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Interdisciplinary model for infusing food security into STEM curriculum

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Abstract
Integrating applied learning and research experiences into the curriculum at any academic level represents hands-on, student-centered learning at its best. It provides expanded opportunities for instructional innovations and faculty-student mentorships that can both translate to the classroom and extend beyond the classroom. Here we propose an interdisciplinary, comprehensive, and immersive approach to integrating service-learning and research into the science, technology, engineering and math (STEM) classroom by devising the infrastructure necessary for students to have the opportunity to actively participate in a local food security network. Presented here are two examples of experiential-learning activities integrated into STEM curricula that align learning objectives with food security stakeholder needs. We hypothesize that the sense of personal responsibility to serve and empower food security network stakeholders will be a very important motivating factor for students to master the accompanying STEM learning objectives that have been integrated into the framework of the service-learning project.

Keywords
community stakeholders, experiential learning, food security, health clinic, hoophouse, service-learning, STEM

Introduction
The multifaceted and complex issues associated with food security allow for a wide array of interconnected, globally and locally pertinent research and service-learning activities that immediately connect students to their communities. A food security network helps to establish safe, nutritious, and affordable food for all citizens that is culturally acceptable, can be obtained in a dignified manner, and is produced in ways that are environmentally sound and socially responsible. Here we present an interdisciplinary, comprehensive, and immersive model for integrating service-learning and research into the science, technology, engineering, and mathematics (STEM) classroom by developing a network of community and campus food security stakeholders (local food pantry, community garden, faculty, and community members utilizing the services offered) and identifying areas for research and service that align and overlap. When the term "STEM" was first coined in the early 2000s, the

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National Science Foundation (NSF) envisioned that high-quality STEM educational experience should be highly integrative and cross-disciplinary (Duggar, 2010). We hypothesize that aligning service-learning and research experiences with the needs of food security stakeholders in the local community results in transformational curricular experiences. We also hypothesize that these tangibly impactful experiences are an important motivating factor for students to master the accompanying STEM learning objectives that have been integrated into the framework of the associated curricular activity.

The broad, complex, and diverse components of "food security" as described by the Food and Agriculture Organization of the United Nations (FAO) (figure 1) provide an ideal framework for creating interdisciplinary service-learning and research opportunities that are tightly woven into the larger food security stakeholder network. In 2007–2008, requests for emergency food assistance increased by about 18 percent in the 25 cities surveyed by the U.S. Conference of Mayors, on Hunger and Homelessness; however, there was only a five percent average increase in the quantity of food distributed (U.S. Conference of Mayors, 2008). When asked to anticipate their biggest challenges for 2009, "nearly every city cited an expected increase in demand resulting from the weak economy coupled with high prices for food and fuel" (U.S. Conference of Mayors, 2009, p. 1). In Dunn County, Wisconsin, 14 percent of the population lives at or below the poverty level (U.S. Census, 2007), and over 10 percent of the population receives food stamps (University of Wisconsin–Extension [UWE] and the Wisconsin Department of Health and Family Services [WDHFS], 2005) While three food pantries operate within the county, there are no community gardens specifically targeting low-income families, nor are there community supported agriculture (CSA) programs with special access for low-income families (UWE and WDHFS, 2012)

Having access to nutritious food is vital to good health (Bernstein, de Konig, Flint, Rexrode, & Willett, 2012; Halton, Willett, Liu, Manson, Stampfer, & Hu, 2006; Malik, Popkin, Bray, Despres, & Hu, 2010; Marckmann & Gronbaek, 1999; Oh, Hu, Manson, Stampfer, & Willett, 2005; Srinath Reddy & Katan, 2004).

Maintenance of good health is also significantly impacted by the provision of health care. In 2009, 11 percent of the population was uninsured or was insured for only part of the year (Wisconsin Department of Health Services, 2010). This suggests that over one-tenth of the population persistently lacks insurance coverage and access to preventative and potentially life-saving care. The poor are at the highest risk, as they generally lack preventative health care and consume the least nutritious food (Andrulis, 1998; Baker, Schootman, Barnidge, & Kelly, 2006; Flores, Abreu, Olivar, & Kastner, 1998). Perhaps the worst culprit in the diet of the poor is fast food (Baker et al., 2006). Fast food is highly processed and often deep-fried in partially hydrogenated oil — a precursor to high cholesterol levels and subsequent heart attacks (Hu & Willett, 2002). Combined with starchy vegetables and sugary drinks, these foods have a high glycemic load, a factor that contributes to obesity, which has been linked to the onset of diabetes, although the mechanism is still under investigation (Shimabukuro, Zhou, Levi, & Rounger, 1998). The rapid growth of the fast food industry has dramatically changed the population's health and well-being (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004).

Abundant research has shown that students are typically more engaged and become more aware of problems faced by members of their own community after taking part in a classroom activity based on service-learning (Bringle & Hatcher, 1996; Giles, 1994; Lui, Philpotts, & Gray, 2004; Markus, Howard, & King, 1993; Mentkowski & Rogers, 1993; Shumer, Treacy, Hengel, & O'Donnell, 1999). Through service-learning, students use what they learn in the classroom to solve real-life problems. They not only learn the practical applications of their studies; they also become actively contributing citizens and community members through the service they perform. Development of academic skills, life skills, civic responsibility, and citizenship occur when service is introduced to undergraduate students (Astin & Sax, 1998; Eyler & Giles, 1999). One particularly advantageous feature of service-learning is that it is not suited to just one type of

student; the gifted, the talented, the average, and the exceptional can all contribute to and benefit from the experience. It is an all-encompassing activity that allows all to serve, usually in a team environment. Service learning projects that benefit both students and community are built from authentic partnerships defined by the Community Partner Summit Group (2010) as (1) embracing quality processes, (2) achieving meaningful outcomes, and (3) being transformative at multiple levels. An important aspect of the learning in service-learning is reflection (Bringle & Hatcher, 1999; Eyler, 2002; Payne, 2000). Reflection is an internal process that allows students to think about how the external experience (service) has affected them on both personal and cognitive (learning) levels (Daudelin, 1996). The reflection activity, therefore, becomes the lynchpin for connecting service-learning with course content (Eyler, 2002; Hatcher & Bringle, 1997). There are a variety of reflection activities that one may assign to students (Eyler, Giles, & Schmiede, 1996). We have used survey questions that allow for open-ended answers so that students may freely express themselves.

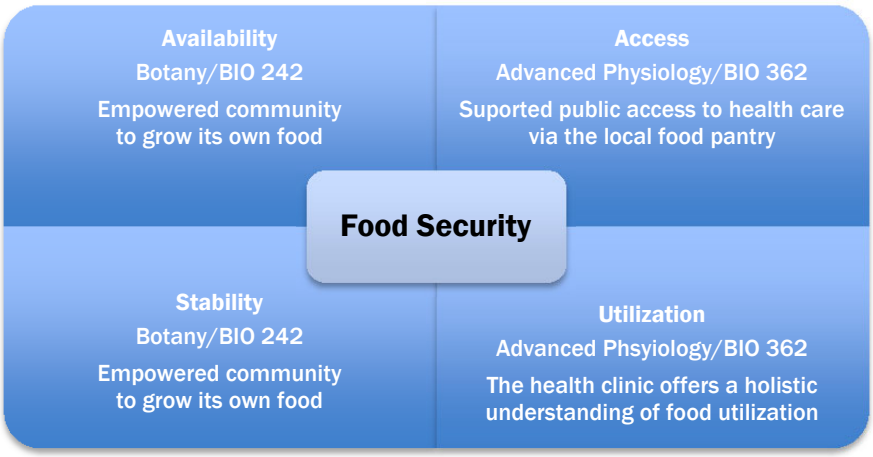
The integration of applied learning and research experiences into the curriculum at any academic level represents hands-on, student-centered learning at its best. It provides expanded opportunities for instructional innovations and faculty-student mentorships that can both translate to and extend beyond the classroom. These applied types of learning opportunities engage and retain groups at risk of dropping out of STEM programs (Lee, 2002). The NSF identifies these applied types of practices among the core principles of a high-quality and effective educational experience in biological sciences in its 2011 Vision and Change document (see figure 1).

This study presents two examples of curricular experiences that embed food security principles and practices into the classroom and connect students to the community in impactful ways.

Method

Activities related to food security were integrated into two courses at University of Wisconsin–Stout, a polytechnic university that blends theory with practice to produce innovative solutions to real-world problems. The courses were BIO 242 (Botany), a course for Applied Science majors, composed of a lecture and lab with 24 to 48 students per semester, and BIO 362 (Advanced Physiology), a course for Applied Science pre-professional majors and Food and Nutrition majors. This course is also composed of a lecture and lab with 18 to 36 students per semester. Both courses integrated a six-week-long service-learning project into their curricula. Botany students were directed in the establishment of four-season growing (FSG) facilities at the newly established community garden. Advanced Physiology students were directed in the establishment and running of a preventative health clinic (PHC) at a local food pantry. To ensure that curricular experiences were the most likely to result in effective and transformational pedagogy and significant outcomes for the community, four key principles were applied to the design and implementation of the work:

Figure 1. Components of Food Security According to the Food and Agriculture Organization of the United Nations (FAO) and How Curricular Experiences Supported Local Food Security



1. Service-learning projects were carefully aligned with course learning objectives and goals.
2. Service-learning projects were interdisciplinary in nature.
3. Service-learning projects made a tangible and overt connection to a food security stakeholder.
4. Service-learning project outcomes were aligned with the needs of community food security stakeholder.

Both curricular experiences used the NSF's core competencies of a biological education as a guide for framing the service-learning project, as shown in table 1.

Project Alignment with Course Learning Goals and Objectives

Both projects were designed to integrate and apply course content into their respective service learning activities. The FSG project was devised as a way to tie in many of the fundamental learning objectives of a traditional botany major's course, including fundamentals of plant cell structure and function, basic plant anatomy and physiology, and plant breeding and genetics. Through the semester-long activity, students were introduced to concepts of sustainable agriculture and horticultural techniques. This activity enabled the students to learn about the challenges involved in growing plants for food.

In the PHC experience, one major learning goal for students was to learn about the integrated nature of the organ systems and how organs systems rely on each other to maintain health. Specifically, the students learned about the importance of maintaining parameters such as blood pressure, glucose levels, and body weight in the healthy range. Those parameters are usually adversely affected by food insecurity due to poor or inadequate nutrition. Students also solved problems using real-life clinical case studies. Armed with this knowledge together with limited clinical experience via case studies, the students then ran a health clinic where they routinely measured

Table 1. NSF Core Competencies and Disciplinary Practices

Core Competency	Ability to apply the process of science	Ability to use quantitative reasoning	Ability to tap into the interdisciplinary nature of science	Ability to communicate and collaborate with other disciplines	Ability to understand the relationship between science and society
Examples of core competencies applied to Four Season Growing (FSG) and Preventative Health Clinic (PHC)	Both projects required students to synthesize scientific information to solve complex problems. *FSG students:* Researched crop plants and season-extension strategies to implement their own plan. *PHC students:* Analyzed medical protocols and health guidelines to provide patient participants with appropriate feedback.	Both projects required students to apply quantitative analyses to understand biological data. *FSG students:* Calculated crop production and yield. *PHC students:* Measured blood pressure and calculated mean arterial pressure to assess cardiovascular health. Measured height and weight to calculate BMI as an indicator for obesity.	Both projects allowed students to think about factors that play a role in the initial need for the projects. *FSG students:* Developed an appreciation for the physiological consequences of food shortage and lack of access to fresh fruits and vegetables. *PHC students:* Observed the link between nutrition and health in the community.	Both projects frame their work within sociology, economics, governmental policy-making, health care policy-making, ethnic studies, and epidemiology to give context to the background and need for the projects.	Both projects provided the students with a deeper understanding and appreciation for how science is tightly integrated into all aspects of society. They saw the positive aspects of this relationship (using botanical principles to grow food out of season, using knowledge of the human body to determine health status), in addition to the negative consequences (poor health outcomes due to food insecurity).

patients' blood pressure, urinary glucose levels, and body weight. They provided customized health and nutritional advice based on each patient's clinical results. Another major goal of the course was to provide free preventative health screenings for the prevention of chronic illness through the PHC.

Interdisciplinary Nature of the Work

Together, both class projects addressed the four key components of food security that immediately provided an interdisciplinary foundation for the activities. While the FSG project directly addressed food availability and stability, the PHC focused on access and utilization (refer to figure 1). Importantly, the consequences of food insecurity and further preventing the deleterious effects of food insecurity were themes of both courses that connected students to the significance of their work in the larger community. The two projects represented a synergistic approach to addressing a common issue.

In addition to the broader interdisciplinary concepts that applied to both courses, through the FSG project students were introduced to the highly interdisciplinary nature of plant science. Students investigated chemical properties of the soil, considered nutrient deficiencies in plants, and discussed the health benefits of fresh, locally grown, and organically produced food.

While working at the PHC, students researched the factors that necessitated the need for such clinics and therefore explored the relationship between socioeconomic status and health insurance coverage, or the lack thereof. Students also researched the relationship between pathophysiology, food, and nutrition, as well as the effect of exercise from a physiological standpoint with the onset of diseases such as hypertension, diabetes, and obesity.

Aligning Course Objectives with Stakeholder Needs

Both projects were developed with the long-term goal of establishing authentic and impactful partnerships with the community. It was important to carefully align goals of projects with the needs of stakeholders to ensure that all parties benefited from the experience. Both projects also built on previous successful community-based efforts, such as a local community garden that had been established in the community in the previous year. University students were critical to the successful establishment of the garden and maintain a strong presence on the board of the local community garden. In previous years, students had interned and volunteered at the Stepping Stones Food Pantry and participated in food drives and fundraisers for the facility.

For the FSG project, a direct community connection to the project was established by enlisting the support of the community garden board. The board director met the students on-site to assist them in the selection of hoophouse sites and inform them of other responsibilities associated with their community garden work. In addition to maintaining their hoophouses, students were required to participate in a pre- and postseason garden cleanup. The community garden board was the primary point of contact for requesting space in the newly existing garden facility. At the end of each semester, students prepared reports of their FSG results to the garden director so that outcomes could be shared with the larger community.

The Menomonie Community Garden has the mission of providing gardening space, horticultural training, and community-building activities to the larger Dunn County community. The FSG project was designed around the mission of the community garden and emphasized opportunities to empower community members to establish their own hoophouses and other simple yet innovative strategies for growing healthy food.

A hoophouse is a structure that is used as a season extender; crops may be grown out of their normal crop-growing season, thus effectively extending the growing season. This is a very important method for increasing the availability and stability of food, two of the key components of food security (see figure 1). Hoophouses are named due to their characteristic semicircular hoop shape with a frame typically constructed of lengths of PVC pipe (Upson, 2005). Other advantages of using a hoophouse include weather protection, selective pest protection, and cost. Hoophouses are easily constructed and last many years (Blomgren & Frisch, 2007).

The PHC was developed specifically to provide preventative health screenings for hypertension, obesity, and diabetes — three conditions associated with food insecurity that are studied in depth within the Advanced Physiology course. Populations living under the threat of food insecurity typically have inadequate or nonexistent health insurance and cannot pay for preventative health screening, which has been shown to result in better long-term health outcomes (Maciosek, Coffield, Flottemesch, Edwards, & Solberg, 2010).

The Stepping Stones food pantry is a custom-built facility that serves Dunn County by providing healthy and nutrient-dense foods to anyone in need. In the design of the building, it was always envisioned that a health clinic would be part of the establishment so that people using the food pantry service would also have easy and convenient access to basic preventative health-screening services. The timing for the student-run health clinic could not have been better. The proposed health clinic was perfectly aligned with the mission of the food pantry in that the health clinic would cater to people who are uninsured or underinsured with regard to health insurance and it would provide essential preventative health screening to the most vulnerable in the community.

Project Implementation

FSG. In this activity, teams of three or four botany students were assigned to a community garden plot with the materials to build a small (6 ft. x 6 ft. or 1.8 m x 1.8 m) hoophouse and given a goal of developing and implementing strategies to grow a winter crop. Students were responsible for selecting a crop (fiber, flower, or edible), growing their crop, and having a logical use based on community need for their crop. Students were given the choice to grow any number of different plants in any method they chose, but were required to clearly indicate how and why they chose a particular crop. Students were given the choice of starting with seeds, pregerminated seeds, or stem cuttings, the only stipulation being that the crops had to be planted in the hoophouse for a minimum of six weeks. Students were also required to assemble and maintain their own hoophouses and associated growing structures, maintain a log of activities, determine the role of each group member, make appropriate community contacts, inform the contact that the crop may not yield, and identify ways of handling and distributing the crop post-harvest for actual use by the community stakeholder. Two important aspects of this work connected the students to the community: (1) Students were required to research and select food crops to grow in their hoophouse structures that could be used for some purpose in the community, such as donation to local food pantry or for a cooking demonstration at the food pantry. A number of students cited the Stepping Stones food pantry as the final destination for their crops. This aspect of the project required students to research areas of need in the community and participate in outreach activities that aligned their potential food crop with an end user who had a food need. (2) Students were required to complete an end-of-semester report on the successes and failures of their four-season growing activities. The purpose of this report was to inform future users about successful strategies. The final report requirement integrated a student reflection component into their service-learning activity. This component gave the students an opportunity to reflect on their perceived learning outcomes, impact on the community, and ways they could improve project outcomes for future classes and the community.

PHC. Students were divided into groups of four and assigned time slots for working at the clinic according to their schedules. Before work at the clinic commenced, the students were trained to measure blood pressure and calculate mean arterial pressure from the measurements. Students were also trained on urinalysis and auscultation and interpretation of lungs sounds. They learned about self-breast examinations and how to teach patients to self-examine. They also learned how to weigh patients and measure their height accurately and calculate their BMI from the measurements. In addition to the technical training, students were trained to interact with patients in a respectful, friendly, and diplomatic manner. The PHC operated in a room of the food pantry. Students operated the clinic five days per week for a two-hour period. Every day before it opened, the students organized the clinic by setting up a heart

and lung station to measure blood pressure and pulse rate and to listen to lungs. A BMI station was set up for height and weight measurements, and a urinalysis station was set up for measuring urine glucose and ketones. Once the various stations were organized, they then invited patients to the screening. The screening room was adjacent to the waiting area for the food pantry. Students would enter the waiting area and distribute a list of services provided by the screening clinic. Patients would check one or more services of which they wished to avail themselves. When patients were called, they were escorted into the clinic and screened. During the screening students were required to interpret blood pressure measurements and determine whether the patient was normotensive (normal blood pressure), prehypertensive (normal but elevated blood pressure), or had stage 1 hypertension (moderately elevated blood pressure), or stage 2 hypertension (significantly elevated blood pressure) (Chobanian et al., 2003). Based on the patients' clinical results, students were required to make lifestyle recommendations for patients who were not normotensive. After the urinalysis, students interpreted the glucose and ketone readings and determined whether the patient was normal, prediabetic, or diabetic.

Coding for Qualitative Data

Having completed the six weeks of service learning, students were given the opportunity to reflect upon their experience. This activity enabled FSG students to reflect upon whether they could communicate successes and failure in growing crops; suggest strategies for improving crop growing; whether their harvest had been successful; and whether they could create detailed reports of the crop-growing activities for the community garden board. For the PHC students, the reflection activity was an opportunity for determining whether they understood the connection between course content and the services they performed at the clinic; how they felt about themselves having worked in the clinic; whether they understood the underlying need for the clinic; and how they felt about the impact of the clinic on the community. Students' open-ended responses were assessed as either positive or negative with respect to the questions in the reflection activity and then tabulated as a percentage of total responses for each question (see table 2). In addition to the specific reflection questions, students were asked for general comments or recommendations for their respective projects. These responses were grouped into major themes for each project.

Results

Botany — FSG Outcomes

Eighty students in 18 groups over three semesters (fall 2010, spring 2011, and fall 2011) participated in the FSG project. All participants were able to communicate their successes and failures in growing crops and provide suggested strategies for successful season extension. Approximately 25 percent of groups were able to successfully harvest edible or otherwise useable plants from their season-extension efforts (see table 2a). All students created reports to present to the community garden board detailing their four-season growing project and describing how they would improve their efforts.

Students' self-reported learning outcomes showed three major themes:

1. Students reported that it was more difficult to grow and care for crop plants than they had initially anticipated. They also reported a better understanding of the influence of soil, temperature, and light on plant growth.
2. Students reported that selecting the appropriate crop plant is a critical factor in

Table 2a. Results of Botany Student Reflections (n = 80)

Student Reflection	Percent Positive Comments
Able to communicate successes and failures in growing crops	100%
Able to suggest strategies for improving crop growing	100%
Successful harvest	25%
Able to create detailed report for community garden board	100%

attempts to extend the growing season. While researching plants in the beginning of the project, students underestimated the importance of making careful crop selections and by the end of the project students were much more aware of the need to select crops appropriate to the growing conditions.

3. Students reported difficulty in making connections to local food security stakeholders. Nearly all groups reported contacting the local food bank as a place to donate their food. It wasn't until after their project ended that students reported learning that to adequately serve their community stakeholder, their crop required specific post-harvest handling and a distribution plan. Specific post-harvest handling requirements as outlined by safety and regulatory bodies include food safety standards in schools, hospitals, and daycare sites, to name a few (Wisconsin Department of Agriculture, Trade and Consumer Protection, 2011). In addition, daycare sites and schools also have guidelines that require specific nutritive standards for meals (Nutrition Standards in the National School Lunch and School Breakfast Programs, Final Rule, 2012). Adhering to these safety requirements would require strict coordination of the end users' needs with the students' post-harvest handling.

Advanced Physiology — PHC Outcomes

Results obtained from the reflection activity following the health clinic demonstrated that students understood how course concepts directly related to the service learning activity; that they felt they were better citizens for having participated in the service learning activity; that they felt positively about the impact of the service-learning activity on the community; and that the overwhelming majority of them understood the underlying factors that necessitated the need for the health clinic within the community (see table 2b).

A breakdown of student recommendations following the service-learning activity showed four major themes:

1. The health clinic should continue and also expand to multiple locations within the community.
2. Better marketing should be done to attract more patients to the health clinic.
3. All students on campus should participate in similar service-learning activities.
4. The range of health services offered in the clinic should be expanded.

Discussion

The FSG and PHC projects represent two projects from seemingly unrelated disciplines that directly address the four components of food security: availability, stability, access, and utilization. Importantly, these two projects lay the foundation for a series of food security–related curricula that will be embedded across the Applied Science program in the future. Embedding food security themes into multiple curricula will provide a connective scaffolding and knowledge base of food security presented from different perspectives throughout each student's academic career. These projects also helped us identify and make plans to address significant gaps in understanding between campus stakeholders and community stakeholders.

The FSG project was initiated in fall 2010 and for three semesters has resulted in engaging botany students in an applied, community-focused research activity. During their self-reflection activity, most students reported that this was their first experience attempting to grow food. The

Table 2b. Results of Advanced Physiology Student Reflections (n = 30)

Student Reflection	Percent Positive Comments
Understood connection between course content and real-world applications	100%
Believed to be better citizens for participating in health clinic	97%
Appreciation for the fundamental needs of the health clinic	93%
Positive feelings about impact of health clinic on community	87%

experience offered students a real-life opportunity to understand the challenges involved both in growing food and with season extension in a cold climate. Beyond simply researching the theory of growing food and season extension, students applied their knowledge to design and build FSG structures, make crop plant selections, and devise plans to keep their plants alive in extreme environmental conditions. All students reported having a much greater appreciation for the skills and knowledge required to grow food, and all groups documented how they would modify their strategies for successfully growing food in a season-extension system in the future. This is a significant outcome for this work, mainly because the students participating in the FSG project now possess the skills and strategies for growing their own crops or passing on that knowledge to others within the community.

Our research suggests that providing members of the community with the autonomy to grow their own food may be a small but important step toward achieving a more sustainable food system. In addition to the goal of providing students with an applied, research-focused educational experience, a second goal of the work was increasing students' awareness of the role that plant scientists play in supporting a secure food system by increasing food availability and food stability in the local community. As an important aspect of the FSG activity, students were required to select crop plants with the needs of the local food security stakeholders in mind. The instructor provided direction on crop selection through one-on-one meetings with groups early in the semester, providing students with a text on the subject of season extension, and several laboratory and lecture sessions dedicated to the topic. However, students did not report leaving the experience with an understanding of how their crop selection could be connected to a community need.

The project aligned students with the community through stakeholders responsible for the community garden, and students were actively involved in the community by maintaining the community garden facilities and their own hoop-houses. However, the students' lack of understanding how their crop selection was tied to community need identifies an important gap in the project. In this project iteration the instructor failed to align the project also with other possible community stakeholders who would have been valuable resources for students when tasked with identifying "community need."

The pilot PHC was successful in terms of its goals and objectives, that is, student appreciation of the integrated nature of the organ systems for maintenance of health; understanding the significance of abnormal readings for health parameters, such as blood pressure, BMI, and glucose levels; and fully realizing their potential deleterious health consequences. Students reported perceiving their learning outcomes to be of greater depth due to their work experience at the PHC. The fact that every student participating in the clinic fully understood how the clinical work directly applied the knowledge they had acquired in the classroom (based on the reflection activity) demonstrates that service-learning is an effective tool for student engagement.

The second principle goal of the health clinic was to provide free preventative health screenings for the prevention of chronic illness. Access to health care is necessary not only for the prevention and/or management of diseases (such as hypertension, obesity, and diabetes), but also because poor health and certain diseases negatively affect food utilization (Stratton, Green, & Elia, 2003). Students were encouraged to focus on this important aspect of food security. Many of the students were Food and Nutrition majors and therefore possessed a vast wealth of knowledge regarding maximum utilization of food as well as diseases that affect nutrition. Informal chats with the patients revealed conditions (for example, acid reflux disease, Crohn's disease anddiarrhea) that did not necessarily show up through the tests offered at the clinic and allowed the students to counsel patients towards proper food utilization.

It is interesting to note that while 100 percent of the advanced physiology students understood the needs for the health clinic and how it related to the food security stakeholder, many of the botany students did not fully appreciate the need for the project in the larger context of food security, evidenced by their inability to make crop selections

based on community need. This suggests that to fully realize project goals, the FSG activity requires a more thoughtful alignment with food security stakeholders in the community. However, while additional stakeholders may benefit students, meeting the needs of all community stakeholders can become a delicate balancing act for the instructor. The FSG activity was intentionally designed to minimize the number of community stakeholders involved in order to reduce the likelihood of failing to meet expectations of stakeholders, which can lead to increased and long-term friction between the campus and the community.

Conclusion

Meeting both course learning objectives and community needs is not always easily achieved through a service-learning activity. When designing and implementing service-learning projects, instructors must carefully consider limitations they will have in establishing authentic partnerships in the community. These limitations may include scheduling issues, the necessity to meet course-learning objectives at the appropriate academic level, and limitations on the time, resources, and abilities of students, faculty and stakeholders. Projects do not always lend themselves well to establishing authentic partnerships that are based on shared decision-making, have meaningful outcomes, and are impactful on multiple levels in the community.

The PHC activity provides a good example of a project that aligns students with community stakeholders, meets stakeholder need, and does not overburden the course instructor. The FSG activity provides an example of an activity that may have overambitious goals, and likely requires multiple iterations in order to establish partnerships between campus and community that are transformative at many levels. Great care was taken in both projects to not promise stakeholders more than the course could provide. Stoeker, Beckman, and Hee Min (2010) suggest that the true impact of service-learning on the community is likely overstated and underassessed, and in most instances the primary beneficiary of service-learning projects are students and not the community. We believe that promising more than we can provide to our stakeholders is destructive to long-term community-campus partnerships and must be carefully balanced with providing students quality instruction. Specifically, our lessons learned include:

1. Projects should be carefully planned with the learning objectives as the primary goal and the needs of the community food-security stakeholder as a close second. Without careful planning and alignment with the needs of the food security stakeholder, the students' efforts in the community could in fact be detrimental to the mission of the food security stakeholder and could result in a very negative experience for both the student and the community partner. Scaling back and staging larger projects into longer time frames to allow for better communication and project management may lead to more effective educational outcomes and more impactful interactions with the community.
2. Successful projects should allow students to have direct contact with the food security stakeholder. A critical aspect of students recognizing their role as scientists or professionals in society appears to be interaction with the community members most affected by their service-learning or research activities. Opportunities for students and community members to work together would be mutually beneficial to both the student and the community and may help students understand their role as it relates to food security.
3. All projects should incorporate multiple opportunities for skills assessment and student self-reflection. Skills assessment allows the students to understand the sometimes intangible outcomes of their service-learning or experiential learning experience and feel more confident in their abilities at the end of the classroom experience. Self-reflection is critically important to students understanding their role and impact as future scientists, farmers, or medical professionals working

within a local food system (Eyler, 2002; Hatcher & Bringle, 1997).

4. Both projects successfully resulted in offering students an applied learning experience that intentionally connected them to the community through food security stakeholders. This was achieved by carefully aligning the projects to desired learning outcomes and developing collaborations with food security stakeholders but also using great care and thought when determining how and when to involve stakeholders. Anecdotally, students reported that their learning experience and outcome were more valuable than the traditional classroom model. The project would be improved by better aligning student training with the needs of the food security stakeholders. Future project goals include the establishment of a campus-based "food security coordinator" who would act as a liaison between faculty, students, and food security stakeholders in the community to better refine student projects and skills training to meet the needs of the community.

Recommendations for further research include assessment of the specific impact of these two service-learning projects on the community from the perspective of the community stakeholder. Very little research has been done to investigate the long-term impact of service-learning on the community (Bailis & Ganger, 2009). We also recommend further assessment of the affective domain (Bloom's taxonomy) on student learning (Bloom, 1956) through the two service-learning projects presented in this paper.

In conclusion, framing service-learning projects around a central theme such as food security serves to benefit both student and community. These interdisciplinary types of projects allow students to think about a central problem from multiple perspectives, thus providing the student an appreciation for the complex nature of solving problems within a community.

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