RESEARCH REPORT

# From Generation to Generation:
## Incorporation of Intergenerational Informal Science Education into an Introductory College Science Course

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## Abstract
Restoration of forest ecosystems following the loss of biodiversity associated with non-native species invasions is an issue of civic consequence that has the potential to engage audiences of all ages, backgrounds, and abilities. In this project, the strong sense of community connection felt toward a local forest preserve was leveraged to inspire native plant seed collection, propagation, and planting for a community-driven forest restoration project. As part of a larger project, informal science education was integrated into a general education environmental science course to engage college students in this civic project and in intergenerational community building. The introduction of students to informal science education (ISE) through collaboration with an outdoor education center was successful at increasing awareness of ISE as a potential career path, developing environmental science content knowledge, inspiring interest in restoration projects among elder participants, and building community. Intergenerational workshops resulted in bidirectional knowledge exchange among participants related to a strong sense of place shared by both generations.

## Background
In 2013, a partnership between a small liberal arts college and an environmental outdoor education center was funded through a SENCER-ISE II grant to infuse civic engagement into informal science learning and integrate informal science education into higher education science teaching. During the first year of the grant work, college students, middle-school students, senior adults, and partnership institutions became an intergenerational community of practice centered around the critical issue of biodiversity loss through species invasions. The overall project included multiple components: young students collecting seeds of native plants, college students cleaning and propagating plants and initiating restoration research, and older community members participating in civic engagement activities related to restoration. The focus of this article is on the incorporation of informal science education methods into a general education, first-year college environmental science course using intergenerational learning and civic engagement. The intention of this portion of the larger project was to enhance student learning and promote community building by involving senior adults and college students in an intergenerational learning experience. The project combines aspects of informal science education with intergenerational

learning and civic engagement. The project was designed to strengthen the link between environmental science learning and action (Ballantyne et al. 1998) by engaging participants in a topic relevant to their lives and involving them in interactive learning (Falk 2001).

## Introduction

### *Informal Science Education and Civic Engagement*

"Experiences in informal environments for science learning are typically characterized as learner-motivated, guided by learner interests, voluntary, personal, ongoing, contextually relevant, collaborative, nonlinear, and open-ended" (National Research Council [NRC] 2009, 11). In formal venues, learning is compulsory, structured, and teacher-centered, with content more central than social aspects of learning (Wellington 1990). Non-formal learning, a process that fits between formal and informal learning, is more structured but is more easily adaptable than formal education (Eshach 2007). The numerous definitions of informal, non-formal, and formal learning were recently reviewed by Stocklmayer et al. (2010). In this study, informal learning is understood as taking place outside of the classroom; it is learner-centered, includes both academic and social aspects of importance and, although it is not entirely unstructured, it relies to some degree on the learner's intrinsic motivations (Wellington 1990; Malcolm et al. 2003; Martin 2004). Research in teaching and learning in informal settings shows that, among other benefits, informal science education (ISE) is effective in increasing interest and engagement in science and increasing general scientific literacy, (Bouillion and Gomez 2001; NRC 2009; Stocklmayer et al. 2010), and that ISE is pertinent throughout a learner's lifetime (NRC 2009).

Because informal learning is personal and relevant as well as voluntary (NRC 2009), it is necessarily related to learning through civic engagement. In the spirit of SENCER, civic engagement is both personal and relevant, because society is replete with "wicked problems" that resist simple resolution and require interdisciplinary approaches grounded in civic responsibility (Lawrence 2010). In this sense, learning through civic engagement is similar to community-based service learning in that it is a meaningful connection between students and community, where students use new skills in real-world situations to serve their community. Experiential learning through civic engagement and tackling capacious problems takes this one step further; it exposes the interconnections that make problems "wicked" and promotes deeper learning on the part of both the students and the community. Service learning and civic engagement may be especially important in environmental education where there is a risk of leaving students feeling despondent and powerless as they learn more about environmental issues (Hillcoat et al. 1995). Service and civic engagement have the potential to awaken agency and empower students to make change (Bloom and Holden 2011).

Community-based service learning at its best encourages reflection that promotes civic responsibility, academic success, and personal growth (Arenas et al. 2006). Service learning increases awareness of environmental issues, conservation knowledge, enjoyment of nature, student motivation and engagement in school, and strengthens bonds between community members (Schellner 2008). Importantly, positive environmental attitudes and behaviors ignited through service lasted beyond the service-learning experience (Schellner 2008).

### Intergenerational Learning and Community Building

The new generation of older people lead active lifestyles and have interest in future-oriented activities that promote personal fulfillment and social integration characteristic of the "active aging paradigm" (Chadha and Malik 2010). This project leverages the desire for continued lifelong learning and significant community involvement among elders to facilitate civic engagement through intergenerational learning. Intergenerational learning opportunities are most often defined as occurring with youth under age 21 and adults over age 60 (Kaplan 1997; 2002) and are common in fields of social and health sciences (Roodin et al. 2013). Intergenerational learning programs create intentional exchange of resources and learning among generations (Kaplan 2002). Importantly, intergenerational learning is based on reciprocity of benefit and thus is expected to be mutually beneficial for all generations involved (Ellis and Granville 1999; Tam 2014). Lifelong learning may be intergenerational but typically takes place in informal settings (reviewed in Broström 2003); thus, the articulation of intergenerational learning in informal settings is a natural combination with potential to enhance education and community connectedness.

Intergenerational learning programs have been successful with a range of age groups in a variety of venues, though

most of the documentation of their success comes from students working in gerontology (Roodin et al. 2013). There were both curriculum and relationship-based benefits from a service-learning course in which college students worked with elderly participants (Tam 2014). Community elders working with primary school students (Peterat and Mayer-Smith 2006) showed cross-generational social learning and reciprocity of benefit. On a much larger scale, the Granddad Program in Sweden was successful at bringing senior adult male role models into schools as volunteers (Broström 2003). Many community-based intergenerational experiences focus on environmental activism, and seniors make especially good environmental steward role models because they possess the self-motivation for protecting the Earth for future generations (Ballantyne et al. 1998). When seniors were incorporated into a residential outdoor education program, children who worked with senior adults (as compared to the control group) gained more information on a wider variety of topics, and there was a trend toward improved environmental attitudes (Shih-Tsen and Kaplan 2006). In an ISE program, seniors were paired with students on an urban farm, and program participants showed increased environmental awareness associated with the experience (Mayer-Smith et al. 2007).

The benefits of intergenerational service learning programs are well documented (see reviews in MacCallum et al. 2006 and Roodin et al. 2013). Through bidirectional information flow including sharing life experiences and constructive knowledge exchange, participants increase their understanding of each other (Springate et al. 2008). Intergenerational learning programs or courses have the effect of reducing age-related stereotypes (Kaplan, 1997), with students reporting a more positive and appreciative attitude towards the older generation (Zucchero 2009 and 2011; Penick et al. 2014). Benefits to the elderly include benefits attributed to lifelong learning (Broström 2003): improved self-esteem and life satisfaction (Newman et al. 1997), physical, social and psychological as well as economic benefits (Tam 2011; 2014), maintenance of cognitive functioning (e.g., Ardelt 2000; Boulton-Lewis et al. 2006; reviewed in Tam 2014), and promotion of pro-social values (Broström 2003).

The benefits to youth from intergenerational learning are better documented than benefits to college students. Intergenerational learning experiences are reported to increase confidence and self-worth and improve practical skills among youth (MacCallum et al. 2006). Youth involved in intergenerational activities showed increased enjoyment in school, were less likely to become involved with drugs, displayed enhanced literacy development (MacCallum et al. 2006) and became more civic-minded and viewed their citizenship in more action-oriented terms (Kaplan 1997). Although many intergenerational service-learning experiences involve young children, working with college students has been shown to enhance the general well-being of older adults also (Hernandez and Gonzalez 2008). Our project adds to this literature by documenting bidirectional information flow and a sense of community belonging among college students and elders.

### *Project Description*

Antioch College and the Glen Helen Outdoor Education Center (OEC) are situated in a Midwestern USA town of approximately 3500 residents, where the median age is 48 and the population is aging; approximately 47.5 percent of the population is aged 50 and older (US Census Bureau 2010). The College has approximately 200 students and very small class sizes. The OEC is within close walking distance to the college campus. Over 2700 grade school students and in-service teachers participate in educational programs that meet state teaching standards and are designed and led by a team of paid and trained naturalists at the OEC. The OEC is located within the city limits in a 1000-acre nature preserve (Glen Helen or The Glen) that receives over 10,000 visitors annually and is an important part of the local community.

We used the critical community issue of biodiversity loss to involve students and community members in forest restoration in the local nature preserve. The Glen encompasses a forest ecosystem negatively impacted by invasive species, most notably by bush honeysuckle. Bush honeysuckle has been documented to prevent growth of native understory plants through resource competition, allelopathy, and depleted soil seed banks (Cipollini et al. 2008; Cipollini et al. 2009; McKinney and Goodell 2010; Arthur et al. 2012; Bauer et al. 2012). Forests with invasions of bush honeysuckle also have lower amphibian species diversity and richness, altered patterns of pollinator visitation, song bird assemblages, and soil fungal communities, higher soil compaction, lower soil quality, and lack of certain other qualities that are indicators of a healthy forest understory (Watling et al. 2011). Restoration of forest ecosystems following invasive species removal is dependent on replanting native forest understory species and involves the consideration of numerous intertwined ecological principles

that must be in place to sustain and promote the return and establishment of a biodiverse community (Vidra et al. 2007; Swab et al. 2008; Aronson and Handel 2011). Through this project, youth at the OEC, college students, and senior adult community members participated in the propagation of native plants for a forest restoration project in Glen Helen.

As part of our project, college students in the course entitled Introduction to Environmental Science visited the OEC, observed a naturalist-led hike, studied native and invasive species in class and in the Glen, and offered plant propagation workshops to senior adults at a local senior center. Workshops in which students participated were held in the "great room" at the Center, a large, open area. Eight tables with planting supplies were situated in a circle around the room and each table was attended by a student with a different native plant species to propagate. Chairs were arranged so participants could sit or stand at stations and there was ample room for moving from station to station. The workshop began with an introduction to the project, invasive species impacts, and restoration efforts in the Glen. Then participants were encouraged to help clean or plant seeds at any of the stations and to move among stations. The effect was to optimize personal, intergenerational interactions in an experience with direct relevance to people with some connection to the Glen.

The objectives of this curriculum innovation were to

1. Introduce students to informal science education (ISE) as a potential career path
2. Teach content knowledge related to invasive species and biodiversity loss
3. Design and implement an intergenerational learning opportunity that results in bidirectional knowledge sharing

The workshops were designed to engage older adults and college students in meaningful work and ultimately create a sense of community purpose while encouraging environmental responsibility and civic engagement. This type of community connection through active civic engagement promotes the personal fulfillment and social integration sought by elder community members (Chadha and Malik 2010). College students benefit from working with adults of a different generation and forming ties that spill over and enhance community life (Roodin et al. 2013).

## Methods

There were two primary activities in the curriculum design; one introduced students to ISE and the second put the students into the position of informal science educators in an intergenerational workshop. We scaffolded the student-led workshops by introducing students to the OEC and having them observe and reflect upon an informal science lesson. The class walked to the OEC at the beginning of the quarter to meet the Director, tour the facility and discuss OEC programs. During the quarter, students were required to attend one naturalist-led hike, observe the lesson, and submit a reflective assignment within two weeks of completing the hike. The reflection activity included a description of the lesson, suggestions on how to improve or extend the experience, and thoughts on the importance of ISE in education. Two weeks before the workshops, students participated in class work that introduced them to the project, biodiversity, and issues related to invasive species. They chose a native plant (from a list of those available) and completed individual research on the natural history of the plant. Students designed and printed an information sheet on the species and were told to be prepared to describe their species and the project and to answer questions during the workshops. They submitted the species information sheet for feedback and grading before the workshops. Students were divided into two groups to offer two workshops at the local senior center during February 2014. In the workshops, students managed their own "propagation stations," provided information on their native plants, and cleaned and planted seeds with workshop participants. Students learned seed cleaning and planting before the workshops in a separate classroom activity.

Students taking the class in fall 2013 participated in the naturalist-led hikes, but workshops were offered only during winter 2014 quarter. Thus, included here are two sets of student reflections on OEC involvement and one set (winter quarter) of workshop assessments. Student responses to an open-ended question on the hike reflection assignment were coded using presence/absence codes based on the assessment prompts (Table 1). Codes included experience (positive or negative), expressed interest in ISE (yes or no), and recognition of ISE as important to the student's education (yes or no). Two additional codes were added to the analysis of the winter quarter reflections: awareness of ISE before the class (yes or no), and whether or not students noted learning something that they previously did not know about ISE (new

learning). To further quantify interest in ISE, students were asked in 2014 if they were interested in a cooperative working experience (co-op) as a naturalist assistant. They could answer yes, no, or maybe and were asked to provide an explanation of their choice. Given the presence/absence format of codes, there was very little room for interpretation. A second coder, unfamiliar with the project, coded the same student responses; the inter-coder reliability, calculated as the proportion of individual excerpts and codes that the individual coders applied similarly, was 95 percent.

To assess knowledge sharing and community building during the workshops, students completed workshop reflection sheets, and older adult participants were asked to complete a post-workshop survey before leaving the Senior Center. Before the start of the workshop, students were asked to keep a tally of the number of participants with whom they interacted and to remember conversation topics. Students completed the reflection sheet immediately at the end of the workshop. The survey for older adult participants included ten statements with 10-point anchored responses that ranged from 1 (not at all) to 10 (very much or a great deal) with the prompts "How much did this workshop…" and "To what degree…" and a space for additional comments.

Four exam questions were used to evaluate student content knowledge about biodiversity and invasive species: (1) What are the five major threats to biodiversity that we discussed in class? (2) What is the number one cause of the loss of biodiversity on the planet? (3) Outside of bush honeysuckle, what are two additional examples of invasive species that are negatively impacting ecosystems in the USA? (4) Bush honeysuckle and other invasive plants impact native plants by shading, competition for space and soil nutrients. Describe two additional negative impacts that this invasive has on natural ecosystems (outside of impacts on plants under the honeysuckle). In addition to these questions, students were asked to rate the extent of their knowledge about bush honeysuckle as an invasive species compared to their knowledge before they started the class. Answers were on a five-point Likert scale ranging from none to very high.

## Results

### *Naturalist-led Hikes*

Students who attended their required naturalist hike and submitted a reflection assignment all provided adequate descriptions of the lesson and responded to additional questions appropriately. This indicated that the students attended and engaged in the lesson. Students had an enjoyable experience at the OEC, expressed interest in ISE, recognized the importance of informal learning opportunities and in most cases were interested in additional ISE experiences. Some students noted that the cold weather was the only aspect of the experience that they did not enjoy, but 100 percent of students in both classes described positive experiences overall.

Some students began with an interest and strengthened or acknowledged that interest, whereas others gained interest in ISE through their participation in the hike at the OEC. Interest ranged from very interested to no interest (Table 1) and, 86 percent (fall) and 87 percent (winter) of students expressed interest in ISE. Students who expressed interest in ISE, recognized ISE as a potential career path and a way to garner teaching experience. One student wrote, "…I am very interested, in fact, that is what I hope to do as a career." Another wrote, "I am definitely interested in informal science education…. Even if I do not choose being an educator in my profession, I will probably run into a situation where I will be teaching in some way, and informal education can be a great option to handle this opportunity." One student was interested in education but not specifically informal science education: "…I am somewhat interested in education as a possible career. I'm not entirely sure if informal science education would be the specific career path…." For some students, their experience at the OEC led them to reconsider ISE: "Before this hike I would not have believed I had any interest in informal science education [;] however now I believe I might," whereas another student, even after this experience, was "still not very interested in informal science education … I have other things that I want to do." It is not possible to determine whether the lack of interest was because it was specifically science education; none of the students were science majors.

In 2014, when asked about interest in a co-op work position as a naturalist assistant, of the twelve students who replied, only two gave a negative response; the others chose either yes or maybe. The two students who were not interested explained their response by their lack of knowledge in science, lack of interest in working with children, and the need for experience related to their non-science major. Although these two students did not recognize how this experience might benefit them regardless of their major, another student commented, "I would say it'd be a better fit for an environmental

**TABLE 1.** Prompts for college student reflection about their experience on a naturalist hike at the outdoor education center

| Class | Prompt |
|---|---|
| Fall 2013 (n = 15) | "Write a short paragraph about your experience with the OEC. Include whether or not you might be interested in informal science education and how informal science education has been or may be important to your education." |
| Winter 2014 (n = 12) | Same text as above with the following addition: "Were you aware of environmental education/informal science education as a career before this exercise?" |

science major, or someone who has a bigger interest in being a teacher someday! However, I think it'd be a good experience to have and I would consider it!" Two students who chose "yes" and one who chose "maybe" specifically tied their response to their positive experience on the naturalist-led hike.

Almost all students in both classes (87 percent in fall and 100 percent in winter) provided anecdotes describing the importance of informal learning to their education or, more commonly, in educating youth in environmental science. Many students provided examples of their own positive experiences with informal science education at their grade and secondary schools and through interactions at nature centers. No one described a negative experience with informal science education, and most were very interested in the "outdoors," and especially in learning more about the specific nature reserve used in this project.

Among the students who described themselves as previously aware of informal science education (86 percent, n = 7, in winter quarter), five of them described how their view changed after the hike. Two admitted that before their experience in the class, they had different concepts of what it meant to work in informal science education (e.g., park ranger). Two students gained appreciation for ISE: "…I never knew how amazing it was" and "Before this hike I knew what informal science education was but I never really considered it as one of the career paths…." One became aware of the OEC for the first time and another gained awareness of the importance of naturalist jobs: "Looking back however I can understand the importance of her [the naturalist's] job and of other careers such as hers."

Increased awareness was often tied to "new learning" about ISE. Although the assessment prompt did not specifically ask about new understanding, half of the students in the 2014 class indicated that they learned something new about ISE through their experience. For example, one student commented, "Visiting the OEC gave me a different perspective on the types of education I might be suited for or interested in" and another, "I had not thought very much about a career in informal science education but now I definitely see how important it is to teach young ones about nature."

### *Senior Adult Workshops*

The workshops received very positive reviews from students and adult participants. The reflections that the participants provided on the surveys indicated that the workshops facilitated bidirectional sharing of knowledge across generations and a sense of community building. One shortcoming of the workshops was that they occurred during a particularly cold and snowy winter, which limited attendance by senior adults. There were eight students at each workshop and twelve adult participants at the first and only six at the second workshop. Not all participating adults chose to complete a post-workshop survey, and so, our sample sizes for adult reflections are low. The structure of the workshops encouraged adult participants to move from station to station and interact with several students. Thus, although the number of participants was low, all students had the opportunity to engage with multiple participants during the course of the workshop.

### *Bidirectional Knowledge Sharing*

Post-workshop surveys completed by students showed that on average, each student shared their knowledge of native plants with four adult participants and, on average, three older adult participants shared knowledge with the student. Students listed the types of information that they shared with adult participants, which included information on the plant's habitat, pollination, use of natural insecticides, forest understory, mesic wetlands, similarities to other plants, planting methods, germination requirements, types of plants (herbaceous and woody), and invasive species impacts. The

responses indicated that students were synthesizing and sharing what they had previously learned in class as part of this project or other class activities.

The examples that students provided indicated that participants shared their knowledge of plants as well as general knowledge about a wide range of topics. Students commented that they learned about tree diseases, organic gardening methods, the history of the Glen, how to recognize some native flowers, and how seeds are dispersed. Adult participants were sharing their expertise with students while the students shared information with them. For example, when asked to provide examples of knowledge shared by participants, students wrote

*"One woman talked about the dogwoods she had…."*

*"…the paw paw festival and different kinds of paw paw cultivation…"*

*"…the trees [she] saw in the Glen…"*

*"past/current gardening experiences, talking about their lives in general…"*

*"…The seeds are long because they can be carried easier by the wind…."*

*"…got a great book recommendation" and*

*"I feel like I learned a lot from those who visited my station."*

## Sense of Community

Student reflections revealed a positive sense of community connectedness. For example, some student responses to the prompt "How did the experience influence your connection to the community (outside of the campus community) and connection to the Glen?" included

*"It felt good to chat with community members and to see how they feel about…"*

*"I loved to meet members of the community … and get to hear their stories."*

*"I was able to make connections based on common interests"*

*"…It made me feel more connected and more open to the community…."*

*"I felt more strongly connected to both the Glen and the community, particularly because we took action to improve the Glen with the help of the community."*

And several students indicated a desire to become more involved in the community:

*"…encourage me to reach out more to the community at large; they are awesome!"*

*"I would like to … be more involved with the Yellow Springs community."*

Among the eighteen adult participants in the two workshops, only 14 elected to complete a survey. The highest rated survey questions were "To what degree did you enjoy interactions with students?" and "How much did this workshop increase your interest in getting involved further in Glen Helen restoration efforts?" (Figure 1). On average, all responses were over six out of ten possible levels and indicated an overall satisfaction with the workshops. Interestingly, older adults did not feel that they shared their knowledge with students to the same degree that they increased their own knowledge and that students shared with them. This is contrary to the student's description of knowledge exchange and appreciation for information shared by older adults. Older adult participants

**FIGURE 1.** Average scores from senior adult workshop participant responses on post-workshop surveys. (n = 14)



liked the degree of interaction possible in the workshop and expressed a stronger personal connection to the community as a result of their participation.

### *Content Knowledge*

Exam questions for students in the environmental science class were graded as "all or none" to assess content knowledge. Fourteen students completed the four assessment questions included on their exam in winter 2014. Among those 14 students only two described their prior knowledge of honeysuckle as an invasive plant as high and both of these students had some experience working with invasive plant removal in the Glen through other opportunities. All students identified the most common cause of biodiversity loss and correctly listed invasive species in addition to bush honeysuckle; 93 percent were able to provide additional negative impacts of honeysuckle on an ecosystem, and 86 percent correctly listed five threats to biodiversity. Despite their perceived initial lack of knowledge about honeysuckle as an invasive species, students gained knowledge about invasive species during the course of the class activities.

## Discussion

Students increased their understanding of informal science education, biodiversity, and invasive species impacts and strengthened connections to the local community through participation as informal science educators in intergenerational plant propagation workshops. The naturalist-led hikes provided students with concrete examples of informal science education in action and appropriate scaffolding for stepping into the role of informal science educator. Students and senior adults alike were extremely positive about the workshops, and within the workshops there was successful bidirectional, cross-generational information sharing.

Student participation in naturalist-led hikes as an introduction to ISE was successful at stimulating interest in and increasing awareness of ISE as a potential career path among college students. This project focused on increasing awareness of the OEC as a local environmental education resource and the potential for students to participate in ISE as part of their science career. Other studies have shown that students' career planning was enhanced and that they changed their beliefs about careers following short summer programs (Barnett et al. 2011). Anecdotally, there is an indication that the interest in ISE persisted among students: one student applied to the OEC for a paid naturalist position.

The combination of ISE, intergenerational learning and civic engagement with college student participants is relatively unique. Informal science education programs at museums or zoos (NRC 2009), for example, are generally designed for unidirectional knowledge flow from an educator to a diverse public audience. Many intergenerational learning programs at the college level are situated in gerontology programs and often these programs neither promote nor are designed for bidirectional knowledge exchange (Roodin et al. 2013; Tam 2014). Such programs are more correctly deemed multigenerational rather than intergenerational (Tam 2014). In the case of this project, workshops were truly intergenerational, and bidirectional knowledge sharing was easily documented. Sharing of knowledge between students and older adult participants suggests that academic knowledge was in no way privileged over community knowledge (Trickett 1997), and this epistemic equality promoted knowledge flow and, most likely, community connectedness.

Community building as an objective of informal science education and intergenerational learning is based in the theoretical framework described as tapping in to "funds of knowledge" (Basu and Barton 2007). These "funds" are the cultural and historical knowledge residing in the community. Communication of this community knowledge may enhance science education by making science more relevant to the lives of students (Basu and Barton 2007). In this project, intergenerational workshops were described by students as strengthening community connectedness, and the appreciation that students expressed for the knowledge shared with them by senior adults appeared to enhance this community connection and support the overall positive evaluation of the experience.

The success of intergenerational experiences in the context of civic engagement is dependent in large measure upon choosing a critical issue whose approach serves both the public and academic communities. For this project, it was the connection to place, Glen Helen, that was a driving force for a successful program. Place-based experiential learning has been shown to enhance undergraduate student content knowledge in the plant sciences (Bauerle and Park 2012) and influence individual agency related to environmental issues (Rodriguez et al. 2008; reviewed in McIreneny et al. 2011) and public participation in science (Haywood 2014). Glen Helen is a valued resource in the community, and satisfaction with

the workshops was related to the perception that older adult participants were helping the Glen. Workshops also stimulated interest in being involved with Glen Helen restoration projects, and student reflections on the naturalist-led hikes indicated an interest in learning more about Glen Helen.

Students demonstrated an understanding of content related to invasive species, biodiversity, and native plants on an exam, but more impressively, students communicated content knowledge to adult participants in workshops. Communication of their knowledge to community members indicates that students have some confidence in their abilities and understanding of science. When graduate education students assumed the role of informal science educators, they honed communication skills and increased their confidence in using skills and knowledge gained in the classroom (Crone et al. 2011).

The success of the workshops and the project overall can to some degree be attributed to the consideration of recommendations from previous research on intergenerational service learning. In general, students benefit from authentic learning and participatory experience coupled with structured reflection (NRC 2009). This was incorporated into the project in the form of an educator-community partnership rooted in a civic issue relevant to the lives of participants. Intergenerational ISE programs are best when they incorporate opportunities for significant personal interaction (Fenichel and Schweingruber 2010), something that the senior adults prized about their workshop experiences. It is also important that there is a potential for one-on-one interactions and that programs proceed at a leisurely pace (Shih-Tsen and Kaplan 2006) and take into consideration the mobility or limitations of participants. This project offered student-led workshops that had all of these characteristics.

Shortcomings of the project are primarily related to the low participation by older adults and the lack of a control group. Attendance at the workshops was complicated by poor weather, and this is especially pertinent for older adults who may experience decreased mobility. Winter was chosen as the best time for propagation workshops based on the college schedule and conditions needed for germination and establishment of plant stock for the restoration project. Thus, there was a trade-off between appropriate conditions for participants and logistics imposed by the academic and research schedules. Why some senior adults chose not to complete a survey is not clear. Also, it is not possible to know whether student content knowledge was enhanced as a result of the intergenerational interactions, because there was no control group for comparison. Additionally, because some assignments were graded, it is possible that some student responses lack sincerity, but we have no way of knowing whether this is true. Despite low numbers, results indicate a very positive response by both students and adult participants that is sufficient to warrant scaling up the project.

Whether the benefits of the experience are long-lasting or coupled with increased environmental activism is unknown but an interesting question for further research. Civic engagement tends to increase among students who participate in service learning with older adults (Hegeman et al. 2010; Karasik et al. 2004), and these interactions with a larger community may influence personal ecological identities (Morris 2002). Thus, it is possible that programs that combine ISE, civic engagement, and intergenerational learning yield benefits far beyond those documented for this project.

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