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### **Effects of an Environmental Educator Training Workshop on Environmental Knowledge, Awareness, and Teaching Self-Efficacy**

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# **Effects of an Environmental Educator Training Workshop on Environmental Knowledge, Awareness, and Teaching Self-Efficacy**

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## **Abstract**

Efforts to expand the depth and scope of environmental education (EE) programs that help children connect with nature often depend on the preparation and development of skilled environmental educators. However, the impact of professional development on aspiring EE teachers has not been adequately explored. This study used a mixed-methods approach to investigate the effects of EE training on elementary school teachers in Athens, GA. Survey data analysis showed that, relative to a control group, workshop participants displayed a significant increase in knowledge and awareness regarding specific environmental topics. Knowledge and awareness related to broader, more general concepts were difficult to change. Interview analysis suggested that the training helped build teachers' self-efficacy and increased their willingness to try EE activities in the classroom. Future EE training programs that target EE knowledge and awareness could facilitate the development of environmental literacy and promote teaching self-efficacy that translates into effective EE instruction.

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**Keywords:** environmental Awareness, environmental Knowledge, environmental literacy, elementary teachers, ethnobotany, teaching self-efficacy

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### Introduction

According to the National Environmental Education and Training Foundation (NEETF), few Americans have an adequate understanding of the natural world and the complex environmental issues that will shape the future (Coyle, 2005). Global conservation efforts may ultimately depend on the quality and delivery of environmental education (EE) curricula that address this environmental literacy gap (McBeth & Volk, 2010). A growing movement to revitalize comprehensive EE curricula within school systems calls for research that identifies proven and promising EE strategies that support student learning (NEEAC, 2005). The preparation and development of skilled environmental educators has emerged from this milieu as a critical factor in ongoing efforts to promote student achievement (Supovitz & Turner, 2000).

Environmental education teacher training has been a priority since the end of the twentieth century (UNESCO-UNEP, 1990). Robottom, Malone, and Walker (2000) claimed that “behind every successful environmental education curriculum is a committed teacher” (p.157). Committed or successful teachers possess a special combination of content knowledge, awareness, and pedagogical expertise that helps them communicate with students (Kapyła & Wahlstrom, 2000; Palonsky, 1993; Summers, Kruger, Childs, & Mant, 2000). In fact, many studies have identified the critical importance of a strong environmental knowledge and awareness base in science teaching praxis (Kapyła & Wahlstrom, 2000; Michail, Stamou, & Stamou, 2006; Summers, Kruger, Childs, & Mant, 2001).

Despite the documented benefits of advanced knowledge, most teachers are not familiar with the critical theoretical and conceptual issues underlying basic EE curricula (Cross, 1998; Dove, 1996; Summers et al., 2000). Educators with limited science knowledge and skills are often afraid to make EE part of their daily routine (Hug, 2010). Furthermore, many skeptical educators believe that

EE can be used only to address a limited set of pre-determined goals; they fail to acknowledge the vast potential of EE in the context of interdisciplinary learning (Van Petegem, Blicke, & Pauw, 2007). Research shows that although 61% of teachers claim to include environmental topics in their lessons, most devote fewer than 50 hours to EE-related instruction throughout the course of an entire year (Coyle, 2005). These alarming figures have stimulated a push for evaluation and assessment of training programs that help teachers develop a better understanding of EE content and delivery methods (Ernst, 2007).

Even if teachers recognize the importance of EE as a learning tool, they often lack the basic knowledge and procedural skills to become successful EE instructors (Cutter-Mackenzie & Smith, 2003; Ernst, 2009; McKeown-Ice, 2000; Spork, 1992; Van Petegem et al., 2007). Unfortunately, most teachers have had little or no effective training on how to teach EE in the classroom (Ernst, 2007). Hence, many teachers feel uncomfortable working with a curriculum that includes EE components. Some reactions to EE are so extreme they border on “ecophobia” (Hug, 2010). Research suggests that unless EE is consistently used and adequately integrated within schools, teachers will continue to struggle teaching environmental concepts (Mastrilli, 2005). To expedite the growth of effective EE in the formal education sector, the North American Association for Environmental Education (NAAEE) has established a balanced, comprehensive, scientifically accurate model for developing professional EE instructors through the organization’s “Guidelines for Excellence in K-12 Education” (NAAEE, 2004). Although the guidelines provide a useful framework for the preparation and development of environmental educators, initiatives designed to educate teachers about EE content and pedagogy proceed at a remarkably slow pace (McKeown-Ice, 2000; Van Petegem et al., 2007).

Few studies to date have evaluated the effects of EE professional development programs on teacher's environmental knowledge and awareness (Arvai, Campbell, Baird, & Rivers, 2004; Mastrilli, 2005; Smith-Sebasto & Cavern, 2006; Van Petegem et al., 2007; Volk & Cheak, 2003). Most research has also neglected to incorporate teacher's self-efficacy beliefs. Bandura (1986) characterized these beliefs as "people's judgments of their capabilities to organize and execute course of action required to attain designated types of performances" (p. 391). For prospective EE teachers, self-efficacy refers to one's confidence in their ability to teach about environmental issues (Sia, 1992). Sia (1992) discovered that even when teachers possess positive outcome expectancy beliefs (i.e., they think EE learning can be improved by effective teaching), their negative self-efficacy beliefs have substantial negative effects on their teaching success. Subsequent research has indicated that, although content knowledge and subject-matter awareness are important elements of teacher training programs (Kennedy, 1998; Garet, Porter, Desimore, Birman, & Yoon, 2001), exposure to essential teaching skills and methods that build confidence may be the most critical contributors to science teaching effectiveness (Morrell & Carroll, 2003). Teaching self-efficacy associated with EE training programs is therefore an important outcome that warrants further investigation.

As the emphasis on teacher preparation continues to grow, scholars are recognizing the need for additional instruments and empirical data that supports, maintains, and improves professional development opportunities across disciplines (Supovitz & Turner, 2000). In the field of EE, legislative proposals such as the No Child Left Inside Act have garnered political and financial support for EE grant structures that promote students' environmental literacy through professional development (No Child Left Inside Coalition, 2009). However, methods for assessing the benefits of these EE training programs have not been adequately developed (Marcinkowski,

2010). Improved evaluation strategies for teacher training programs that specifically target environmental knowledge, awareness, and science teaching self-efficacy may help educators foster environmental literacy that translates into effective EE instruction.

### **Research Objectives**

To address this research gap, we used a mixed-methods, quasi-experimental approach to investigate the effect of a three-day EE workshop on the environmental knowledge, awareness, and teaching self-efficacy of elementary school educators. The study focused on three objectives: (1) the development of a reliable and valid metric to quantify teachers' environmental knowledge and awareness; (2) the examination of the impact of an EE workshop on teachers' environmental knowledge and awareness; and (3) the examination of the impact of an EE workshop on teachers' self-efficacy related to environment-based curricula.

### **Methods**

#### **Environmental Education Workshop**

The EE workshop selected for this study was hosted by the State Botanical Garden of Georgia (SBG) and conducted with federal funding from the "Teacher Quality Program for the Improvement of Math and Science Education." The workshop was advertised through the SBG, the Athens-Clarke County School District, and other school districts in the surrounding counties. The curriculum met requirements of the Georgia Performance Standards (GPS) and specific needs identified by teachers surveyed in two high-needs elementary schools.

The goal of the workshop, held from February 28 to March 1, 2008 (8:00am to 3:00pm each day), was to introduce elementary school teachers to EE principles and activities through the lens of ethnobotany. Ethnobotany, the study of humans' relationship with plants, brings a unique conceptual combination to the classroom by simultaneously encouraging cross-cultural discovery and scientific inquiry. By strengthening interdisciplinary connec-

tions, celebrating diverse cultures, and emphasizing environmental issues, ethnobotanical curricula provide an ideal forum for EE instruction that effectively “humanizes” nature-based themes (Strife, 2010). Additionally, modern teachers often seek resources that differentiate learning and engage students from different cultural and intellectual backgrounds in classroom activities (McShane, 2003). With America’s population becoming more ethnically diverse, there will be a greater need for EE curricula that reaches culturally diverse groups and appeals to heterogeneous populations (EEA, 2009; Larson, Green, & Castleberry, 2011). Ethnobotanical curricula offer a unique opportunity to achieve this objective.

The ethnobotanical curriculum used at the EE workshop was created through a collaborative project involving SBG and a University of Georgia team including the College of Education, the College of Environment & Design and the Latin American & Caribbean Studies Institute. The interdisciplinary partnership is indicative of new approaches to EE that challenge historical boundaries (Krasny, Dillon, & Meyers, 2009). The project concentrated on ethnobotanical gardens as a way of describing distinct human and plant relationships throughout history. Topics included learning objectives in life, physical, earth, and environmental sciences that focused on plants from five distinct regions of the world and their relationship to Georgia. Workshop participants listened to presentations, engaged in interactive demonstrations, and compiled packets containing ecological information and instructional guides to meet their specific needs. Materials were modeled and introduced from multiple perspectives to mesh with various pedagogical and learning styles of teachers and their students. At the conclusion of the workshop, participants were expected to emerge with greater environmental knowledge and awareness and an enhanced ability to confidently implement the ethnobotanical EE curricula in multiple formats including traditional classrooms, outdoor classrooms, or school gardens.

### **Measuring Teachers’ Environmental Knowledge and Awareness**

We measured the environmental knowledge and awareness of teachers using a survey comprised of Likert-type responses items. We asked teachers to indicate the extent to which they disagreed or agreed with a statement by circling the appropriate number ranging from one = “strongly disagree” to five = “strongly agree.” An additional option, “don’t know or refuse,” was also included. The instrument was created and modified through a multi-step process that included an in-depth literature review, initial scale construction, scale revision and reduction, pilot testing, and refinement. We adapted items from existing scales to cover general concepts and specific facts related to the ethnobotanical EE curriculum (Shepardson, 2005), creating a modified evaluation tool suitable for teachers in the workshop. These items were designed to measure several important components of environmental knowledge and awareness covered in the EE workshop including the Earth as a physical system, the living environment, and the traditional and current utilization of plants by human societies.

We conducted a pilot test of the initial 41-item survey during February 2008 with a volunteer group of elementary school teachers from Athens-Clarke County, GA, schools (N=36). Our analyses of the pilot test demonstrated high levels of internal consistency (Cronbach’s alpha = 0.78) and revealed four underlying constructs. However, observations, participant questions, and preliminary data analyses indicated that the instrument could be improved through revisions regarding wording, clarity, and the removal of four problematic items. These changes eliminated confusion, reduced redundancy, and enhanced the reliability of responses, resulting in a modified 37-item survey. The researchers then used the shortened survey to examine the effects of the EE workshop on teachers’ environmental knowledge and awareness.

### **Effects of Workshop on Teachers' Environmental Knowledge and Awareness**

We evaluated differences in environmental knowledge and awareness scores for both teachers participating in the SBG's ethnobotanical workshop (treatment,  $n = 23$ ) and non-participants from three local elementary schools (control,  $n = 38$ ) using a pre-test, post-test approach. Random sampling was not feasible for the treatment group given the workshop's structure and relatively small size, so each registered participant who completed the three-day workshop was included in the study. We systematically selected control group participants to represent a geographic and demographic range comparable to the treatment group. Teachers in the control group were also asked to indicate whether or not they had previously participated in a formal EE training program. None of the teachers in the control group reported previous EE experience.

We administered a pre-test survey to treatment group subjects at 8:00am on the first day of the workshop, and an identical post-workshop survey was administered at 2:45pm on the final day. Control group surveys were conducted at the beginning and end of a similar three-day period without an EE intervention. The researchers administered the control group pre-tests. Post-tests were distributed by the school principal and returned to a designated collection box the same day. After controlling for pre-test score differences, we used data from the post-tests to compare adjusted post-test score differences in the environmental awareness and knowledge of teachers from the treatment and control groups.

### **Effects of Workshop on Teachers' Self-efficacy**

Although quantitative survey data provides a solid baseline for assessment, qualitative data may yield more comprehensive and holistic views of experiences and perspectives (Patton, 1990). Therefore, we obtained additional data regarding the participants' environmental knowledge, awareness, and EE teaching self-efficacy through brief pre- and

post-workshop interviews. The interviews were designed to provide additional insights into the functional value of the EE workshop to teachers and identify potential barriers to EE instruction. General questions asked participants about their plant-related experiences, ability to explain particular concepts or processes related to ethnobotany, and level of confidence teaching these same concepts to their students. We interviewed a subset of workshop participants ( $n = 14$ ) in small focus groups (three to four individuals) during lunch on the first and last day of the workshop. Each interview lasted approximately 10-15 minutes. Due to logistical constraints related to time and funding, we were not able to conduct interviews with teachers in the control group.

### **Data Analysis**

We calculated reliability estimates of internal consistency for the overall survey and specific constructs using the Cronbach's alpha coefficient. We used principal components analysis (PCA) to explore survey content and identify latent constructs; a varimax rotation helped to clarify the data structure. We employed analyses of covariance (ANCOVA) to evaluate program-mediated effects on post-test score means after controlling for initial pre-test differences. Preliminary checks were conducted to ensure that the assumptions of reliable covariate measurement, normality, linearity, homogeneity of variances, and homogeneity of regression slopes were not violated. The Eta-squared effect size statistic ( $\eta^2$ ), which represents the proportion of the variability in the dependent variable accounted for by the different factor levels, was calculated using the following formula for  $F$ -tests:  $\eta^2 = \frac{SS_{\text{between groups}}}{SS_{\text{total}}}$ . We conducted all tests using SPSS Version 17.0 (SPSS, 2008).

After recording and transcribing the interview data, two researchers used an inductive analysis approach to identify emerging patterns in the qualitative data. The researchers classified responses into a set of ordered categories that highlighted trends in the quantitative data and revealed patterns

in participants' self-efficacy regarding EE instruction.

## Results

### Measuring Teachers' Environmental Knowledge and Awareness

A total of 61 participants across both the treatment and control groups completed the pre-test and post-test, resulting in a 100% response rate for the captive audience. Analysis of the psychometric properties of the 37-item pre-test incorporating scores from both the treatment and control groups suggested the metric was reliable (Cronbach's alpha = 0.82). Principal components analysis revealed the presence of ten factors with eigenvalues greater than or equal to one. These ten factors accounted for 86% of the total variance. However, the scree plot showed that three factors accounted for the largest portion of the overall variance. A closer examination of the rotated pattern matrix showed that most items loaded on a few components, providing further support for a reduced factor structure. Hence, we removed 21 items because they did not contribute to the simplified factor structure and failed to meet the minimum criterion: a primary factor loading value  $\geq 0.4$  without substantial cross-loading. Ultimately, the survey was reduced to 16 items to facilitate data interpretation and ensure that the instrument was accurately measuring what it was intended and purported to measure. This reduction improved the instrument's overall reliability (Cronbach's alpha = 0.852).

Acceptable scores on the Bartlett's test of sphericity ( $p \leq 0.001$ ) and the Kaiser-Meyer-Olkin measure of sampling adequacy (0.632) showed that an exploratory factor analysis of the modified 16-item pre-program survey was appropriate (Pallant, 2007). Principal components analysis revealed a three-factor solution that accounted for 59.9% of the variance with a varimax rotation that converged in five iterations. Items in the three latent constructs - named *Georgia-specific ethnobotanical connections* (*GA-Spec*), *general ethnobotanical awareness* (*Gen-EA*), and *general ecosystem concepts* (*Gen-EC*) -

were used to evaluate workshop effects on various components of environmental knowledge and awareness (Table 1). The *GA-Spec* category ( $M = 4.37$ ,  $SD = 0.49$ ) highlighted parallels between Georgia's ecological landscape and the rest of the world. The *Gen-EA* ( $M = 4.82$ ,  $SD = 0.32$ ) category reflected participants' awareness of the multiple uses of plants around the globe. The *Gen-EC* ( $M = 4.78$ ,  $SD = 0.34$ ) category targeted knowledge of the complex interactions that drive ecosystem function. Overall, the items grouped under these three categories seemed to represent distinct components of teachers' environmental knowledge and awareness.

### Effects of Workshop on Teachers' Environmental Knowledge and Awareness

Using the revised 16-item survey, we conducted an analysis of covariance (ANCOVA) to measure the effects of the EE workshop on the dependent variable, teachers' overall environmental knowledge and awareness, as well as scores on the specific *GA-Spec*, *Gen-EA*, and *Gen-EC* subscales. Mean pretest scores were the covariate, and the participant group (EE workshop treatment or control) served as the independent variable. The within-group relationship between the covariate and the dependent variable on each subscale was linear for both levels of the independent factor. The relationship between mean adjusted post-test scores and mean pre-test scores varied by group, violating the homogeneity of slopes assumption,  $F_{(1,57)} = 2.4$ ,  $p = 0.029$ . However, the treatment group consistently displayed higher adjusted mean post-test scores than the control group. Graphical examination of the linear relationship confirmed the ordinal interaction, so we dropped the interaction term from the ANCOVA models examining treatment effects.

The EE workshop appeared to have a statistically significant effect on overall environmental knowledge and awareness,  $F_{(1,58)} = 20.2$ ,  $p < 0.001$ ,  $\eta^2 = 0.19$  (Table 2). The total adjusted mean post-test score (controlling for pre-test scores) was higher

**Table 1: Rotated Loadings for Principal Components Analysis of 16 Likert-type Pre-test Items Describing Three Latent Factors of Teachers' Environmental Knowledge and Awareness**

Factor/Items	Factors		
	GA-Spec	Gen-EA	Gen-EC
<i>Georgia-specific Ethnobotanical Connections (GA-Spec)<sup>1</sup></i>			
Georgia's climate enables many plants from Africa and Asia to be grown.	0.844		
Georgia's climate is similar to other parts of Asia.	0.752		
Georgia's climate is similar to certain parts of Africa.	0.649		
Many plants that we rely on in GA are not originally from GA.	0.587		
Georgia's climate enables peanuts from Africa and peaches from Asia to be grown here.	0.561		0.477
Temperature changes have dramatic effects on ecosystems.	0.521		
<i>General Ethnobotanical Awareness (Gen-EA)<sup>2</sup></i>			
Some plants are valued by people for their cultural significance.		0.799	
Some plants are used for a variety of different uses by different cultures in the world.		0.791	
Different parts of a county may hold several different ecosystems.		0.781	
Plant communities help stabilize soil erosion in ecosystems.		0.757	
The interaction between plants, animals, and people is critical for our survival.		0.745	
Many plants have other uses associated with them by other cultures around the world.		0.699	
Beyond merely simple food consumption some plants are regarded very highly by certain cultures for their medicinal purposes.		0.644	
<i>General Ecosystem Concepts (Gen-EC)<sup>3</sup></i>			
One ecosystem may hold many different types of plant communities.			0.792
Plants help to keep their ecosystems stable and healthy.			0.736
Both people and animals have an effect on plant communities.		0.473	0.504
Total Variance Explained (%)			
	35.4	13.8	10.7

Note: Each item included 5 response choices (1 = strongly disagree, 5 = strongly agree). Only eigenvalues  $\geq 0.400$  are reported.

<sup>1</sup>Cronbach's alpha for the 6-item GA-Spec scale was 0.79.

<sup>2</sup>Cronbach's alpha for the 7-item Gen-EA scale was 0.85.

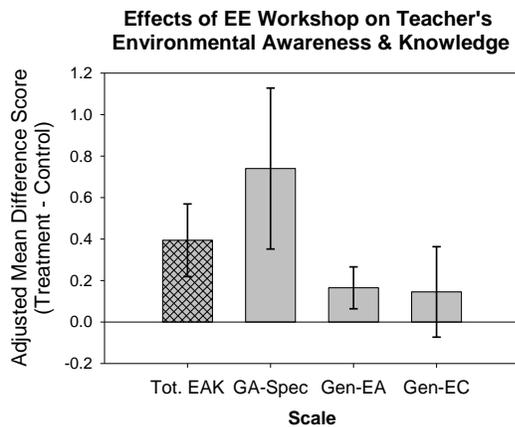
<sup>3</sup>Cronbach's alpha for the 3-item Gen-EC scale was 0.68.

in the treatment ( $M = 4.90$ ,  $SD = 0.33$ ) than the control group ( $M = 4.50$ ,  $SD = 0.33$ ). Similar positive treatment effects were observed across all subscales: *GA-Spec*,  $F_{(1,58)} = 14.6$ ,  $p < 0.001$ ,  $\eta^2 = 0.16$ ; *Gen-EA*,  $F_{(1,58)} = 10.8$ ,  $p = 0.002$ ,  $\eta^2 = 0.06$ ; and *Gen-EC*,  $F_{(1,58)} = 3.8$ ,  $p = 0.057$ ,  $\eta^2 = 0.06$ ; though program effects on the *Gen-EC* subscale were not statistically significant (Figure 1).

**Table 2. ANCOVA Examining Environmental Education Workshop Treatment Effects on Mean Differences in Teachers' Post-test Environmental Knowledge and Awareness (N = 61).**

Source	Df	Type III SS	F	Sig.	Eta Squared
Intercept	1	0.82	7.68	0.007	
Treatment	1	2.15	20.21	0.000	0.19
Pre-test (Cov.)	1	2.04	19.18	0.000	0.18
Error	58	6.16			

**Figure 1. Adjusted mean post-test differences scores between teachers in the environmental education workshop treatment and control groups for overall environmental knowledge and awareness (Tot. EAK) and the Georgia-specific Ethnobotanical Connections (GA-Spec), General Ethnobotanical Awareness (Gen-EA), and General Ecosystem Concepts (Gen-EC) subscales (with 95% CI; N = 61).**



### Effects of Workshop on Teachers' Self-efficacy

Interviews of teachers in the treatment group indicated a wide variety of background experiences that contributed to environmental knowledge and awareness. Most of the teachers had some previous experience with plants and other ethnobotanical themes. One participant described gardening and landscaping work with her mother and grandmother. She indicated that she had maintained an interest in plants and was excited about planting her own herb garden with kids. Other participants recounted stories of their own gardens and emphasized their passion for plants, both as a hobby and a teaching tool. Some participants expressed a love of the outdoors and passion for general natural resource recreation. Despite previous experience with specific ethnobotanical subject matter and other nature topics, pre-interviews indicated that the teachers were not especially comfortable incorporating EE into their classrooms. Several teachers admitted that their confidence teaching about ethnobotany was "very limited" or "superficial," and many participants ex-

pressed a desire to "gain greater knowledge and awareness," "develop new strategies for discussing (environmental systems)," and "learn more about EE teaching" during the workshop. Overall, pre-workshop interview analyses suggested that EE teaching self-efficacy was rather low.

Post-interviews revealed a marked contrast in confidence levels and self-efficacy related to teaching about ethnobotany and similar EE topics. One teacher admitted that she was much more likely to "think about the topic now, even though (she) had not thought about it before." Nearly all of the participants stated that they were more confident following the workshop, and many praised the "great new ideas," "access to resources," and "cross-curricular connections" emphasized during the teacher training sessions. One teacher was particularly impressed by the interdisciplinary nature of EE instruction and was surprised to discover that topics including "climate and different ecosystems could be taught using with this specific EE curriculum." Another reflected, "All of the materials provided (at the workshop) will enhance and help students connect with the debate between space and resources. I'm excited to process all the stuff I'm taking back to school." Following the workshop, teachers said that they were better prepared to bring new ethnobotanical topics into their classrooms. "We teach habitats," one participant said, "and the workshop enriched this knowledge and provided new awareness to extend what I know... The workshop also introduced new cultures to incorporate into class and made it so I am not just limited to information on Georgia." A few participants confessed that they were only "semi-confident" or "pretty confident" applying these ideas in their classrooms, and they acknowledged that more research and resources would be needed before teaching some of the concepts to higher grades. In general, however, workshop participants expressed an increased awareness of ethnobotanical topics and greater self-efficacy discussing and using EE con-

tent, materials, and instructional techniques following the three-day session.

### Discussion

Environmental education represents an effective mechanism for addressing the world's ecological problems and promoting sustainable development (Orr, 1994). Despite this promise, EE remains one of the weakest areas of pre-service teacher training programs across the United States (McKeown-Ice, 2000; Heimlich, Braus, Olivolo, McKeown-Ice, & Barringer-Smith, 2004). The results of this study suggested that even a short three-day workshop can have a positive influence on teachers' familiarity and comfort levels with EE in their classrooms. The professional development workshop did not produce significant gains in general ecological knowledge relative to the control group; however, participants' knowledge and awareness on more specific subscales (e.g., *Georgia-specific ethnobotanical connections* and *general ethnobotanical awareness*) were significantly affected by the treatment. The workshop also appeared to cultivate participants' self-efficacy related to science teaching, increasing the likelihood that teachers will attempt to implement EE themes into their elementary school classrooms. According to participants, the materials and resources associated with the workshop were helpful. The greatest asset appeared to be the workshop's illumination of cross-curricular connections. A focus on the multiple advantages of EE in a diverse array of instructional contexts could help to minimize teachers' perceived barriers to EE implementation and promote receptivity towards environment-based educational approaches (Ernst, 2009).

The research process and results also highlighted several needs that could be addressed to improve EE professional development evaluation strategies. Researchers attempting to examine the effects of EE training programs should conduct rigorous psychometric assessments of their instruments throughout the evaluation process (Gray, Borden, &

Weigel, 1985). This study described a preliminary attempt to create a short survey that represented a reliable and valid strategy for measuring specific components of teachers' environmental knowledge and awareness. The survey was comparable in item structure, length, and time requirement to similar evaluation instruments (Dove, 1996; Gruver & Luloff, 2008), and appeared to successfully measure specific and general components of ethnobotanically oriented knowledge and awareness. This survey may have limited applicability in the general education sector because of its ethnobotany-focused content, but the instrument could serve as a model for other research efforts. Continued efforts to refine and revise the evaluation tool and corresponding framework will undoubtedly enhance its utility.

Results also supported the idea that EE training efforts should place a particular emphasis on building environmental knowledge and awareness. Although researchers have recognized the critical connection between teachers' knowledge of the natural world and their ability to effectively generate students' environmental literacy, few teacher education providers have implemented effective, lasting strategies for reinforcing science content and developing awareness about environmental issues (Cutter-Mackenzie & Smith, 2003; Supovitz & Turner, 2000). In this study, researchers worked closely with workshop instructors to create an instrument that appropriately matched curricular goals and objectives. Workshop materials and resources focused on *Georgia-specific ethnobotanical connections*, and this emphasis provided a likely explanation for the largest treatment effect: the knowledge and awareness increase on the *GA-Spec* subscale. Workshops that utilize a systems-based approach to environmental issues and emphasize general ecological principles may help teachers understand broader concepts, but they would inevitably sacrifice specific knowledge gains. Hence, these tradeoffs highlight the importance of clearly articulated learning goals

and objectives prior to any professional development training.

Participant interviews revealed relationships between environmental knowledge, awareness, and teaching self-efficacy, demonstrating that workshop benefits transcended cognitive gains. Prior to the training, teachers seemed uncertain and uncomfortable when asked about their use of environmental topics in the classroom. This finding reflects earlier research documenting an array of barriers to EE including insufficient environmental literacy, knowledge, and skills (Ernst, 2009). After the workshop, teachers expressed increased teaching self-efficacy and confidence levels, supporting the theory that workshop-mediated gains in environmental knowledge may translate into successful EE instruction (Gruver & Luloff, 2008; Hug, 2010; Van Petegem et al., 2007). Programs that provide teachers with professional development opportunities highlighting the value of EE may increase subsequent classroom involvement, thereby inspiring teachers to explore new fields and extend their content beyond existing lesson plans (Ernst & Monroe, 2004; Van Petegem et al., 2007). Many teachers in this study also expressed gratitude for the ready-to-use EE curricula, resources, and materials, a pattern that has been observed in similar research (Hug, 2010; Kapyla & Wahlstrom, 2000). Interview responses suggested that the EE workshop provided the instructional guidance necessary to help participants confidently and successfully incorporate ethnobotanical concepts into their classrooms. These trends could help to galvanize EE research efforts that endeavor to capture the interacting aspects of cognitive growth, self-concept, and pedagogical context knowledge associated with professional development workshop participation (Barnett & Hodson, 2001).

### **Future Research**

Future efforts to assess the effects of EE training programs could benefit from several methodological changes that address the limitations of

this study. New research should strive to explore a broader range of EE topics across a larger geographical area. Many authors (e.g., McKeown-Ice, 2000) have noted issues with EE training at multiple scales, and the lessons learned in this Georgia study may not apply to all locations and contexts. Future research should also examine the effects of workshops on participants with limited previous exposure to EE curricula. The ethnobotanical EE workshop in this study seemed to attract participants who possessed a predisposition for environmentally-oriented programs. Consequently, the treatment group pre-test knowledge and awareness scores were clustered around the high end of the scale. Hence, workshop effects on teachers' environmental knowledge and awareness may be more pronounced in studies where self-selection bias is minimized (Leeming, Dwyer, Porter, & Cobern, 1993). Limited variability may have decreased statistical power and masked possible treatment effects as well. An expanded scale with a broader range of response options might help to alleviate potential problems associated with the ceiling effect and reveal more information about participants' environmental knowledge and awareness across a variety of topical areas. Post-workshop interviews with individual participants could also yield more in-depth data about teachers' experience, attitudes, and self-efficacy than the in-session focus groups employed in this study.

Despite encouraging gains following the ethnobotanical workshop, additional research is needed to understand the long-term effects of short-duration training programs on teachers' environmental knowledge, attitudes, and behavior (Pe'er, Goldman, & Yavetz, 2008; Summers et al., 2001). Researchers could also consider programs with longer implementation periods. Long-term training plans might foster teachers' understanding and appreciation of important EE concepts, philosophies, and delivery methods, enabling a seamless and gradual integration of EE into existing curricula (Mastrilli, 2005; Van Petegem et al., 2007). This study provid-

ed encouraging evidence of an EE workshop's immediate influence on teachers' environmental knowledge, awareness, and teaching self-efficacy. Longitudinal investigations would yield new insight into teachers' evolving practices and the potential role of EE within conventional educational structures over an extended period of time.

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