PROJECT REPORT

Why We Should Not 'Go It Alone': Strategies for Realizing Interdisciplinarity in SENCER Curricula

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Abstract

With support from a SENCER Post-Institute Implementation sub-award grant, seven faculty members from six different disciplines began a collaborative partnership to design joint curricular projects across courses and departments on the theme of Food for Thought. To meet our goals, we developed shared learning outcomes for students in courses in the Food for Thought cluster, using SENCER goals as a guide for our work. In order to address those outcomes, we crafted a variety of projects engaging students from two or more courses. We implemented these projects in our courses and assessed student perceptions of learning and student performance in integrative learning. In this article we detail the challenges and benefits of ongoing interdisciplinary collaboration, as well as how this group of faculty members balanced other demands of academia. We conclude with a discussion of our assessment methodology and findings of improved learning.

Introduction

In most of our academic lives as faculty, many of us are used to, and perhaps even prefer, working alone. We can easily empathize with our students who complain about the hazards and time drain that they experience doing group work in classes. Some of us might go so far as to say we'd rather go it alone than ever have to adjust to planning our teaching with others. After all, when we do it alone, course planning can take place in the wee hours, does not

require multiple meetings, and affords us the greatest flexibility and control over what happens in the classroom.

In spite of this tendency to be quite content to "go it alone," our group of seven faculty members has spent the last eight years in a collaborative partnership designing joint curricular projects across courses, departments, and university divisions on the theme of Food for Thought. We work in diverse disciplines— Biology, Chemistry, Economics, Sociology, Spanish, and Health and Wellness— and together we have created numerous projects involving as few as two and as many as five courses that engage students with the science, politics, and human elements of food production, distribution, and consumption. We have not only implemented these multidisciplinary projects in our courses, we have also assessed student perceptions of learning and student performance in integrative learning achieved from this focused, yet multidisciplinary teaching. And while our efforts have taken time and energy, we have evidence, both from our multiple modes of assessment of the effects on students and from the rewards we have experienced teaching in these contexts, that mindfully planned collaboration has important benefits for our work with students.

Our motivation for doing this work occurs in a larger context in which, for more than a decade, universities and colleges across the United States have been newly articulating the value and purpose of undergraduate education. One outcome of this self-interrogation has been a renewed focus on integrative learning and new efforts to work towards assuring that undergraduates leave college with a sense of the complexities of social, scientific, technical, and environmental problems, and with an understanding that problem-solving requires multiple perspectives. In 2004, for example, Carol Geary Schneider, president of the Association of American Colleges and Universities (AAC&U), called for integrative approaches to become more central to the enterprise of education, in order combat the "fragmentation of knowledge" (Schneider 2004). AAC&U has taken on several initiatives related to these concerns, including issues of implementation and assessment (Huber et al. 2007; Ferren et al. 2014/2015). Our work was inspired by our participation in a Summer Institute sponsored by The Science Education for New Civic Engagements and Responsibilities (SENCER), an NSF-funded organization whose focus echoes these concerns about integrative education. Its SENCER Ideals include "robustly connect[ing] science and civic engagement by teaching 'through' complex, contested, capacious, current, and unresolved public issues 'to' basic science" (SENCER 2015).

In this essay, we share our experiences with collaboration in planning, implementing, and assessing cross-course projects that, when experienced by students especially over several semesters, lead to enhanced integrative, interdisciplinary learning. In this context, we define our teaching efforts as multidisciplinary, because projects are approached from each faculty member's traditional disciplinary area of expertise. We argue that a viable approach to the goal of promoting citizen science (science broadly accessible to informed citizens) is to draw on the strengths of multiple experts from more than one discipline, rather than retraining ourselves in realms of expertise that are not our own. Yet we also describe and demonstrate that student learning from this approach is integrative and interdisciplinary, as students are better able to synthesize content and make connections between multiple disciplines. If the goal of a "SENCER-ized" curriculum is to help students learn science and its relevance to and limitations in a range of public issues and in solving complex problems of interest to students, we argue that we enhance these goals by bringing in multiple disciplinary perspectives with real representatives of those lenses. If we forgo "going it alone," we bring more context and connection to civic issues and provide a model of civic engagement for our students.

Cross-Class Collaboration to Promote Interdisciplinary Learning

In 2006, with the help of a SENCER Post-Institute Implementation sub-award grant used to provide faculty summer stipends for planning, we embarked on a path of collaboration, creating a cluster of courses focused on developing the student as an informed consumer of food by providing a platform for discussion of what we eat, why we eat, where our food comes from and its journey from production to consumption, and how food affects our bodies and health. As faculty from across the university

in natural sciences, social sciences, and humanities, we sought to create a set of offerings that would meet a multidisciplinary general education requirement[1] by inviting our students to recognize and appreciate the different ways that our disciplines were concerned with issues of food. We hoped to encourage students to recognize ways in which human bodies and societies are interlinked by numerous processes, many of which can be understood by investigating the dynamics of food in chemical, biological, cultural, and social systems. Our primary goal for students was to create an enhanced, interdisciplinary understanding of the interplay of these systems and a more attuned sense of how food is a civic issue.

To meet our goals, we developed a set of shared learning outcomes (Table 1) for students in courses in the Food for Thought cluster. We based these on SENCER Ideals of civic engagement, focusing on contested issues and encouraging student engagement through multidisciplinary perspectives, as a guide for our work of demonstrating to our students the value and interconnectedness of natural sciences, social sciences, and humanities disciplines. In order to address those outcomes, over the years we have crafted a variety of projects that students from two or more courses engage in as part of the requirements of those courses. Many of these projects included community organizations. Some of the projects and activities required funding external to our departmental budgets, especially those that involved the preparation and sharing of food and those that required travel. In many semesters, we also offered our students out-of-class experiential learning opportunities such as guest speakers, movie screenings, or farm tours.

Each semester's projects and the level of collaboration and coordination varied according to which courses were offered that particular semester. During the first years of the cluster, we created large-scale projects such as the Harvest Bounty Shared Meal and the Food and Nutrition Guidelines, which included every cluster course taught that semester. These projects required students to work in small teams (four to eight students) with students in several other classes. Highly coordinated, large-scale projects required intensive time preparation and collaboration between four to seven different faculty members (often including faculty who were not teaching a cluster course but who helped with project coordination) and our students.

Given the desire to continue meaningful projects, while recognizing the other demands of academia, in later years we created small-scale, yet still intensive, cross-course projects by partnering two or three classes and faculty members, who facilitated coordination when necessary. All projects, regardless of the scale or number of classes or students, involved a presentational component (i.e., students sharing and/or creating information to be shared with either community members or students in another class). To further simplify, we sometimes asked students to work in teams with their own classmates rather than in teams with students from other classes, thereby reducing the need for facilitated, extensive, out-of-class meetings. Most recently, we have been able to organize these coordinated small-scale projects into a showcase-style larger event held once an academic year, such as the Food Day event or the Festival of Dionysus in the Mountain South event. These projects, and other projects implemented over the past eight years, are summarized by semester in Table 2. Supplementary campus and community activities intended to enhance student experience with food, food systems, and culture are also included in Table 2.

To illustrate the difference between the multi-course large-scale projects and some more manageable small-scale projects, we offer four examples. The Food and Nutrition Guidelines Policy Project was offered three times between 2007 and 2009. In the 2008 version of this large-scale project, students studying Food Politics were organized into two committees charged with overseeing the development of guidelines for UNC Asheville; one committee focused on food guidelines and the other focused on nutrition guidelines. These students became experts in a specific food or nutrition topic and then drafted and discussed with each other a recommendation in their area of expertise. The committees then received oral or written suggestions from students in the other Food for Thought cluster classes, discussed all the guidelines as a committee,

1 During this time, UNC Asheville's Integrative Liberal Studies general education curriculum required a 9-credit hour multidisciplinary experience, called a "topical cluster," where students must complete at least one natural science course and at least one social science course from a menu of courses with content and focus loosely connected to a common theme.

TABLE 1. Student Learning Outcomes (Cited from Wingert et al. 2011)

LEARNING OUTCOME	SAMPLE ELEMENTS INCLUDED IN THE OUTCOME
Academic Attitudes	Develop interest in natural and social science fields; develop appreciation for interdisciplinary learning; develop commitment to a major
Civic Engagement	Develop appreciation of how food consumption and production is a civic issue; identify connection between science and ethics
Informed Consumer	Acquire and use knowledge to make informed food choices; acquire knowledge about the links between food production and consumption and its relationship to consumers
Interdisciplinary and Disciplinary Skills (Food and Research Literacy)	Develop research skills; develop interdisciplinary understanding of social and biological systems; understand the scientific method
Information and Communication Skills	Ability to communicate expert knowledge to a lay audience (in a range of fields); work to solve problems and present information in teams
Food Systems (Relationship between) and Social Processes	Understand the science and technology of food production and the development of food policy related to production and distribution
Food Systems (Relationship between) and Environmental Systems	Understand the impacts of food production on the environment; understand the ecological relationship between plants and humans
Food Systems (Relationship between) and Individual Health and Wellbeing	Understand where food comes from and how it impacts humans; plan and prepare a nutritionally balanced meal; understand the biology of human nutrition

and then each produced a set of proposed guidelines for our campus. Students studying Nutrition, individually or in teams of two, prepared written comments on a specific topic related to food (local, organically grown, genetic modification, waste reduction, etc.) or nutrition (achieving healthy weight, fat, sugar, salt, fiber, whole foods, etc.). Working in small groups (three to four students), students studying Food of Chemistry measured the amount of sodium in several different foods offered in the dining hall, and students studying Land Economics developed evidence-based arguments for local or organic food, specific procurement strategies, and changes to the UNC Asheville food environment. All classes presented their analyses, guidelines and recommendations to the Food Politics student committees, typically as both written and oral recommendations, for inclusion in the food guidelines. The Food Politics students then formatted the data, recommendations, and rationale from the other courses into an eighty-page document and presented their findings to campus decision-makers in December 2008. Approximately 120 people were involved (including 100 students and 20 members of the campus community including faculty, administration, and Dining Services staff), and classes met jointly at least three times over the term. Campus dining services responded by making a series of changes to their food purchasing and labeling that have largely been in place since that time. Based on their post-project reflections, Food Politics students reported that they had a sense of empowerment from participating in this ambitious effort with tangible policy change implications.

Another example of a large-scale cross-course project was the Plants, Nutrition, and Latino Food and Culture Project in Spring 2011, which involved courses from three different disciplines: Biology, Health and Wellness, and Foreign Languages. Student groups from each of the three courses were assigned a Plant of the Americas, designated by the Plants and Humans instructor as native to the Americas, and worked together to create a joint poster presentation for the UNC Asheville Undergraduate Research Symposium. Students researched each plant through the lens of their particular discipline, participated in a workshop on abstract writing, and attended a panel discussion by local food experts who use these plants in their restaurants. They then created the final posters that included botanical information (Plants and Humans students), nutritional information about the plant (Nutrition students), and a traditional recipe along with relevant cultural information (Spanish students). Additionally, students studying Nutrition completed a nutritional analysis

TABLE 2. Food for Thought Cross Class Projects and Activities

Term	Cross-Course Cluster Projects	Other Cluster Activities
Fall 2008	**Harvest Bounty Shared Meal** (Food of Chemistry, Land Economics, Nutrition, Food Politics)	Farm Tours (Cluster)
	Food and Nutrition Guidelines (Nutrition, Food Politics, Food of Chemistry, Society and Technology, Land Economics)	Seminar Series (Campus)
Spring 2009	**Poster Presentations at Undergraduate Research Symposium and North Asheville Tailgate Market** (Pathophysiology, Sociology of Gender, Nutrition, Plants and Humans)	Seminar Series (Campus)
Fall 2009	**Social Marketing Campaign Development** (Sociology of Gender, Pathophysiology) **Harvest Bounty Shared Meal** (Nutrition, Food of Chemistry, Land Economics, Spanish for Health Professionals, Freshman Seminar Course) **Food and Nutrition Guidelines** (Land Economics, Food Chemistry, Food Politics)	Seminar Series (Campus) Farm Tours (Cluster) Community Garden Tours (Cluster)
Spring 2010	None	Seminar Series (Campus) Community Garden Tours (Cluster)
Fall 2010	**Understanding Food Commodities Policy Project** (Food of Chemistry, Economics of Food, Food Politics)	Film Festival (Campus) Urban Farm Tours (Cluster) Seminar Series (Campus)
Spring 2011	**Plants, Nutrition, and Latino Food and Culture Project** (Plants and Humans, Nutrition, Elementary Spanish Fast-Track)	Seminar Series (Cluster) Film Screening (Community)
Fall 2011	**Nutrient Sources: Truth in Labeling Project** (Food of Chemistry, Nutrition) **Latino Contributions to the Food System Project** (Food Politics, Elementary Spanish II) **Gendered Health: Sugars and Artificial Sweeteners** (Sociology of Gender, Pathophysiology)	
Spring 2012	**Understanding the Economic, Botanic, and Environmental Costs and Benefits of Urban Gardening** (Economics of Food, Plants and Humans)	Seminar (Cluster) Campus Garden Tour (Cluster)
Fall 2012	**Food Day—Food Policy, Chemistry, Marketing and Food Presentations** (Sociology of Gender, Food Politics, Economics of Food, Nutrition, Food of Chemistry)	Event included speaker panel, food drive, local food tastings (Community) Seminar (Cluster)
Spring 2013	**Food Addictions Discussion** (Pathophysiology, MLA Class on Food Justice)	
Fall 2013	**Film Screening: Escape Fire Viewing and Solutions Brainstorm and Discussion** (Pathophysiology, Nutrition)	Community Garden Hours (Nutrition) Agroecology Panel (Community)
Spring 2014	**Festival of Dionysus in the Mountain South—Meal and Poster Presentations on Cultural Perspectives on Plants and Healing Traditions** (Plants and Humans, Pathophysiology, Foodways of Blue Zones) **Foodways of Nicoya, Costa Rica Meal** (Elementary Spanish II, Foodways of Blue Zones)	

of the chosen recipe, and students studying Spanish created a summary in Spanish of basic plant information shared by their peers to accompany the bilingual recipe; the posters were also shared with a YWCA Latino health program. Campus and community members were invited to learn about and taste the foods prepared, and students were evaluated on their presentations. Students from each course had to navigate group work within their own course as well as coordinate preparing the poster with groups from other courses. At the Symposium, students reported learning much more about the plant because of the collaboration with students from other disciplines.

A third example of a large-scale project involved three classes: Pathophysiology of Chronic Conditions and Illnesses, Sociology of Gender, and Health Communications. Students generated evidence-based and socially aware health recommendations for the YWCA's Diabetes Wellness and Prevention Program. This project engaged students with underserved populations in the Western North Carolina region and empowered people living with diabetes with practical information about their chronic condition. The Pathophysiology students synthesized the complex science underlying type 2 diabetes for students in the two other courses. Sociology of Gender students examined the scientific messages for evidence of bias and considered how health messages are presented in the media. Finally, Health Communications students worked to optimize the health message for people in the community who were living with diabetes and who had varied educational backgrounds. The final products from students in the Pathophysiology and Gender courses were poster presentations with various perspectives on diabetes. Health Communication students presented their social marketing campaign strategies to the YWCA Diabetes Prevention Program Coordinator orally, and in writing to the students in the other classes. Students in all three classes were highly motivated to translate their knowledge to help others better understand and prevent this very challenging disease. This unique opportunity allowed students to practice educating people from diverse backgrounds about relevant health topics. Additionally, students were offered immediate and meaningful feedback on their instruction from their audience.

An example of a small-scale cross-course project involved two courses, Economics of Food and Plants and Humans, and focused on the topic of economic and environmental sustainability of campus food production. Students studying biology (Plants and Humans) were assigned vegetable crops to grow in the campus organic garden. Each student wrote a research paper that explored the tradeoffs of some aspect of organic food production (e.g., heirloom vs. hybrid seeds, sustainable methods to amend the soil, or the tradeoffs of land-extensive vs. land-intensive cultivation methods). The students studying biology were then combined into groups of four to give presentations to the students studying economics that summarized the results from their research papers as well as the results of their garden project, including the yield of the crops they grew. This information was used by students in the Economics of Food class to finalize their analysis of the costs and benefits of campus food production and consumption. Groups of students in the Economics of Food class investigated several topics such as the time, money, and resource costs; legal and logistical issues; marketing; and revenue potential (cost savings) associated with food produced on campus and either sold on campus or used to replace food that is currently purchased. At the end of the term, students enrolled in the Economics of Food class presented the results of their analysis to the students enrolled in Plants and Humans and to campus administrators. Reflection assignments revealed that students in both classes learned a great deal not just about their assigned topic but also about the environmental and economic issues associated with campus food production. One telling feature of these reflections was that a great number of students reported learning that these issues were much more complex than they initially believed.

Even though we have interpreted our class feedback from students on cross-class projects of these types as positive, we also strove from the beginning of our collaborative teaching endeavors to objectively determine the effectiveness of this type of instruction and the student learning gains from engagement in cross-course projects. To this end, we have implemented numerous modes of assessment, which are described below.

Assessment of the Food for Thought Cluster Pedagogy

Since the inception of the Food for Thought cluster, we have worked together to assess whether cross-course projects and cluster activities impact student learning, using a variety of assessment methods (Wingert et al. 2011 and 2014). Our first assessment strategy utilized an adapted version of SENCER's Student Assessment of their Learning Gains (SALG) instrument. Since the SALG is designed for individual STEM courses, rather than for a cluster of courses across disciplines, we developed an instrument designed to measure the Food for Thought cluster learning outcomes (Table 1). Our adapted SALG was used as an entrance (start of semester) and exit (end of semester) survey instrument administered electronically using a quiz form in an internet-based course management system (Moodle).

The entrance and exit assessment surveys had sixty-one items, including eight demographic questions, one open-ended question, and fifty-two questions addressing learning outcomes and course mechanics using a five-point Likert scale. 106 students completed both surveys. The learning outcomes questions were organized into four parts: academic attitudes; civic engagement and informed consumer; interdisciplinary and disciplinary skills; and understanding of food, food systems, food choices, and social and biological relationships (Table 1). At the end of each survey students were also asked to answer the following open-ended question: "Please list three food issues that interest you most." Students were asked to list three entries in order to complete the survey.

Results from this first assessment demonstrated that our collaborative, multidisciplinary approach using cross-course projects across cluster courses led to statistically significant increases in student perceptions of their learning gains, especially related to civic engagement (effect size (Δ) = 8.0%; $p = 0.036$), food literacy (Δ = 13.8%; $p < 0.0001$), research literacy (Δ = 9.7%; $p = 0.0018$), information and communication skills (Δ = 9.2%; $p = 0.0003$), and understanding food systems (Δ = 14.2%; $p < 0.0001$). We attributed much of the positive change in students' evaluation of their learning to the cross-course projects and activities. Qualitative analysis of the open-ended questions revealed that students' interest in and engagement with food issues increased over the course of the semester, especially with respect to changing the food production and consumption systems related to the American diet (Wingert et al. 2011).

In a second assessment, we sought to extend our findings on students' perceptions of learning gains by assessing the cluster's impact on student learning, specifically regarding integrative learning across disciplines (Wingert et al. 2014). We focused on three of our student learning outcomes (Table 1) that require integrative learning: civic engagement, informed consumer, and food systems and choices. Specifically, we tested whether exposure to a focused, multidisciplinary learning environment (the Food for Thought cluster courses and activities), could result in integrative, interdisciplinary learning gains (Rhodes 2010) compared to a control group of students. In our assessment instrument, we asked students to demonstrate their achievement in integrative learning by writing statements in response to prompts about a New York Times article. The article was specifically selected because it is complex and interdisciplinary in focus. It explained the costs and benefits of the popularity of quinoa, which, although endemic to the Andes, has become popular in the U.S. due to its nutritional profile, forcing change onto the culture and economy of Bolivia. In addition, this specific topic was not discussed in any of our courses.

Using a corresponding evaluation rubric, we tested the students' evaluation of the quinoa article to determine if exposure to a focused, integrative learning environment could result in superior critical thinking skills and abilities to understand food systems, integrate learning across disciplines, and make informed decisions about food choices, markers of three of our student learning outcomes: civic engagement, informed consumer, and food systems. The instrument and rubric were based on the Critical Thinking Value Rubric created by the AAC&U (Rhodes 2010) and on studies in which critical thinking is assessed by asking students to respond to a specific article or reading. Two studies that informed our protocol prompted students to read a designated article or reading and then to evaluate an issue in written form based upon the article or reading; these responses were then evaluated using a rubric designed to assess critical thinking skills (Miller 2004; Connors 2008).

The quinoa evaluation assessment instrument was completed by 161 students in nine Food for Thought

Cluster classes and by 177 students in nine control classes. Our results showed that Food for Thought students scored significantly higher on the evaluation rubric compared to controls ($\Delta = 14.0\%$; $p = 0.0008$). Rubric scores also significantly correlated with the number of cluster courses taken (Spearman $r = 0.32$; $p = 0.04$), demonstrating the increased gain of interdisciplinary, integrative learning skills with each multidisciplinary cross-course project experience. Importantly, rubric scores did not correlate with increasing year in college, indicating that our students' learning gains were related to the learning experiences specific to the cluster and not to academic maturity (Wingert et al. 2014).

Our earlier research also showed that students perceived gains in their communication skills (Wingert et al. 2011). Our most recent assessment efforts have sought to objectively determine whether these gains are demonstrable. Student communication skills will be evaluated from cross-course project student products, such as group poster presentations and two to three minute "selfie" videos of students describing their class research. Rubrics have been designed, based on the Critical Thinking Value Rubric created by the AAC&U (Rhodes 2010), to quantitatively assess communication abilities.

Faculty Reflections on Multidisciplinary Teaching and Integrative, Interdisciplinary Learning

By making a conscious decision not to "go it alone", we (the faculty involved in this type of collaborative teaching and scholarship) have benefited in multiple ways. We have not only implemented opportunities to provide students with meaningful interdisciplinary learning (described above), but we have also added to our teaching tools, learned about each other's disciplines, delved into new areas of research, forged friendships, and have had a remarkable amount of fun along the way.

Student Learning Gains

The first reason we have chosen to not "go it alone" is that we are convinced that it makes a difference for our students. We have previously highlighted the evidence we collected that demonstrates that students have both real and perceived gains in their learning. We suggest that they benefit from seeing an integrated model of teaching and learning in front of them—we undo before their eyes illusions they (or we) may have about solutions being simple or solvable from a single perspective. Instead, they are offered the opportunity to understand disciplines' capacities to illuminate facets of a complex problem and to witness that collaboration across disciplines offers more synthetic solutions.

Teaching Gains

We also recognize a number of benefits we receive from abandoning the strategy of going it alone, and these are worth highlighting for those who might otherwise believe it is too big an effort for faculty to undertake. One particular benefit is the enhanced perspective we have on our own teaching. Pursuing the interdisciplinary learning in this collaborative manner ensures that our understanding of our effectiveness as teachers begins with us, and it has the benefit of arising organically from a collaboration of faculty who are actually doing the teaching. We have the opportunity to critically examine our strengths and weaknesses in the classroom and quickly act to build on our successes and ameliorate any deficiencies. As an example, one colleague learned from our assessment of cross-course projects that he is successful in guiding students through the steps necessary to write a good research paper, but not as successful in having them translate that research into posters and oral presentations. It is also rare for faculty to truly understand the student experience as they work through our curriculum because we generally only see them in courses in our home department. Our collaboration gives us a more nuanced understanding of the student academic experience and allows us to develop a more frank assessment of the strengths and weaknesses of students and faculty in our individual departments with respect to faculty and students in other departments.

Faculty Learning Gains

Another significant outcome of our collaborative teaching and research experience has been the opportunity to learn more from other team members about each other's disciplines, including disciplinary perspectives and pedagogical methods. We are all now more literate in

each other's fields; this is, in and of itself, an outcome that is probably worth the time and energy we have put into this joint endeavor.

Faculty Scholarship Gains

We have also gained from the unique opportunity to participate in the intersection of the scholarship of teaching and learning with scholarship in our disciplines. It is more likely, however, that disciplinary scholarship and the scholarship of teaching and learning (SoTL) will coincide for the social scientists than for our colleagues in the natural sciences and humanities. That is true simply because the scholarship that social scientists pursue in their discipline bears more similarity to our scholarship of teaching than that pursued by natural scientists and faculty in the humanities. We are all teachers, so one can argue that none of us should feel conflicted as we consider undertaking pedagogical research, but it may be that someone whose research training is in the natural sciences or the humanities would need to work harder to absorb and integrate the pertinent literature, and would need more assistance in study design, analysis, and interpretation of results than would a social scientist who regularly uses these methods in their disciplinary research. Moreover, although the scholarship of teaching and learning is a project shared by scholars from all disciplines, both explicit and implicit norms about how to conduct SoTL research come primarily from the social sciences. As a team, we have become stronger in our understanding of strategies for navigating those norms. From these opportunities to learn from each other, we have all benefited both individually and collectively from the sharing of our disciplinary research expertise. It has also been a real pleasure to implement curricular ideas and write collaboratively on a topic of shared interest—innovative ways to promote student learning—and to model integrated learning for our students.

Conclusions

In the face of many competing pressures on our time and the fact that our general education curriculum is in a state of flux, we as professors must continuously reaffirm our commitment to our work together and seek recognition and support from our university to continue these efforts. We have developed both a meaningful multidisciplinary collaboration and, indeed, friendships over these years and do not wish to see this partnership dissolve. Although we risk overworking ourselves if we do not locate efficiencies in our work, we also fear that our productivity and success as teachers and researchers will decline unless we find a way to adapt to the changing needs of society, the changing learning styles of students, and a changing curriculum.

Even at a small school, it is rare to build a collaboration across departments and divisions that allows faculty to develop trust and empathy across the university. Because we have worked closely together we have come to understand each other's unique teaching and research environments and to break down barriers to communication across disciplines. Information gleaned from the experiences of these faculty members allows us to more effectively advocate for a work environment that is more humane and equitable.

We are engaged faculty—engaged in meaningful lines of inquiry with students both in our class and our colleagues' classes, engaged with the discipline of our own training as well as the disciplines of our colleagues, and directly engaged with each other. Perhaps equally important, however, is the shared recognition of our own disciplinary and individual limitations that comes from this engagement. The economist among us will never teach a chemistry or nutrition class, just as the biologist among us will not teach a sociology class. Knowledge of chemistry, economics, or Spanish alone will not be sufficient to solve the world's problems. While we (and our students) are now more able to speak each other's language and recognize our own discipline's strengths in contributing to solutions, we also recognize that the strongest teams, those teams needed to solve the world's most complex problems, are composed of individuals with exceptional disciplinary strength.

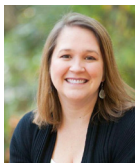
In a recent essay regarding AAC&U initiatives for integrative learning, Ann Ferren and her co-authors argue that

> Developing faculty's capacity for leadership in integrative learning, then, is not just about working with other faculty for institutional change, but also demonstrating for students what this form of leadership looks like: adaptive, collaborative, inquisitive, reflective, and boundary-crossing.

> The process of implementing integrative learning on a campus becomes a teaching tool, a means of modeling for students how to engage thoughtfully and actively in their communities toward a common purpose (Ferren et al. 2014/2015, 6).

Our experience on our campus reflects this spirit, and we concur with their conclusion that providing a model of a dynamic, functional, multidisciplinary team demonstrates to our students that no one person faces the burden of solving the problems associated with food insecurity or climate change. Indeed, choosing not to "go it alone" models engaged citizenship for our students, other faculty, and ourselves. Assessments of our multidisciplinary model provide evidence for student gains in perceptions of integrative learning and accomplishment of our goal to develop more informed citizens with multifaceted perspectives on complex civic issues. The context we provide for our students through our cross-course projects and meaningful cross-disciplinary action is exactly what is needed for promoting citizen science.

About the Authors



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works with colleagues in UNCA's Biology Department on the conservation biology of threatened plants such as American ginseng and Virginia spiraea, as well as the ecological threats posed by non-native invasive species. He also works in the rainforests and savannas of Guyana, South America to document its rich plant diversity and has had a new species of passionflower from Guyana (Dilkea clarkei) named in his honor.

Ellen Bailey is a Lecturer in the Department of Foreign Languages at the University of North Carolina Asheville and occasionally teaches in the Department of Health and Wellness as well. She earned her M.A. in French/Foreign Language Pedagogy from the University of Delaware and her Master of Public Health from the University of North Carolina Chapel Hill. Ellen enjoys working with students and community members to better understand how culture and environment influence health behavior.

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References

Connors, P. 2008. "Assessing Written Evidence of Critical Thinking Using an Analytic Rubric." Journal of Nutrition Education and Behavior 40: 193–94.

Ferren, A., C. Anderson, and K. Hovland. 2014/2015. "Interrogating Integrative Learning." Peer Review 16/17 (4/1): 4–6.

Huber, M.T., P. Hutchings, R. Gale, R. Miller, and M. Breen. 2007. "Leading Initiatives for Liberal Learning." Liberal Education 93 (2): 46–51.

Miller, D.R. 2004. "An Assessment of Critical Thinking: Can Pharmacy Students Evaluate Clinical Studies Like Experts?" American Journal of Pharmaceutical Education 68: 1–6.

Rhodes, T.L., ed. 2010. Assessing Outcomes and Improving Assessment: Tips and Tools for Using Rubrics. Washington, DC: Association of American Colleges and Universities.

Schneider, C.G. 2004. "Changing Practices in Liberal Education: What Future Faculty Need to Know." Peer Review 6 (3): 4–7.

SENCER (Science Education for New Civic Engagements and Responsibilities). 2015. The SENCER Ideals. http://www.sencer.net/About/sencerideals.cfm (accessed January 18, 2016).

Wingert J.R., S.A. Wasileski, K. Peterson, L.G. Mathews, A.J. Lanou, and D. Clarke. 2011. "Enhancing Integrative Experiences: Evidence of Student Perceptions of Learning Gains from Cross-course Interactions." Journal of the Scholarship of Teaching and Learning 11 (3): 34–57.

Wingert J.R., S.A. Wasileski, K. Peterson, L.G. Mathews, A.J. Lanou, and D. Clarke. 2014. "The Impact of Integrated Student Experiences on Learning." Journal of the Scholarship of Teaching and Learning 14 (1): 45–58.