228-acre native prairie/woodland habitat located on a lake. The researchers designed the program, objectives, and activities in accordance with recent literature on effective PD (Darling-Hammond & Richardson, 2009; Desimone, Porter, Garet, Yoon, & Birman, 2002; Johnson & Marx 2006; Lotter, Harwood, & Bonner, 2006; Lumpe, 2007; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Supovitz & Turner, 2000), which resulted in the PD being sustained (in both number of hours and duration), active, collaborative, content-rich, and aligned with state science standards and district curricular frameworks.

Participants

Participants included 36 K-12 teachers (5 males and 31 females), most of whom taught in schools within one of the local school district "pyramids" (i.e., elementary and middle schools whose students advance to the same high school). For part of the summer session, participants attended the PD in two separate cohorts, one comprised of 18 teachers from five elementary schools and the other 18 secondary teachers from two middle schools and one high school. In accordance with funding agency requirements, the investigators selected all PD participants from schools characterized as urban and economically disadvantaged, with a high number of English language learners and a low passing rate on the state standardized science assessment.

Data Collection

To assess participant efficacy in the areas mentioned above, the investigators administered a modified version of an efficacy measurement instrument at the beginning and end of the PD event. Riggs & Enochs (1989) developed the Science Teaching Efficacy Belief Instrument [STEBI], version A (STEBI-A) for use with inservice teachers and version B (STEBI-B) for use with preservice teachers (Enochs & Riggs, 1990). The authors modified the STEBI-A for use in this study. STEBI scores reflect two types of beliefs: personal efficacy for teaching science (PTSE) and science teaching outcome expectancy (STOE). PSTE items are "I"-statements that reflect the level of confidence that teachers have in their own effectiveness as science teachers, (for example: "I know the steps necessary to teach science concepts effectively"). The STOE items reflect their beliefs about how much students' science learning depends on teacher effectiveness in general (for example: "If students are underachieving in science, it is most likely due to ineffective science teaching"). The respondent rates each item on a scale of 1 ("disagree strongly") to 5 ("agree strongly"), with negatively-worded items scored in the opposite direction.

Construct validity (N=305) was established for the STEBI-A (Riggs & Enochs, 1990) using a Pearson's r test; seven criteria were selected based upon their established correlation with science teaching efficacy beliefs and were significantly correlated with at

least one scale in a positive direction. Factor analysis conducted initially to assess the instrument's reliability supports the contention that the scales are distinct, measureable constructs (Riggs & Enochs, 1990), although measured internal consistency was slightly higher for the PSTE scale, which is not surprising given that teachers may find it easier to rate their own beliefs and behavior relative to external factors over which they may feel they have little control.

To better align with context of the PD, the investigators created equivalent statements for each PSTE and STOE statement that specifically referred to teaching science in outdoor environments by adding the qualifier "outdoor" to the term "science education." Appendix A contains the 50-item modified version of the instrument that was administered to all registered PD participants through an online survey tool (Zoomerang©) one week before and one week after the PD. The investigators analyzed the quantitative data using a paired t-test to assess the significance of the difference between pre- and post-PD mean STEBI scores.

Supporting data for the qualitative evaluation were obtained from investigator field notes and other assessments, as described below:

- Pre-PD teacher information survey (education level, science background, grade level taught, general inquiry strategies used in the classroom, type/frequency of outdoor use at school, including recess) administered to all participants online

- Results of an activity conducted on the first and last days of the PD where all teacher-participants conducted open "voting"on general belief statements about traditional and outdoor science instruction that were posted around the classroom

- Audio-taped and transcribed focus group discussions in response to the following prompts:

    - Day 1: *What comes to mind when you think of "science?" What are your reasons for using the outdoors for science instruction? What are your reasons for not doing so? What do you hope to gain from this PD experience?*

    - Day 4: *Briefly describe your early life experiences in the outdoors.*

    - Day 7: *What outdoor instructional challenges have been resolved so far by your experiences in this PD? What challenges remain?*

    - Day 9: *Compare and contrast your response to a directive from your principal to teach science outdoors a month ago versus today.*

- Review of participants' journal entries, which included reflections on the Day 1 focus group discussion, expectations prior to and during the OLC visit, and perceived gains from the outdoor PD experience. Reflective writing has been

shown by Bell (2001) and others to positively affect preservice teacher self-efficacy for inquiry-based science instruction.

- Results of an activity conducted about halfway through the PD where all teacher-participants prepared Venn diagrams comparing and contrasting indoor and outdoor classrooms

- Evaluation of the two-week PD experience: *What went well for me/what did I like? What didn't go well/what didn't I like? What would I change?*

The qualitative data were analyzed using methodological triangulation (Denzin & Lincoln, 1998), whereby the authors gathered the data using multiple methods, such as interviews, observations, questionnaires, and documents. Although qualitative inquiry is inherently multi-methodological, triangulation "reflects an attempt to secure an in-depth understanding of the phenomenon in question" (Denzin & Lincoln, 2003, p. 8).

Quantitative Analysis - STEBI Results

Twenty-one of the 36 participants completed both the pre- and post-STEBI assessments. As shown on Table 1, participants at the beginning of the PD generally ranked their self-efficacy in teaching outdoors significantly lower than teaching in the classroom. Pre-PD ratings for teacher beliefs about all outdoor items as a whole (PTSE and STOE) were significantly less positive than those for traditional science teaching [$t(21)=4.52$; $p<0.001$]. As anticipated, belief scores for outdoor teaching increased by the conclusion of the two weeks. Specifically, STOE increased significantly from pre- to post-test for science teaching both in the classroom [$t(21)=2.98$; $p<0.01$] and outdoors [$t(21)=4.25$; $p<0.001$], and PTSE for outdoor science teaching rose significantly [$t(21)=4.59$; $p<0.001$]. An unexpected observation was the observed decrease in PTSE scores for general science teaching over the same time period [$t(21)=8.30$; $p< 0.001$].

Qualitative Analysis & Discussion

Due to the number of participants (n=21) and limitations of inferences about teacher self-efficacy based solely on quantitative data (Labone, 2004; Pajares, 1992; Wheatley, 2005), the investigators conducted qualitative analyses of selected supporting data from the PD to support and explain the quantitative findings.

Table 1
Paired t-test results for modified STEBI-A

Scale	Pre Mean (sd)	Post Mean (sd)	Delta	Significance
Personal teaching efficacy for general science instruction	3.92(0.44)	3.29(0.18)	-0.63	p<0.001
Personal teaching efficacy for outdoor science teaching	3.58(0.36)	3.88(0.32)	+0.30	p<0.001
General outcome expectancy for science instruction	3.66(0.40)	3.88(0.39)	+0.22	p<0.001
General outcome expectancy for outdoor science teaching	3.54(0.41)	3.84(0.42)	+0.30	p<0.001

Observed Increases in PTSE and STOE Scores

Pre-PD. Regardless of the nature of participants' self-reported experiences with the outdoors and outdoor instruction (which varied considerably), pre-PD PTSE-outdoor instruction scores were relatively low overall. Early PD assessments, reflective journaling, and group discussions allowed participants to elaborate. Though most participants believed outdoor learning could be beneficial for their students, many perceived significant challenges. In general, these challenges involved geography (few suitable and/or convenient outdoor spaces close to their campuses), logistics (planning and getting appropriate permissions/waivers), administrators (narrowly focused on standardized testing and in general distrustful of how outdoor instruction could be one means for student achievement), and teachers' own acknowledged deficiencies (in science content, outdoor pedagogy, student management, and aligning outdoor curriculum with the science standards).

> *"My students can't focus [outdoors] despite the specifics I give them. They don't, even if they get the gist of it. I'd like to incorporate more outdoor learning but I don't know how. I need procedures. It all goes back to needing PCK." Elementary teacher*

> *"We don't use them [outdoor spaces} sometimes because either a place isn't available on campus or it's available close by but you have to have permission, the principal has to sign off … **if** they even let you do it at all. I'm grateful that we have a garden." Middle school teacher*

> *"Our focus is to pass TAKS. If we do that, we don't have to go outside." Middle school teacher*

> *"The logistics are too complicated. I've been to the [district's] Outdoor Learning Center twice for training but there was no explanation of who pays for busses and chaperones. Who comes with me? Do I bring all 300 of my students?"High school teacher*

Mid-PD. After seven days of instruction, active learning, reflective journaling, and interaction with the PD instructors, peers, and OLC staff, participants showed evidence of progressing from apprehension to more positive attitudes.

> *"This isn't as bad as I thought it would be; I don't know why I was so scared." Elementary teacher*

> *"I can do this." Middle school teacher*

They also began to figure out how to overcome many originally-perceived challenges, such as logistics:

> *"I feel a lot more comfortable with it [the OLC] now that I know what it is, where it is, and how many kids I can comfortably bring out here." Middle school teacher*

classroom management:

> *"I think that getting procedures in place, giving them [the students] something to focus on; not necessarily giving them the 'punch line' or doing too much, you know, just reviewing your expectations." Elementary teacher*

and curriculum development:

> *"We're only given … 45 minutes and we don't have enough time to do the lab, so we could incorporate science into other subjects. Like, you could do an alphabet walk and you could also, maybe, do some writing [about science] and get your science in for the day." Elementary teacher*

> *"I can see now that maybe I haven't allowed them [the students] the opportunity to enjoy science. Sometimes the TAKS or pressure of staying with the curriculum scope and sequence has dictated our time spent on science content." Middle school teacher*

> *"We got some ideas for other labs that you would normally never have thought about going outside before." High school teacher*

In addition, these experiences appeared to provide a new perspective for

both novice teachers:

> *"As a new teacher, getting to do this is letting me learn the boundaries of what we can and can't do, what the options are. Talking to you guys [peers from the HS science dept] is really helping me." High school teacher*

as well as those with more experience:

> *"I liked hanging the sheet up with the fluorescent light over it - that was cool! We could do that at our school very easily, and do it during the different seasons and see what different bugs we get." High school teacher*

Post-PD. Course evaluations completed on the last day of the PD indicated that most participants made significant gains as a result of the two-week experience. Many reported the greatest enjoyment with the overnight trips at the OLC. Other items mentioned on the evaluations that lend great support to the high PSTE and STOE scores for outdoor instruction include:

- Greater confidence as a teacher and outdoor educator

- Knowledge gains in environmental science content, pedagogy, field techniques, and logistics for outdoor instruction

- Ideas for outdoor destinations to visit with students (including their own school yards) and what to do there, in ways that align with state standards and district curriculum requirements

- Opportunities to interact and collaborate with other teachers in an informal setting – this was most frequently mentioned by participants who attended the PD with their grade level or science department colleagues

Though not explicitly planned in this way, the PD actually provided participants with various opportunities to tap into all four sources of personal information believed to influence self-efficacy, as described by Bandura (1977). The investigators modeled actions and behaviors associated with teaching outdoors, providing *vicarious experiences* that may have generated expectations for improvements in participants' behavior. Allowing participants to *perform tasks and accomplish them successfully* may have elicited feelings of mastery and subsequently, higher self-efficacy, particularly among those who didn't believe they could perform these tasks at all. However, their sense of mastery was in the role of student and not as teacher. Some of the observed increases may also have been due to the *verbal persuasion* and support offered by the investigators and peers. One of the most successful long-term outcomes of the PD was the formation of professional learning communities, particularly among the 6th grade teachers from one participating middle school and the high school science teachers who were all from the same campus. These groups continued to communicate and collaborate long after the PD ended. Finally, providing participants with time for reflective journaling outdoors may have provided some with a mechanism to minimize their *emotional arousal*, as they gradually became desensitized to negative feelings about the outdoors.

Decrease in Self-Efficacy Scores for Traditional Science Teaching

As stated previously, this observation was both interesting and unexpected. Although the primary focus of the PD was to develop PCK in environmental science (ES) topics and strategies for teaching ES *outdoors*, we incorrectly assumed that this knowledge would translate easily to the indoors and that the PTSE scores would reflect that. Further analyses of the qualitative data provide several possible explanations.

Reliability of self-report data. The PD primarily served teachers from schools within a local district pyramid as part of a larger district-driven ES initiative. The goal of the initiative was to turn a low-performing high school into an environmental academy. Therefore, administrators from several schools within the pyramid made attendance mandatory (or strongly recommended) for their teachers. Of these, a few had previously attended similar PD events with us, and were almost immediately at ease in the PD. Several of the remaining participants (who were unfamiliar with us) were initially distrustful and reticent about PD in general:

> *"I have been there [the OLC] numerous times and I felt like each experience has been worse than the last. I really want to find something that I can use in my classroom and take away with me. This is not something that I am good at or really interested in. I prefer to see the big picture and why and how things work. It has never really been important to me to know the little minor details. I expect to learn how this is useful to me!" High school teacher*

For the latter group, pre-PD responses may have been artificially high due to these teachers' over-estimating their level of efficacy based on their perceived expectations of the providers instead of their own genuine personal beliefs.

Novelty of a new experience. After experiencing outdoor learning and teaching through "rose-colored glasses" for two weeks, teachers may have begun to perceive traditional classroom instruction as relatively monochromatic by comparison. We administered the post-PD STEBI assessment within a few days of the PD conclusion, before participants had returned to their classrooms to begin a new academic year. Therefore, the teachers' post-PD beliefs about their own abilities in traditional science teaching may have been based, to some extent, upon the "reality" of their prior experiences, current directives and constraints imposed by their administrations, and the anticipation of a new school year where their newfound knowledge may not yet have been translatable to their classrooms. By contrast, the responses for outdoor science teaching may have been artificially high if the novelty of the summer experience had not yet begun to wear off.

> *"The other thing is lack of support from the administration because they don't see second grade science as an important subject." Elementary teacher*

> *"If they [administrators] see you outside, they're going to think that you're out at recess." Elementary teacher*

> *"About the OLC, I don't know if we are allowed to diverge from what the admin wants us to do."Middle school teacher*

> *"You guys go to PD … it doesn't have to be outside; workshops, conferences, and you get all these great resources and you never use them again because there's no way to see how it fits in the framework, And then it doesn't matter because if it's not in the framework, you can't even do it because I have to do x-y-z." High school teacher*

Subsequently, they may have downplayed their PSTE responses for traditional science teaching. Indirect evidence for this observation exists primarily in the overwhelmingly positive PD evaluations and the VENN diagram exercise comparing outdoor and indoor classrooms (Tables 2 and 3). Many of these diagrams, particularly those prepared by the elementary teachers, appeared to "glorify" the outdoor classroom *at the expense of* the indoor and surprisingly lacked significant commonalities between the

two environments. With time, efficacy scores for outdoor instruction may have decreased, as observed after other outdoor learning programs. Moseley, Reinke, & Bookout (2002, 2003) attributed this observation several weeks after a three-day PD to the effects of the positive experience wearing off over time.

Theoretical disequilibria. The investigators helped participants revise their PCK for environmental science topics, outdoor instruction, and inquiry-based science teaching. What they learned did not always align with their own knowledge & belief frameworks – or the district's. As a result, some participants may have felt more uncertain about their own traditional science teaching effectiveness or a potential loss of control (closely correlated with efficacy [Huitt, 2000]) after discovering *how much they really didn't know*.

> *"I learned that I might have to give up some control to achieve certain outcomes." High school teacher*

> *"I learned that in an educational setting, you sometimes don't have control of your tasks and outcomes." High school teacher*

Contextual Nature of PD Not Addressed by the STEBI. The STEBI has served science education well for many years. However, in today's classroom environments and considering the evolved view of what constitutes quality science teaching, we must ask ourselves if the STEBI instrument can still adequately measure the perceived self-efficacy of today's teachers. Perhaps the STEBI (and other efficacy instruments of the same era) does not accurately reflect either the reality of accountability-at-all-costs of No Child Left Behind or the democratic, inquiry-oriented classroom to which many science teachers and science teacher educators currently ascribe (Wheatley 2005).

Table 2
Elementary Teacher VENN Diagram Results: Outdoor vs. Indoor Classrooms

Outdoor	Both	Indoor
Perceived Positive Attributes -Children love to be outdoors; physical fitness benefits -Change of scenery; natural beauty, diversity, variability, light, expansive, always changing -Can be solitary/peaceful or group/active - Teachers better understand students & can be more flexible, empowered -Content: concrete, brings "vocabulary to life," more lessons to take home -Pedagogy: sensory, kinesthetic, exploratory, student/interest-driven inquiry, mental stimulation -Results: slow pace, observation, reflection, independent thought, discovery, open-ended questions, empowerment, vocabulary **Perceived Negative Attributes** -Can motivate or aggravate (too many distractions) -Less control over students -Can't control environment -Need chemicals to deal with bugs -More logistics (admin support, time, money, parental permission, chaperones, curriculum), less student control	**Perceived Positive Attributes** -Learning occurs, knowledge is generated -Can be fun -Can use many different tools & strategies **Perceived Negative Attributes** -Requires a lot of preparation and planning	**Perceived Positive Attributes** - Better control of environment (temperature, noise, light, dirt) -More structure, better student control (including sending them to the principal's office) -Easy access to materials, restroom, food, technology Conducive to lab experiments, procedures and routines, teacher-led inquiry **Perceived Negative Attributes** -Confined, sterile (have to create your own beauty) -Indoor distractions (announcements, fire drills, always watching the clock, waiting for the bell) -Greater tendency for students to cheat -Less time/space for good reflection

Table 3
Middle/Secondary Teacher VENN Diagram Results: Outdoor vs. Indoor Classrooms

Outdoor	Both	Indoor
Perceived Positive Attributes -Extension of the classroom -Natural diversity, always changing, open space & time, fresh air, peaceful -Content: sensory, interdisciplinary, "real-world" connections, concepts come to life -Pedagogy: conducive to student-centered (and sometimes, teacher-led) inquiry, engagement, interactive, diversity of activities, exploration -Results: concepts "come to life," students can grow in different directions **Perceived Negative Attributes** -Need to create context -Can't control environmental conditions -Less control over students -Liability, health & safety concerns -Too "biology-heavy" -More logistics (transportation, chaperones, equipment)	**Perceived Positive Attributers** -Outdoors & indoors are complementary -Conducive to inquiry and learning experiences -Make use of best practices and "teachable moments" -Depending on students, can be a positive experience **Perceived Negative Attributes** --Depending on students, can be a nightmare -Potential health & safety risks -Requires preparation, planning, setting expectations & setting ground rules	**Perceived Positive Attributes** -Better control of environment (temp, noise, light, dirt) -Safe & predictable -Better student control -Easy access to resources -No sponsors, logistics, travel **Perceived Negative Attributes** -Confined, sterile (lacks natural diversity), institutional -Indoor distractions/ disruptions lead to poor student behavior -Less conducive to interdisciplinary study

If so, then changes in teacher efficacy research must occur. Efficacy researchers must develop new instruments that better reflect today's classroom environments and current beliefs about science teaching. In addition, qualitative methodologies must supplement this research to better understand the context of teachers' self-efficacy beliefs.

Conclusions

Education reform has called for revised science standards that include ES, and the teacher expectations that go along with them for improving student gains in science. Teacher professional development is one of many responses to this call. Research has shown the benefits of using the outdoors for teaching science, not the least of which is that many outdoor spaces naturally lend themselves to ES study. We conducted this research during a two-week summer PD intended to improve K-12 teachers' ES content

knowledge and teach pedagogical strategies for inquiry-based science teaching, particularly using outdoor spaces.

Because the PD was research-based, we used multiple measurement instruments and data types to assess participant gains and the quality of the experience. One of the constructs measured was teacher self-efficacy, which Bandura (1977) posits is a precursor to teacher motivation and behavior. The initial objective of the study was to measure changes in participant self-efficacy using a well-tested measurement instrument (Riggs & Enochs, 1989, 1990), with the expectation that improved self-efficacy beliefs would result from teachers' positive PD experiences. The post-PD STEBI scores and associated qualitative data support this hypothesis. The observed decrease in post-PD scores for traditional science teaching, though unexpected, can also be reasonably explained by the qualitative data and supports the arguments in the recent literature for re-evaluation of research on PD and teacher self-efficacy.

Factors that made the PD challenging were our discovery during the PD that teachers' needs identified by the school district and participating schools (and upon which we planned the PD program) did not always align with individual teachers' needs. In addition, the experience didn't appear to resonate as meaningfully with teachers who felt pressured into attending the PD by their administrators, in addition to some teachers who came to the PD seeking pre-packaged activities and lesson plans. Additional research into these factors, which potentially could have affected the results of this study, is needed.

Noted successes of the PD were 1) activities aligned with Bandura's (1977) four *sources of personal information* believed to improve efficacy – and we hope, motivation and behavior; 2) development of professional learning communities among participants; and 3) observation of several teachers putting summer PD gains into practice within the first few months of the academic year.

Developers and providers of PD programs with small participant populations like ours can improve quantitative analysis by conducting multiple assessments over time. The authors believe that the quality of data from existing quantitative instruments used to measure self-efficacy can be improved by the inclusion of a multi-method, qualitative component to assess teachers' context beliefs and frames of reference about their own science learning and teaching, as well as their students' learning outcomes. Although the authors did not conduct interviews with the participants after the conclusion of the PD experience, review and evaluation of data collected from various assessments during the PD (particularly the teachers' reflective journals, Venn diagrams comparing indoor and outdoor science instruction, and audio-taped group discussions about the use of outdoor spaces for instruction) were used to support the observed efficacy changes reported by the teachers using the modified STEBI instrument. This type of information will help efficacy researchers: 1) complement quantitative data and develop profiles of science teachers' belief patterns; 2) determine antecedents to these belief patterns; 3) assess teachers' perceptions of science and school science programs; and 4) make necessary improvements to science teacher PD experiences (Lumpe, Haney, & Czerniak, 2000).

Researchers should rigorously evaluate their data collection methods to ensure that the measured constructs appropriately represent PD objectives and anticipated outcomes (i.e., efficacy for instruction versus efficacy for developing positive, trusting relationships with one's students [Labone, 2004]). Also, measurement instruments should produce data that are reasonably generalizable and/or transferable while also capturing some context. To these ends, PD providers should ask the following questions: Are assessment items consistent with the goals and methods of inquiry-based science teaching and student learning? (Wheatley, 2005). Can qualitative data (including interview questions and reflective journal entries) provide us with information that can further assist us in answering our research questions? (Labone, 2004).

Lessons learned from this research have influenced our subsequent PD design and research methodology, and have kept us moving toward improvements in our PD practice for teacher growth. Furthermore, they are guiding the questions we ask about the effectiveness of this, and future, PD experiences that we plan: How close are participants' perceptions of *good teaching* (and the obstacles that prevent it) to the *reality* of their own practice based upon their self-efficacy beliefs? Do participants believe that district staff and administrators overly monitor them in order to ensure compliance with district mandates, or are they just as concerned about their students' test scores as the district? Does a professional development experience focused on inquiry-based science teaching undermine the belief systems of *traditional* science teacher participants by causing them to question their own professional abilities and effectiveness? Or does it provide them with new ways of valuing themselves as professionals? As we continue to play the dual roles of PD providers and science education researchers, we continue to seek answers to these questions and create subsequent PD experiences based upon on our new knowledge.

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Appendix A

Modified STEBI-A

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement:

SA	**strongly agree**
A	**agree**
UN	**uncertain**
D	**disagree**
SD	**strongly disagree**

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.
2. When a student does better than usual in science taught in an outdoor environment, it is often because the teacher exerted a little extra effort.
3. I am continually finding better ways to teach science.
4. I am continually finding better ways to teach science in outdoor environments.
5. When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.
6. When the science grades of students improve, it is often due to their teacher having found a more effective outdoor teaching approach.
7. I know the steps necessary to teach science concepts effectively.
8. I know the steps necessary to teach science concepts effectively using outdoor environments.
9. I am not very effective in monitoring science experiments/activities.
10. I am not very effective in monitoring science experiments/activities conducted in outdoor environments.
11. If students are underachieving in science, it is most likely due to ineffective science teaching.
12. If students are underachieving in science, it is most likely due to ineffective science teaching in outdoor environments.
13. I generally teach science ineffectively.

14. I generally teach science ineffectively when I use outdoor learning environments.
15. The inadequacy of a student's science background can be overcome by good teaching.
16. The inadequacy of a student's science background can be overcome by good teaching using outdoor learning environments.
17. The low science achievement of some students cannot generally be blamed on their teachers.
18. The low science achievement of some students cannot generally be blamed on their teachers use of outdoor environments.
19. When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.
20. When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher in their use of outdoor environments.
21. I understand science concepts well enough to be effective in teaching my level of science.
22. I understand science concepts well enough to be effective in teaching my level of science in outdoor environments.
23. Increased effort in science teaching produces little change in some students' science achievement.
24. Increased effort in science teaching using outdoor environments produces little change in some students' science achievement.
25. The teacher is generally responsible for the achievement of students in science.
26. With regard to using outdoor environments to teach science subjects, the teacher is generally responsible for the students' achievement.
27. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.
28. Students' achievement in science is directly related to their teacher's effectiveness in science teaching in outdoor environments.
29. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.
30. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher and their use of outdoor environments.

31. I find it difficult to explain to students why science experiments or activities work.

32. I find it difficult to explain to students why science experiments or activities work in outdoor settings.

33. I am typically able to answer students' science questions.

34. I am typically able to answer students' science questions related to science taught in outdoor environments.

35. I wonder if I have the necessary skills to teach science.

36. I wonder if I have the necessary skills to teach science in outdoor environments.

37. Effectiveness in science teaching has little influence on the achievement of students with low motivation.

38. Effectiveness in science teaching outdoors has little influence on the achievement of students with low motivation.

39. Given a choice, I would not invite the principal to evaluate my science teaching.

40. Given a choice, I would not invite the principal to evaluate my science teaching using an outdoor environment.

41. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.

42. When a student has difficulty understanding a science concept related to learning in the outdoors, I am usually at a loss as to how to help the student understand it better.8

43. When teaching science, I usually welcome student questions.

44. When teaching science in outdoor environments, I usually welcome student questions.

45. I do not know what do to turn students on to science.

46. I do not know what do to turn students on to science using outdoor environments.

47. Even teachers with good science teaching abilities cannot help some kids to learn science.

48. Even teachers with good teaching abilities in outdoor environments cannot help some kids to learn science.

49. Even when I try very hard, I do not teach science as well as I teach most other subjects.

50. Even when I try very hard, I do not teach science outdoors as well as I teach most other subjects, or or as well as I teach science in the classroom.