

Planting a Native Pollinator Garden Impacts the Ecological Literacy of Undergraduate Students

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ABSTRACT

Ecological illiteracy exists, in part, because students may be technologically advanced but often lack intellectual curiosity about their natural environment. Botanical illiteracy, often referred to as “plant blindness,” results from several interacting factors, including a lack of interest in plants and insufficient exposure to plant science before students reach college. We were interested in understanding how a hands-on activity planting native plant species translates across undergraduate majors in improving botanical literacy, as well as increasing awareness and concern about the loss of plant and pollinator biodiversity worldwide. We conducted a survey of both life-science majors and nonmajors to examine their attitudes toward native plants and pollinators. We also examined the change in attitudes of science majors following a hands-on native garden planting activity. We found that life-science majors generally had a stronger understanding and valuation of native plants and pollinators than nonmajors. We also found that life-science majors demonstrated an increase in their knowledge and valuation of native plants and pollinators after participation in the gardening activity. We suggest that this type of activity is important in alleviating plant blindness and in increasing ecological literacy, even among already knowledgeable science students.

Key Words: native plants; native pollinators; environmental education; plant blindness.

○ Introduction

Gardening is widely recognized as an activity that promotes overall health and quality of life, physical strength, fitness and flexibility, cognitive ability, and socialization (Blair, 2009; Wang & MacMillan, 2013; Scott et al., 2015). Gardening with native species can be an effective way to combat some of the negative effects of “plant-blindness,” which include (1) the

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inability to notice plants in the environment, (2) the inability to recognize the importance of plants in the environment, and (3) the tendency to rank plants as inferior to animals (Wandersee & Schussler, 1999, 2001). We anticipated that participation in a hands-on garden-planting activity focused on native plants and pollinators would increase valuation of native plants and insects and decrease some of the negative effects of plant-blindness among undergraduate students, both life-science majors and nonmajors.

Zhang et al. (2014) found that Chinese students from urban schools who had less contact with nature had different attitudes about conservation, and children’s contact with nature was significantly, positively related to their biophilia and negatively related to their biophobia. Similarly, we predicted that undergraduate students who participated in a hands-on planting of a native pollinator garden on campus would demonstrate improved biological literacy and decreased plant blindness, as measured through a series of before-and-after questions assessing basic botanical and ecological knowledge. Students’ views of nature were also briefly explored. We predicted that participation in planting a campus pollinator garden would result in students demonstrating an increased likelihood of establishing their own native pollinator garden compared to those who did not participate in the event. We also expected that students would demonstrate increased knowledge about both native plants and insects in North Carolina after participating in the garden planting. We further predicted that life-science majors would generally have a higher level of scientific literacy going into the study than nonmajors, due to the material covered in required major core courses regarding basic botanical and ecological knowledge.

The overall aim of our project was to assess whether a hands-on experience planting a native pollinator garden on the campus of the University of North Carolina at Charlotte (UNCC) affected student valuation and knowledge of native pollinator habitat in their own lives.

○ Methods

Investigators built two large raised garden beds on the east lawn of the McEniry academic building on UNCC campus. The two rectangular beds were built at a height of approximately 1.0 m tall, 1.7 m wide, and 7.4 m long and filled with organic soil. Investigators acquired native plants from the UNCC Botanical Gardens, where they were grown from seed. Students from two courses – offered through the Department of Biological Sciences, Ecology and Conservation Biology – planted four to six small starts of the following North Carolina native plant species in our garden beds: *Asclepias syriaca*, *Baptista australis*, *Coreopsis palustris*, *Echinacea purpurea*, *Eupatorium* sp., *Helianthus occidentalis*, *Lobelia cardinalis*, *Monarda fistulosa*, *Rudbeckia maxima*, *Solidago* sp., and *Symphoricarpon lateriflorum*.

The garden planting occurred on February 22, 2019, from 8 to 10 a.m. EST on a clear day. Before starting the garden activity, all participants were surveyed with nine questions assessing their basic knowledge and valuation of native plants and pollinators. The survey is described in more detail in the section below. After the pre-activity survey, participants were given a brief introduction to native plants and pollinators by peer members of the Pollinator Club at UNCC. Before putting plants in the ground, participants attended a poster presentation detailing information about some local native plants, including *Asclepias syriaca*, *Baptista australis*, *Lobelia cardinalis*, and some of their characteristics. Participants also learned about some native pollinators, including *Papilio glaucus*, *Danaus plexippus*, and various squash bees, and their traits. Information on native pollinators and the insects that pollinate them included facts about their phenology, and benefits provided to agriculture by pollinating insects were presented as a 15-minute lecture by the participants' peers and a poster featuring pictures of native pollinators and native pollinating insects. Information about the status of European honeybees (*Apis mellifera*) as pollinators not native to North America was also explained. The problem of global pollinator decline was discussed, as well as the importance of pollinators in ecology and agriculture, and the symbiotic relationships between some plants and pollinators. Students were then allowed to form small groups and were encouraged to each plant at least one plant species in the garden. After the planting, students were given free milkweed seeds to take with them, to encourage them in starting their own garden at home.

Survey participants were targeted by fliers and by tables set up around central areas of the UNCC campus and included the students from the two courses noted above. A pre-planting survey was completed by each participant on the morning of the garden planting. We asked three yes/no questions, four Likert-scale questions, and two open-ended questions to evaluate students' knowledge and perceptions of native plants and pollinators. One week after the garden planting, participants were sent a post-planting survey consisting of the same questions as the pre-survey, to determine whether their answers had changed as a result of their participation in the garden activity. All questions were answered by participants using Google Surveys.

○ Results

Data collected in this study allowed us to make two different comparisons. First, we compared the attitudes of life-science majors with those of non-life-science majors, to distinguish between

academic backgrounds. Second, we compared the responses on the pre- and post-surveys of the life-science students who participated in the planting event. Asterisks indicate significant results.

Attitudes of Life-Science Majors & Nonmajors

We examined differences in the attitudes of life-science majors vs. nonmajors ($N = 172$ and $N = 84$, respectively) by conducting a Fisher's exact test on the two groups (see Tables S1 and S2 in the Supplemental Material available with the online version of this article). For the first question, *Do you have a flowering plant garden?*, there was not a significant difference in answers (31% positive for life-science majors vs. 20% positive for nonmajors; $p = 0.0743$). In response to the second question, life-science majors rated their knowledge of native plants in North Carolina significantly higher than did nonmajors: using a six-point Likert scale (0–5), life-science majors had a median of 1.71, whereas nonmajors had a median of 1.51 ($p < 0.0001^*$). Life-science majors were more confident in their knowledge of native insects in North Carolina as well: 81% responded positively, compared to 70% of nonmajors ($p = 0.0547$). Life-science majors were also more likely to indicate that they would plant gardens of their own in the future: using a three-point Likert scale (0–2), life-science majors had a median of 1.2, whereas nonmajors had a median of 1.0 ($p = 0.0865$). Life-science majors were more likely to be familiar with the issue of global pollinator decline: they had a median of 0.95, whereas nonmajors had a median of 0.68 ($p = 0.0021^*$). There was no significant difference between life-science majors and nonmajors in rating the importance of native plants in the environment; the medians were 1.78 for life-science majors and 1.68 for nonmajors ($p = 0.1186$). There was also no significant difference regarding attitudes about being connected to nature, with a median of 1.9 for life-science majors and 1.78 for nonmajors ($p = 0.6121$). Life-science majors showed a significant difference in the extent to which they believed they could influence how local to global environmental problems are solved: life-science majors had a median of 1.42, whereas nonmajors had a median of 1.78 ($p = 0.0035^*$). However, there was no significant difference in the extent that life-science majors or nonmajors felt personally that they can help control the decline of native pollinators in their local area: life-science majors' median was 1.31, and that of nonmajors was 1.55 ($p = 0.0724$).

Science Majors before & after the Gardening Activity

We next conducted a Fisher's exact test (Connelly, 2016) on the pretest and posttest scores of the life-science majors to assess how participation in the hands-on gardening activity affected their attitudes toward native plants and insects (see Table S3 in the Supplemental Material). There was no significant difference from pretest and posttest subjects on question 1 (37% positive response pretest compared to 32% posttest; $p = 0.5333$), indicating that life-science majors were not significantly more likely than before to have a flowering garden of their own. All other questions revealed significant differences before and after participation. Subjects rated their knowledge of North Carolina native plants higher (pretest median of 1.73 and posttest median of 3.02; $p < 0.0001^*$) after participating in the garden planting, and significantly more subjects indicated that they were able to name at least one native plant (77% positive response pretest compared to 99% posttest; $p < 0.0001^*$) and one native pollinating insect (86% positive response pretest compared to 99% posttest; $p = 0.0012^*$) following the activity. Participants

rated the importance of native plants in the environment significantly higher (pretest median of 1.79 and posttest median of 1.97; $p = 0.0004^*$) after the garden planting, and further indicated that they were significantly more likely to plant their own native plant garden in the future after participating (pretest median of 1.3 and posttest median of 1.73; $p < 0.0001^*$). Participants indicated that they were significantly more familiar with the problem of global pollinator decline after participation (pretest median of 0.97 and posttest median of 1.55; $p < 0.0001^*$) and felt more of a personal connection to nature after participation (pretest median of 1.9 and posttest median of 2.28; $p = 0.0109^*$). Finally, participants indicated that after the garden planting they believed that they had the power to influence local to global environmental problems (pretest median of 1.28 and posttest median of 1.90; $p < 0.0001^*$) and help prevent local pollinator decline (pretest median of 1.39 and posttest median of 2.14; $p < 0.0001^*$), significantly more than before participation in the garden planting.

○ Discussion

Lack of contact with the natural world has contributed to the unfortunate phenomenon of plant blindness (Meyer et al., 2019). Our results show that participating in a hands-on activity of planting a native pollinator garden increased overall participant valuation of, and engagement in, the creation of native pollinator habitat. Researchers have shown previously that engagement in the natural environment in this manner can lead to an increase in ecological literacy (Orr, 2006; Bruyere, 2008), and our results support this. For the first question, *Do you have a flowering plant garden?*, we did not find any significant difference in answers between life-science majors and nonmajors; it appears that most students, regardless of major, do not have a flowering garden at their own residence. We expected that life-science majors would rate their knowledge of native plants in North Carolina higher than nonmajors and would be more confident in their knowledge of native insects in North Carolina, given that this is part of their academic curriculum in science. Interestingly, life-science majors were more likely than nonmajors to indicate that they would plant gardens of their own in the future, which we attribute to their increased valuation of native plants in the environment. We found that life-science majors were more likely to be familiar with the issue of global pollinator decline than nonmajors, as we predicted. There was no significant difference between life-science majors and nonmajors in rating the importance of native plants in the environment; both groups indicated that native plants are very important in the environment. While there was no significant difference in attitudes about being connected to nature, life-science majors showed a significant difference in the extent to which they believed they could influence how local to global environmental problems are solved. This may be attributable to the increased understanding of native plants in the environment that life-science majors displayed compared to nonmajors. But we found no significant difference in the extent to which life-science majors and nonmajors felt personally that they can help control the decline of native pollinators in their local area; both groups indicated that they felt they had a fair amount of control over this issue.

We attribute our finding that life-science majors were not significantly more likely to have a flowering garden of their own immediately after conducting the gardening activity to the fact that the follow-up survey was sent out only one week after the activity.

Although students received seeds to plant after the event, a week may not be long enough for participants to have started their own garden at home. Also, students living in a dorm may not feel that they have enough space or light to plant a pollinator garden, even in containers.

Except for the first question, our survey suggested that participation in the hands-on garden activity resulted in significant differences in attitudes before and after participation for all questions. Subjects rated their knowledge of North Carolina native plants higher after participating in the garden planting, and significantly more subjects indicated that they were able to name at least one native plant and one native pollinating insect following the activity. However, we did not test the accuracy of this answer, so we are taking participants' word that they can name a native plant and insect. For example, many students were able to name pollinating insects such as the honey bee (*Apis mellifera*) but were not aware that these insects are not actually native to North Carolina, or even to North America. However, students' attitudes toward their knowledge may be telling in regard to how much they care about the topic. Participants rated the importance of native plants in the environment significantly higher after the garden planting, and further indicated that they were significantly more likely to plant their own native plant garden in the future after participating. We think that the experience of putting native plants in the ground, in combination with discussing their importance, caused a shift in these attitudes by creating a personal connection between the participants and the plants. Participants also indicated that they were significantly more familiar with the problem of global pollinator decline and felt more of a personal connection to nature after participation. These are both major components of ecological and botanical literacy. Finally, participants indicated that they were more empowered after the garden planting, and that they believed that they had the power to influence local to global environmental problems and help prevent local pollinator decline, significantly more so than before participation.

Activities like the one we conducted allow participants to have a hands-on experience with plants native to their local area. Plant blindness seems to be enhanced by the more "animal-oriented" and less "plant-friendly" educational systems (Amprazis & Papadopoulou, 2020). Since most of us exist in a predominantly zoocentric world, this kind of hands-on experience with native plants and pollinators can help bridge important gaps in reducing plant blindness and improving ecological literacy. Planting a native pollinator garden provides an experience to reduce inherent bias against plants and instead encourage plant conservation behavior (Balding & Williams, 2016). Hands-on activities seem to be especially effective at improving attitudes toward plants and plant conservation, and may help reinforce concepts learned, even after the experience is over (Fančovičová & Prokop, 2011). Participating in a plant-centric educational program may also improve attitudes toward studying biological and conservation concepts in a classroom setting (Waliczek & Zajicek, 1999; Fančovičová & Prokop, 2011). Participants felt more strongly after participating in this activity that they can influence how local to global environmental problems are solved and can help control the decline of pollinators locally by adding native plants to the environment. We view this as an especially positive outcome, indicating that a relatively simple activity, such as garden planting, can empower participants to make positive changes to their own environment by noticing the value of native plants.

While we focused on undergraduate students ages 18–27, this activity would be just as suitable for children or older adults.

Teaching both younger and older learners about native plants and their pollinators could lead to higher levels of interest in identification and cultivation of these important species. Appreciation of the importance of plants in general, and of native plants specifically, should be a continuous process that can be incorporated into traditional classroom learning. Integrating plant-based knowledge in K–12 curricula, as well as in college-level general biology education, could include teaching about specific “flagship species” that students show interest in, such as those used for medicinal purposes (Pany & Heidinger, 2017). Hands-on plant-growing projects could be used that coincide with lessons over the course of a unit or semester, such as school gardens (Waliczek & Zajicek, 1999) or the Pet Plant Project (Krosnick et al., 2018), which encourages integration with lessons as well as identification and care of plants by students.

Both adults and students may be encouraged to learn more about native plants through reading, field guides, guided hikes, or nonacademic classroom opportunities, such as those provided by many county Cooperative Extension Services in the United States. Learners of all ages remember the information they learn and share it with others, indicating positive attitudes toward the learned material. It has been shown that positive attitudes toward the information learned and experiences with conservation education last a relatively long time, although evidence of student participants acting on the information they learn is less concrete (Kuhar et al., 2009). However, much of the literature evaluating attitudes is, itself, “plant blind,” focusing on conservation of animals and not plants. Further studies on plant-based education are needed in order to understand the long-term effects on improving plant awareness. By providing participants with native plant seeds, we hoped to sustain participant engagement with native plants, reducing plant blindness and encouraging positive attitudes toward botanical knowledge and plant conservation.

○ Supplemental Material

The following are available with the online version of this article:

- Table S1: Degree majors represented in survey participants.
- Table S2: Attitudes of life-science and non-life-science majors
- Table S3: Attitudes of life-science majors before and after completing the activity.

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