Botanical Knowledge of a Group of South Carolina Elementary School Students

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Education

Abstract

What is the status of plant knowledge among elementary school children in South Carolina, and can informal botanical education experiences increase their interest in and knowledge about plants and their local environment? In a pre-test, fourth- and fifth-grade students (n=11) freelisted plant names and attempted to identify 60 plant photos. They freelisted an average of 30.9 ± 12.1 (mean ± standard deviation) items at different taxonomic levels and were able to identify approximately 33.7 ± 6.84% of plant pictures. Their ability to identify plants varied with usage categories, suggesting that while American children may not be familiar with native species, they do possess some culturally important knowledge. Students then spent two hours each week engaged in activities designed to spark their interest in plants and natural history. Post-assessments indicate increases in children's knowledge of plant names, interest in nature, and awareness of the environment. This research has important implications for conservation, environmental education, and nature study programs.

Introduction

Studies of environmental knowledge demonstrate that Americans are "profoundly ignorant" of their local environment compared to people living in other regions (Hunn 2002:604), and that while advanced scientific knowledge is increasing in our society, basic knowledge of our natural surroundings is decreasing (Atran *et al*. 2004). This deficit of environmental knowledge, particularly among children, is troubling for many reasons. Diminished knowledge of nature is partly a result of diminished contact with nature, and this separation may be detrimental to human health and development (Louv 2006). Conservationists note, with trepidation, that the next generation "will have little knowledge of - or interest in - [nature]" (Huxham *et al*. 2006). Tomorrow's decision makers sit in today's classrooms, and if they are not encouraged to interact with the natural world, they will be ill-equipped to appreciate or protect the environment as adults (Hunn 2002). Local environmental knowledge among members of the public is an essential component of local biodiversity protection and land management programs, even in developed nations (Pilgrim *et al*. 2007). Culturally and environmentally important folk biological knowledge is being lost in the developed world (Nabhan 1998), and generations are maturing without knowing "where in the world they are or what is there with them" (Wendell Berry, personal communication).

Differences in childhood knowledge of plants in the local environment are pronounced between children in indigenous societies and children in mainstream America. Stross (1973) led Tzeltal Maya children ages four to thirteen (n=25) and adults along a plant trail and asked them to identify approximately 200 different plants by name. At age four, Tzeltal children could correctly identify 32 plants at the generic level; by age nine, they could identify 106 generics and 20 specifics. Surprisingly, when Zarger and Stepp (2004) performed a follow-up study 30 years later,

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they found no significant differences between children's botanical knowledge in the first and second studies. Hunn (2002) made similar findings among Zapotec children in Oaxaca, Mexico: A twelve-year old girl identified and often described the uses of 393 plants, and her knowledge is believed to be typical of other girls in the Zapotec society. By contrast, sixth-graders in Texas (n=9) asked to name 64 pictures of plants correctly used fewer than 32% generic names in their identifications (Tull 1994). California children (n=12) taken on a plant walk around the University of California Botanical Gardens displayed extremely limited knowledge of plants (Dougherty 1979). America's knowledge deficit is not unique; researchers in the United Kingdom found that 86% of biology students were unable to identify more than three common wildflowers, and 41% could name only one, or none (Bebbington 2005). Studies conducted in Switzerland and Germany corroborate this low level of ecoliteracy in developed nations (Lindemann-Matthies 2005). It has also been suggested that people in the developed world have become more ignorant of the natural world than they were a century ago; this trend has been dubbed the "devolution" of natural history knowledge (Atran *et al*. 2004, Wolff *et al*. 1999).

One of the main explanations for American children's relative ignorance of their surroundings is the fact that they are having fewer direct experiences in nature now than in the past. Development and urban growth, shifts in recreational activities, increases in electronic entertainment, parents' concern over crime and children's safety, and even the increasing litigiousness of American society have all been implicated in the reductions in children's time spent in nature with knowledgeable adults (Kellert 2002, Louv 2006, Pergams & Zaradic 2006). This diminished contact with plants and the natural world, fashionably labeled "Nature-Deficit Disorder" (Louv 2006), may have serious consequences for American children and for our world.

The objectives of this research were to quantify the botanical knowledge of a group of elementary school children in South Carolina and to determine what effect informal nature and botany education experiences might have on their interest in, and knowledge about, plants and their local environment. This research is important because few studies of American children's knowledge of natural history have been conducted, and the status of plant knowledge among our nation's children may be an important indicator of the need for an increased focus on children's interactions with nature.

Methods

The informant population was a group of nine- to twelve-year-old students (n=11) enrolled in an after-school Pupil Enrichment Program at a small, rural elementary school in the South Carolina midlands. Participants included eight males and three females; five African Americans/Blacks, five Whites, and one Asian/Pacific Islander. All had lived in the area for many years. These students met with the researcher for two hours on Friday afternoons from December 2006 through May 2007. During the first four meetings, the students became acquainted with the researcher and completed three pre-assessments to quantify their initial knowledge of plants. For the next three months, the group participated in several hands-on botany lessons and engaged in studies of local plants and their uses. During the final three meetings, the students completed a series of post-assessments in order to demonstrate the effects of this participation on their knowledge of plants.

The first pre-assessment was a written survey in which the informants were asked to indicate their age, sex, and ethnicity, and to provide information about the context and extent of their prior contact with nature and, specifically, with plants. In the second pre-assessment, students were asked to freelist plants in ten categories, including trees; flowers; weeds and wild plants; garden and crop plants; vines; bushes and shrubs; plants that grow in or near water; houseplants; grasses; and any others. The decision to divide the broad prompt to "list all the plants you know" into these categories was made because freelists should deal with only a single category of knowledge, and other studies report that asking informants to make multiple freelists generally elicits more complete responses than prompting them to freelist items in a broad category (Quinlan 2005). These freelists were analyzed using ANTHROPAC 4.00 (Borgatti 1992) software to determine the cultural salience of responses.

In the third pre-assessment, students viewed a self-paced slideshow of 60 species of plants and were asked to respond, in writing, to the question "what is its name?" for each species. The slideshow included various life-forms (trees, vines, shrubs, and herbaceous plants) of wild, cultivated, native and non-native species, all of which grow, or are planted, locally. Photographs from various online databases were used, and in most cases, several photos of the plant were included on each slide, depicting it at different times of the year and/or in different stages of growth. For example, the slide for red maple (*Acer rubrum* L.) included a picture of the whole tree, a close-up picture of its leaves, a picture of its fall coloration, and a picture of its samaras. Slides of fruits and vegetables generally showed both the plant and its edible portion; the potato slide, for instance, showed both the foliage and the buried tubers. It therefore cannot be said that students who correctly identified a plant in the slideshow would necessarily correctly identify that plant in the field because the slideshow offered information that would not always be available, such as views of the plant in different seasons of the year. However, the reverse is also true; on a plant trail, informants would have additional cues to use in identifying plants, including visual information such as scale, habitat, and the associated plant community; as well as tactile and olfactory cues. A study of children's responses

to plant identification questions (Tull 1994) found that results of interviews in the field and on slide tasks such as the one employed in this study were "remarkably similar," with only a small percentage more correct answers given in the field for some participants. For this reason and because of time constraints, the lack of sufficient floral variety on school grounds, and the dearth of foliage at the time of the assessment, the slideshow was chosen as the best method for assessment.

During post-assessments, students completed the same freelist and plant identification tasks that were employed as pre-assessments. They also responded to a prepared series of questions during a verbal interview with the researcher in order to explore their perspectives on the importance of plants and the effects of the weekly activities on their opinions. Because of periodic student absences, the following results of most assessments are based on 10 rather than all 11 participants.

Results

During the first pre-assessment, six students characterized their home as being "in the country" and four as being "in town," but nine of the ten reported having a vegetable and/or flower garden at their home or at the home of a close relative. All except one reported having performed yard or farm work. The outdoor activities the children reported participating in include sports and games such as football and tag, biking, running, skating, climbing trees, and, for one student, hunting and fishing. Many of the reported outdoor activities are social interactions, such as talking, fighting, and playing with friends. In rating how much they enjoy being outside as compared to being inside, with a score of 5 being "I would much rather be outside than inside" and a score of 1 being "I would much rather be inside than outside," the average score was 4 ("I like being outside"). Nine of ten children reported recycling at least some items at home, and six displayed general knowledge of what a compost pile is or can be used for. Students were able to list 0 to 4 uses of plants, including as food, medicine, and oxygen producers, with an average of 2 uses.

Pre-Assessment Freelists

Students' (n=10) pre-assessment freelists included an average of 30.9 ± 12.1 plants in the 10 different categories. Differences in the average number of plants listed in each category may be seen in Figure 1. More trees were listed, on average, than any other type of plant; the tree freelists were longer than those of other categories for 90% of the students. The categories of plants shown on the x-axis in Figure 1 are also listed, from left to right, in the order in which they appeared on the freelist prompt sheet. The

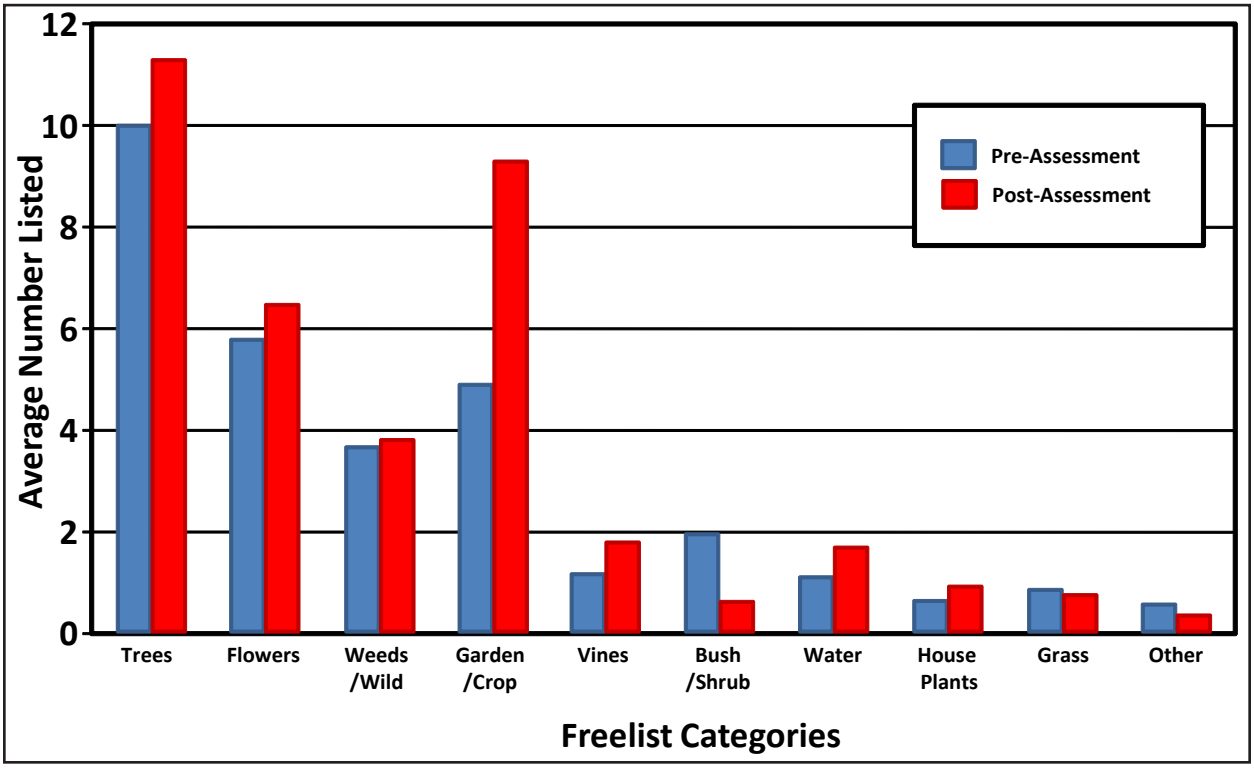

Figure 1. Average freelist length in pre- and post-assessments of botanical knowledge of a group of South Carolina elementary school students.

Table 1. Average number of correct plant identifications in pre- and post-assessments of botanical knowledge of a group of South Carolina elementary school students.

Category (n = number of plants in each category)	Pre-assessments (n=10)		Post-assessments (n=10)		T-test
	Number Correct ± Standard Deviation	Percent Correct ± Standard Deviation	Number Correct ± Standard Deviation	Percent Correct ± Standard Deviation	p-value
Food/Crop* (n=12)	8.5 ± 1.6	70.8 ± 13.7	11.0 ± 0.9	91.7 ± 11.8	0.000
Ornamental** (n=13)	2.0 ± 0.2	15.4 ± 10.3	4.3 ± 0.3	33.1 ± 16.6	0.000
Wild*** (n=27)	4.8 ± 0.2	18.1 ± 6.4	11.5 ± 0.4	42.6 ± 19.3	0.001
Multiple Use**** (n=8)	4.8 ± 0.6	60.0 ± 15.4	6.4 ± 0.8	80.0 ± 15.8	0.005
Total	20.2 ± 4.1	33.7 ± 6.84	33.18 ± 9.4	55.3 ± 15.6	0.000

*Food/Crop plants are those that are commonly cultivated for consumption or as cash crops in the area, such as peanut, soybean, corn, and apple.
**Ornamental plants are those that are intentionally cultivated as landscaping plants but are not typically consumed by the informant population, such as pansy, rose, and tulip.
***Wild plants are native and non-native plants that commonly grow without the aid of cultivation, such as turkey oak, yellow poplar, and morning glory.
****Multiple use plants are those that easily belong to more than one of the above categories, or that belong to one of the above categories and are used in children's play, including bamboo, honeysuckle, and sourgrass.

figure shows a trend of declining responses as the freelist progressed.

In the tree freelists, children listed an average of 10 ± 4.1 items, with a group total of 39 different items. Fully 72.3% of student's responses were reported at the generic level of classification and 21.8% at the specific level, according to Western scientific taxonomy. The remaining 5.9% of responses were at taxonomic ranks greater than the generic rank, such as "Christmas tree." ANTHROPAC analysis reveals that oak and pine were the most salient trees for the informant population, with Smith's S values of 0.822 and 0.773, respectively. The Smith's S statistic evaluates cultural salience by taking both the frequency and rank of freelisted items into account: had every child listed "oak" first on their freelists, it would have had a Smith's S value of 1. All 10 students listed oak and pine in their freelists; however, four students listed "acorn tree" in addition to "oak," revealing some confusion about the identity of members of the genus *Quercus*. Apple, maple, and dogwood were the next most salient and most frequently-listed trees.

Children listed an average of 5.8 ± 4.2 items in their flower freelists, with a group total of 30 different items. Not all items listed are generally considered to be flowering plants, including seaweed, sugar plum, moss, and hay. The taxonomic ranks of responses to this prompt were less specific than in the tree freelist, and only 53.3% of items listed are either generic or specific names of plants that produce noticeable flowers. The four most salient flowers were rose, sunflower, Venus flytrap, and tulip, with Smith's S values of 0.725, 0.448, 0.364, and 0.251, respectively.

Less cultural consensus was observed for the remaining categories of plants. Of the garden and crop plants listed, the most salient types were corn, potatoes, and squash, with Smith's S values of 0.510, 0.350, and 0.310, respectively. In the category "weeds," the most salient items were seaweed (Smith's S = 0.40) and dandelion (Smith's S = 0.30). Too few items were listed in the remaining categories to detect important trends.

Post-Assessment Freelists

Following several after-school activities, students listed slightly more plants in most categories in the post-assessment freelists. T-tests show that changes in the average freelist length in only two categories are significant: the increase from 4.9 to 9.3 items under the category "garden and crop plants" (p-value = 0.027), and the decrease from 2 to 0.6 items in the "bushes and shrubs" category (p-value = 0.006, Figure 1). Students' responses in the post-assessment freelists were more specific, included more local plants, and contained fewer incorrect responses (that is, plants that do not belong to the category under which they were listed) than in the pre-assessments.

Pre-Assessment Plant Identifications

Children correctly identified, usually to genus level, an average of 33.7 ± 6.84% of the plants presented in the slide show, with a range of 25.0 to 48.3% correct (Table 1). There was some subjectivity in coding answers as correct or incorrect; for instance, "acorn tree" was accepted as a "correct" identification for two species of oaks since students also used this name in their tree freelists. Five items were correctly identified by all 10 students: cotton, potato, rose, strawberry, and bamboo. Four items were correctly

identified by nine: Venus flytrap, peanut, sunflower, and dandelion. Thus, the two most salient flowers indicated by freelist results (rose and sunflower) were also among the best-identified plants in the plant identification task. The two most salient trees (pine and oak) were also commonly identified, with eight and seven children identifying both loblolly and longleaf pine respectively as "pine," and seven of seven children identifying both live and turkey oak as either "oak" or "acorn tree."

Chi-square analysis reveals no statistically significant variation in the children's ability to correctly identify different life forms of plants (trees, vines, shrubs, and herbs; p-value = 0.216). However, a highly significant (p-value = 1.508E-9) difference was found in their ability to correctly identify plants in different categories of human usage: those used primarily as food and commercial crops, those used primarily as ornamentals, those encountered primarily only in the wild, and those used in multiple ways by humans (including plants often used in children's play, such as bamboo, honeysuckle, and sourgrass; and plants that are used as both food and as ornamentals, such as sunflowers). On average, food and crop plants were correctly identified 70.8 ± 13.7% of the time; those plants with multiple or ambiguous uses were correctly identified 60.0 ± 15.4% of the time; and wild plants and ornamentals were correctly identified only 18.1 ± 6.4% and 15.4 ± 10.3% of the time, respectively.

Post-Assessment Plant Identifications

In the post-assessment slideshow plant identification task, students correctly identified 55.3 ± 15.6% of all plants, a significant 21.6% increase from the pre-assessment (t-test analysis yields p-value = 0.0001). Food and crop plants were correctly identified 91.7 ± 11.8% of the time; multi-use plants were correctly identified 80.0 ± 15.8% of the time; ornamental plants were correctly identified 33.1 ± 16.6% of the time; and wild plants were correctly identified 42.6 ± 19.3% of the time (Table 1). These percentages represent highly significant increases in children's ability to identify plants in all four categories, with p-values less than 0.006 in each category.

Post-Assessment Interviews

During their final interviews, students were able to name an average of 5.8 uses for plants—approximately 4 more than at the start of the project. There was no change in students' average preference for being inside or outside.

Discussion

While the pre-assessment results corroborate other studies documenting American children's lack of knowledge of their local environments, they also demonstrate, in accordance with Zarger and Stepp (2004), that culturally important plants are more well-known than others and reveal a potentially important oversight in other studies. Comparison of freelist lengths for different categories of plants suggests that trees may be a particularly salient category of plants for children. This is consistent with the evidence that "tree" is the first life-form term added to a language (Brown 2000). Perhaps the large size and prominence of trees in childhood play (for treehouses and climbing, for example) contributes to the longer freelists of tree names relative to other types of plants. However, this explanation of visibility and usefulness does not account for the relative paucity of garden and crop plants freelisted. This category may have been too broad to elicit freelists representative of children's knowledge of food and crop plants; breaking it down further into individual prompts for fruits, leafy vegetables, and root vegetables may have produced better results. Additionally, respondent fatigue may have been a factor affecting freelist length; trees were the first freelist prompt for all 10 students, while garden and crop plants was always fourth.

The high percentage of genus and species names in the tree freelists indicates that these taxonomic ranks are still important to American children, in spite of evidence that these ranks are losing salience in Western cultures (Atran *et al*. 2004, Wolff *et al*. 1999). The lower incidence of generic and specific plant names in the flower freelists again may indicate that flowers are a less salient or less well-known category for children.

It is at first glance surprising that significant increases in the number of plants students were able to freelist were seen in only one category (garden/crop), and that a significant decrease was observed in the number of bushes and shrubs they freelisted. Several explanations exist. Due to unavoidable circumstances at the elementary school, the post-assessment freelists were conducted in the more chaotic setting of the school cafeteria rather than in the classroom where the pre-assessment was held. This confounding variable likely affected students' ability to focus and caused them to list fewer plants than they knew. More interestingly, there was a drastic change in the composition of students' responses. Students' post-assessment freelists contained more specific responses and had fewer incorrect and inappropriate responses than in the pre-assessments. Therefore, the significant decrease in the number of bushes and shrubs they were able to name probably signifies an increase in their knowledge, because rather than, for example, list "honeysuckle" and "pine" as bushes and shrubs as they did in the pre-assessment, students were able to place these names in the appropriate categories of vines and trees, respectively, and were more likely to leave the "bushes/shrubs" category blank in the post-assessment. A more thorough analysis of the incorrect and inappropriate responses students gave in this activity is called for (see also Wagner 2008).

On average, students identified one-third of the plants presented in the plant identification slideshow, and the "most

knowledgable" child (a white male who is an avid hunter) correctly named 40% of the plant pictures presented. As expected, children were able to identify important food and agricultural plants, and plants that have multiple uses in our society. Prior studies of American children's knowledge of plants were unlikely to include food and crop plants in their identification bank (Dougherty 1979, Tull 1994). This represents a shortcoming of existing studies when comparisons are made between American children and children living in indigenous communities: many wild plants growing around the villages of indigenous people are used, whereas the plants that Americans use are typically seen only in home gardens or in agricultural fields. Thus, the plant knowledge of indigenous children may be comparable to the fruit and vegetable knowledge of American children, rather than to American children's knowledge of wild plants.

That said, the dearth of American children's knowledge of wild plants is disconcerting; the children in this study could initially identify only 18.1 ± 6.4% of the "wild" plants presented in the slide show. This lack of knowledge does not bode well for the future of our environment, for without an awareness, knowledge and appreciation of the things in the natural world, our children cannot have a personal respect for the earth that sustains us. The lack of knowledge is also a symptom of Americans' lack of experience with nature, which may, in turn, pose a danger to physical and mental health and to child development (Kellert 2002 2005, Louv 2006).

The prognosis is not yet dire: the children in this study indicated that they generally "like being outside," and their enthusiasm for the activities conducted during the intervention shows that they are willing to become re-acquainted with the natural world. The increases in their ability to identify plants following the brief series of botanical activities, most of which focused on topics other than plant identification, also indicate that the prevalent lack of nature knowledge in modern society is not irreparable. The children's ability to identify ornamental and wild plants had more than doubled by the end of the project, and they were able to identify over 20% more plants in both the garden and crop and multi-use categories.

Perhaps the most important effects of the intervention were ultimately not quantified. During a post-assessment interview, students were asked how their opinion of plants had changed. "There are a lot more plants in the environment than I think, and I've just got to look closer," one child replied. "I used to think plants were boring, and now I think that they're fun," said another. Yet another claimed, "I used to just walk and step on [plants], but now I know how useful plants are and I look down and see where I'm stepping." These statements show that relatively simple activities, such as planting a small garden and learning about the uses of local plants, can and did have a huge impact on children's awareness of, and interest in, the natural world around them.

Conclusions

The informants in this study could initially identify only one-third of 60 common local plants, and an even smaller proportion of "wild" plants in the area. These findings are cause for concern: without knowing what things are in the natural world surrounding them, how will tomorrow's generation appreciate or protect the biodiversity of this planet? Without exploring nearby natural places, will they ever have cause to marvel and wonder at the complexity and intricacy of nature? This study demonstrates the need for an increased effort to include natural history education in the normal school curriculum. Luckily, this project also provides hope. Following a short series of informal activities, children's ability to identify plants increased by 20% overall, and in some categories of plants, more than doubled. The steps that can be taken to bridge the gap between ignorance and knowledge are basic, and have been known for ages: "Let children walk with nature" (Muir 1916:70); "let nature be [their] teacher" (Wordsworth n.d.:6). Encourage and allow children to be in the natural world; take the time to explore nearby natural places; and begin to acquaint the children in your life with the land that sustains us.

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