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Training interdisciplinary "wicked problem" solvers: applying lessons from HERO in community-based research experiences for undergraduates

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Management of "wicked problems", messy real-world problems that defy resolution, requires thinkers who can transcend disciplinary boundaries, work collaboratively, and handle complexity and obstacles. This paper explores how educators can train undergraduates in these skills through applied community-based research, using the example of an interdisciplinary research program at Clark University in Worcester, Massachusetts, USA. Participating students strengthened their abilities to handle setbacks in the research process, improved communication and teamwork skills, and gained familiarity with interdisciplinary investigation. Programmatic elements that could transfer well to other settings include studying local human–environment problems, working in multigenerational, small groups, and using multiple methodologies.

Keywords: wicked problems; active learning; research-based learning; human–environment; undergraduate education; research experience for undergraduates

Introduction

"Wicked problems" are a class of problems that are complex, contentious, defy complete definition and resolution, and for which there is no single solution (Rittel & Webber, 1973). Wicked problems involve many stakeholders with different framings of the problem. Solutions are not readily forthcoming, and any solution is recognized as the best available at the time rather than a final "true" solution. These problems are known as "wicked" because they differ from "tame" or easily resolvable problems. The terminology was originally developed to encourage urban planners to think beyond instrumentalist approaches. Contemporary geographic topics described as wicked problems include environmental sustainability, urbanization, public health, climate change, and development (Xiang, 2013). Scholars have even described climate change as a "super wicked problem" – not only does it exhibit typical characteristics of wicked problems, it also grows more difficult and costly over time, and effective institutional incentives and frameworks do not exist (Lazarus, 2008).

Managing wicked problems requires imaginative thinking that goes beyond the bounds of any one academic discipline (Brown, Harris, & Russell, 2010). Therefore, students must learn to apply academic knowledge to real-world problem-solving beyond disciplinary boundaries, which can and should begin at the undergraduate level (Lopatto, 2003). The methodological and topical breadth of geography provides a strong foundation from which

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to train undergraduates to address complex wicked problems that necessitate interdisciplinary thinking (Baerwald, 2010; Haubrich, 2007).

In this paper, we explore how geographers can train undergraduate students in the science and art of interdisciplinary wicked problem-solving by conducting applied community-based research involving undergraduates from a range of majors, including but not limited to geography. We examine the Human–Environment Regional Observatory (HERO) Research Experience for Undergraduates (REU) program, a multigenerational research program involving faculty, graduate, and undergraduate students at Clark University in Worcester, Massachusetts, to illustrate how educators can use community-based research to train undergraduates in interdisciplinary human–environment problem-solving. Finally, we reflect on how geographers in a range of educational settings can implement applied interdisciplinary research-based educational programs more broadly.

Active learning for wicked problem-solving

Wicked problem solvers must be able to work collaboratively across disciplines (Brown et al., 2010; Weber & Khademian, 2008) because of the need for diverse expertise to address complex socio-environmental issues such as climate change. Those grappling with wicked problems must also be able to handle complexity and uncertainty, and need to be resilient in the face of setbacks and obstacles that inevitably arise (Batty, 2013). How can geography educators best train students to work as wicked problem solvers who can transcend disciplinary boundaries, work collaboratively, and handle complexity and setbacks? Over the past several decades, educators in many fields, including geography, have turned to a wide variety of active learning practices to engage students in complex, creative problem-solving using simulations and real-world problems both inside and outside of the classroom (Bonwell & Eison, 1991; Chickering, Gamson, & Poulsen, 1987; Prince, 2004; Scheyvens, Griffin, Jocoy, Liu, & Bradford, 2008). Because many active learning strategies focus on creative interdisciplinary thinking, collaborative work, and handling complexity, they are relevant for training students to handle the challenges of wicked problems. Specific strategies reviewed here include problem-based learning, service learning, and research-based learning, including community-based and participatory action research (PAR).

Problem-based learning methods include scenarios and simulated real-life situations to foster collaborative critical inquiry into loosely structured problems (Boud & Feletti, 1991; Pawson et al., 2006; Savery, 2006). These methods build teamwork, critical thinking skills, and the ability to understand complexities of real-world problems. Service-based learning allows students to get experience outside of the classroom through volunteering, jobs, and internships (Bednarz et al., 2008). Research-based learning provides another important venue for active learning. Students involved in research programs can especially benefit when they have independence and ownership over an aspect of a project, but also have mentorship and guidance from faculty (Bauer & Bennett, 2003; Healey, 2005; Lopatto, 2003). Researchers and educators can combine research-based learning with community engagement through community-based research and PAR, which focus on issues relevant to the local community with an emphasis on "the analysis of a situation in order to improve it" (Savin-Baden & Wimpenny, 2007, p. 332). PAR in particular emphasizes participatory methodologies and the collaborative role of the community in defining research goals (Kindon & Elwood, 2009; Savin-Baden & Wimpenny, 2007).

When students grapple with real-world problems – whether in the classroom, the community, and/or in research settings – they have a chance to develop important skills relevant to tackling wicked problems. Learners can practice interdisciplinary thinking, teamwork and communication skills, and develop resilience to obstacles – skills identified as important for wicked problem-solving. In this paper, we show how undergraduate students have been able to develop these skills through an interdisciplinary community-based research project within a geography department.

The HERO program: structure and organization

The HERO program is a research program within Clark University's School of Geography that focuses on involving undergraduates in researching global environmental change in local places (Polsky, Rogan, Pontius, & Turner, 2007; Sorrensen, Polsky, & Neff, 2006; Yarnal & Neff, 2007). HERO began in 1999 with internal funding and in recent years has received support from the US National Science Foundation (NSF) REU program. Research topics have varied throughout the 15-year history of the program; the 2012–2014 grant that is the focus of this paper examines the Asian Longhorned Beetle (ALB) infestation in Central Massachusetts.

The ALB is an invasive insect that has arrived in the USA from Asia over the past decade and impacts numerous tree species (US Department of Agriculture [USDA], 2012). In 2008, a serious ALB infestation was declared in Worcester (a city in central Massachusetts). Measures to eradicate ALB – in particular, cutting of host trees, and potential (but not actively infested) host trees – in Worcester have been contentious, with debates among stakeholders over management strategies, impacts, and responsibilities (Palmer, Martin, DeLauer, & Rogan, 2014). Through the HERO program, students and faculty examine social, political, and ecological dimensions of the impact of ALB and associated responses in the Worcester area. The ALB issue represents a wicked problem in that it is complex and contentious, involves multiple scales and stakeholders, and does not have any one "right" solution.

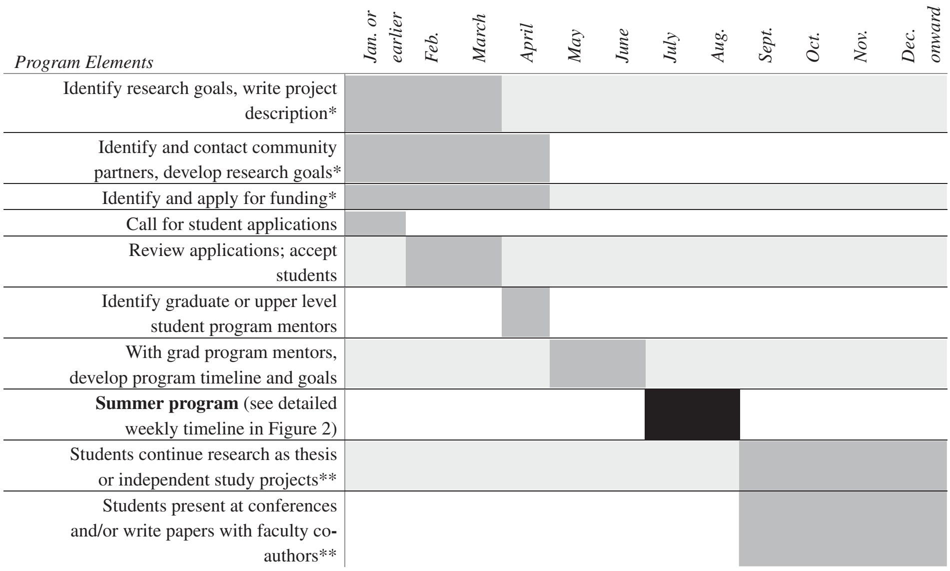
HERO strives to prepare students for handling real-world problems by equipping student learners with the tools to apply the knowledge, skills, and perspectives gained through their academic careers to other contexts. Students learn and apply research skills including interpretation of field data, satellite imagery, Geographic Information Science (GIS) analysis, focus groups, and interviews. The program frames research as not only about intellectual gains, but also about broader community or societal goals (Polsky et al., 2007). The learning environment aims to support self-awareness and integrity, reflection, respect, responsibility, and ownership for all participants, including undergraduate students, graduate students, and faculty. HERO strives to strengthen students' capacities of adaptive expertise, perseverance, collaboration, and creativity – learning objectives aligned with Clark University's Liberal Education and Effective Practice initiative, which combines a liberal arts curriculum with real-world experience beyond the classroom (Budwig, 2013). HERO works from the premise that these capacities are essential for understanding the complexity of social and environmental issues in the twenty-first century, and that geography's interdisciplinary approach is well suited to help students develop these abilities.

In the HERO REU program, 10–12 students from Clark University and elsewhere around the country work as paid summer researchers investigating a Massachusetts-based issue of consequence. Students from a range of academic majors, including but not limited to geography, apply in the winter/spring via a competitive process and are selected based on academic performance, references, and a personal essay demonstrating interest in the program. Based on their own interests and experience as well as program needs, selected students are divided into two "research streams" with different methodological areas of focus (qualitative, GIS/remote sensing); students are not required to have expertise in their research stream before the program, although those with GIS experience are preferred for that stream. The HERO program strives for both gender equity and racial and cultural diversity among student participants. The majority of student participants are rising juniors or seniors.

Undergraduates, graduate students, and faculty collaborate throughout the HERO research process. Graduate students (M.S. and Ph.D.) serve as daily managers and mentors for the undergraduate participants in a team-oriented framework guided by faculty. Undergraduate students are integrally involved in every aspect of the research including research design, collection and analysis of qualitative, quantitative, and spatial field data, and presentation of data to community stakeholders. At the start of the program, students are together oriented to the problem via shared readings about ALB, invasive insects, and the eradication and tree replanting programs in Worcester, Massachusetts. In years 2 and 3, students read papers from the previous summers' work, so as to build knowledge progressively within the 3-year project cycle. Following the mostly shared first week of activities, the two research streams work separately on collecting, processing, and analyzing data. This process involves continued reading of relevant literature with presentations to graduate managers and faculty about key lessons learned, and training on specific data collection methods. As part of the training, students develop specific research plans for their summer of data collection and analysis. Thus, while the overarching research questions have been determined by the directing faculty, the specific summer goals are developed by the students with input from faculty. In addition, each stream frequently gives presentations to members of the other research stream in order to share progress, invite feedback, and practice communication skills. Through this process, students develop a broad understanding of the dimensions of the problem and potential approaches to addressing it, and critical assessment skills across research streams and methodologies. Undergraduate students typically work independently or in small groups of two to three students to complete manageable tasks; students check in with graduate mentors daily or more frequently, and meet with faculty several times a week for advice and feedback. Throughout the program, faculty and graduate students give professional development workshops for the full team of undergraduate participants.

Stakeholders from the Worcester community have engaged with faculty during the development of each research proposal. For example, the HERO work on the ALB meant developing strong relationships with local employees of the USDA, Massachusetts state government and local nonprofit organizations. Because the program focuses on an issue that these organizations directly address, making connections with them was essential for data input and to report findings. These stakeholders not only served as research participants but offered advice on research goals for each year based on the previous year's analysis. HERO students were trained to facilitate break-out groups and present their findings during an end-of-summer, annual stakeholder summit.

After the summer program, Clark undergraduates continue their work throughout the academic year as a senior thesis or independent study, for which they receive course credit rather than a stipend. Students present their work at on-campus research symposia, and all participants are invited (and funded through the program grant) to present their research at the annual meeting of the Association of American Geographers. Often, undergraduate students publish research results with faculty co-authors. See Figure 1 for a timeline of year-round program elements and Figure 2 for a timeline of the summer program.



*These items begin as early as possible – by the summer or fall of the previous year
**These items continue on past the fall into the following spring

Figure 1. Timeline of year-round program elements (including before and after summer program).

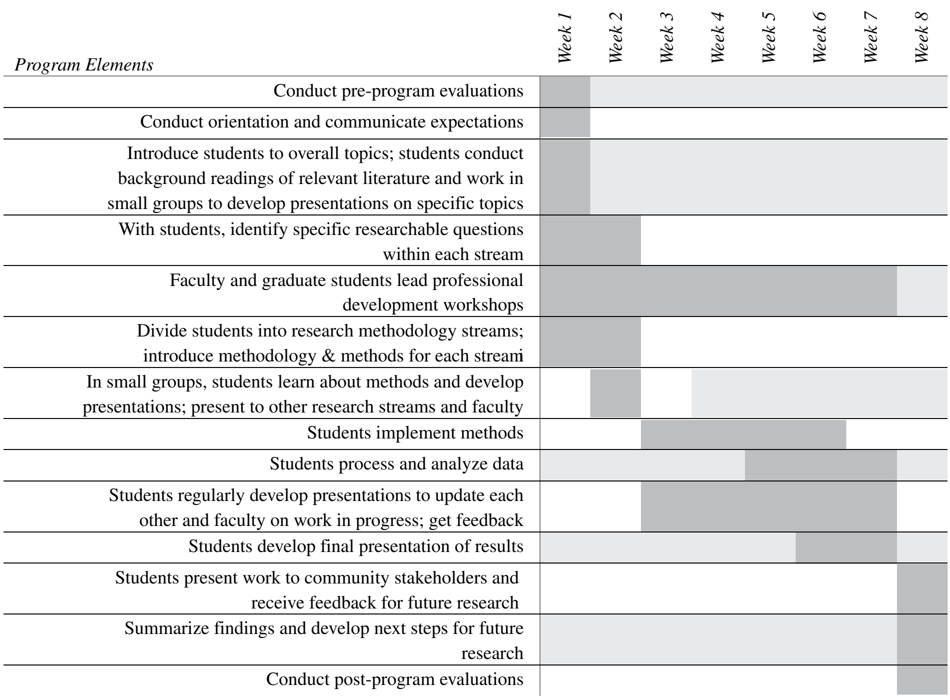


Figure 2. Timeline of key program elements during an 8-week summer program.

Methodology

To examine how successful the HERO program was at training students in the skills relevant to wicked problem-solving, we utilized several types of data, including an annual survey on learning gains and a post-program reflection survey. We draw data from 3 years (2012–2014) of the HERO program, during which time 35 undergraduate research fellows, 4 Master's level graduate student mentors, 3 Ph.D.-level student mentors, and 3 faculty participated in HERO. Fifty percent of participants were female and 11% were students of color.

First, we conducted an annual survey of undergraduate students in the summer program using the Survey of Undergraduate Research Experience (SURE) tool, an online survey instrument developed specifically for evaluating undergraduate research experiences (Lopatto, 2004, 2007). REU programs around the country commonly use the SURE survey to assess skill development, learning gains, and overall experience. All HERO undergraduate participants in each of the 3 years took the SURE survey before and after the summer program (Master's and Ph.D. students did not take the survey). Our total response rate was 11 in 2012, 12 in 2013, and 10 in 2014, which represents 94% of the 35 undergraduate participants for the time period. In the survey, students rated 21 different learning gains on a scale of 1–5 (1 = no gain or very small, 5 = very large gain) on different aspects of the research process. We examined the survey data in order to learn about the students' perspectives on their learning and the specific skills students felt they had gained through the program.

Along with the survey, we conducted a qualitative post-program evaluation. We asked undergraduate students to broadly reflect on their learning experiences, and specifically, how they persevered through a dynamic research process. We also wanted to understand how participants perceived the research stream integration and their roles within it. Lastly, we were interested in what participants learned as a result of their work with stakeholders and the need to provide them with useful qualitative and quantitative data. The evaluation elucidated thoughtful reflections on the benefits and challenges of students' participation in the HERO program. We analyzed these evaluations for emergent themes related to student learning experiences.

Results

The ratings and ranks of all measured learning gains from each of the 3 years, as rated by the undergraduates who took the online SURE survey, are presented in Table 1. The four top average learning gains in the 3 years included improved tolerance for obstacles faced in the research process, ability to analyze data and other information, readiness for more demanding research, and effective oral presentation skills. The lowest scoring learning gains included developing skills in science writing and confidence in one's potential as a teacher.

In the qualitative evaluation, students frequently commented that they had enjoyed participating in a community of researchers and learning to work as a team. Many also mentioned gaining research skills, presentation skills, and enjoying data collection and fieldwork. Several students also commented that they had grown personally through the program, including developing a better sense of their personal and academic goals, and learning to overcome challenges. Students also discussed challenges of the program. The most common challenge was finding a balance between independent work and guidance, and wishing for more guidance at times. Students also wanted more instruction in concrete

Table 1. Learning gains from SURE survey.

	2012		2013		2014		Average	
Learning gain	Rating	Rank	Rating	Rank	Rating	Rank	Rating	Rank[a]
Tolerance for obstacles faced in the research	4.18	1	3.67	2	3.56	5	3.80	1
Ability to analyze data and other information	4.00	2	3.50	6	3.90	2	3.80	2
Readiness for more demanding research	3.91	5	3.92	1	3.50	6	3.78	3
Skill in how to give an effective oral presentation	3.00	20	3.67	2	4.40	1	3.69	4
Understanding how knowledge is constructed	3.82	8	3.50	6	3.60	3	3.64	5
Becoming part of a learning community	3.64	11	3.50	6	3.60	3	3.58	6
Understanding the research process	3.80	10	3.50	6	3.30	8	3.53	7
Skill in interpretation of results	3.91	5	3.36	10	3.30	8	3.52	8
Understanding how scientists work on real problems	3.64	11	3.67	2	3.20	11	3.50	9
Ability to integrate theory and practice	3.45	15	3.58	5	3.40	7	3.48	10
Learning laboratory techniques	4.00	2	3.36	10	2.56	18	3.31	11
Self-confidence	3.36	18	3.17	12	3.20	11	3.24	12
Understanding that scientific assertions require supporting evidence	3.91	5	2.42	20	3.30	8	3.21	13
Clarification of a career path	4.00	2	2.83	18	2.80	16	3.21	13
Ability to read and understand primary literature	3.45	15	3.17	12	3.00	14	3.21	15
Understanding how scientists think	3.45	15	2.92	17	3.11	13	3.16	16
Learning ethical conduct	3.64	11	3.08	14	2.67	17	3.13	17
Learning to work independently	3.82	8	2.58	19	2.90	15	3.10	18
Understanding science	3.64	11	3.00	16	2.44	19	3.03	19
Confidence in my potential as a teacher	3.09	19	3.08	14	2.44	19	2.87	20
Skill in science writing	3.00	20	2.36	21	2.29	21	2.55	21

[a] Shows rank of average rating, not average of all 3 years' ranks.

skills, with computer software such as ArcGIS or SPSS. Students mentioned that group dynamics could be challenging, and noted that working as a group was both a benefit and a challenge.

In the following discussion on building capacity for wicked problem-solving through the HERO program, we draw from the aforementioned data, and also from our own experiences of day-to-day immersive participation in the program itself. This includes the summer program as well as other events throughout the year (such as team meetings, academic conferences, and research presentations) in which students reflected directly upon their experiences.

Student learning outcomes and wicked problem-solving

Through the survey and the post-program reflection, students highlighted learning gains and capacities that they had strengthened throughout the program. In this section, we discuss four of these capacities that are particularly important for wicked problem-solving: improved tolerance for obstacles faced in the research process, strengthening of team building and communication skills, experience with interdisciplinary investigation, and building a community of practice.

Wicked problems inevitably involve complexity, unpredictability, and uncertainty, and those seeking to address them will face setbacks and obstacles along the way (Batty, 2013). The ability to handle obstacles and failure is thus a key capacity for wicked problem-solving.

Students strengthened this ability through the HERO program: "Tolerance for obstacles faced in the research process" was one of the most highly rated learning gains in all 3 years of the SURE survey. By participating fully in the entire research process, students experienced the reality of research difficulties – for example, lack of responses in interview recruitment, or inability to get necessary GIS data in a timely fashion. Alone, one student might give up, but as a group they supported one another in problem-solving, and had the input of faculty and graduate student mentors to build confidence that the process is working as it should. As a 2014 student commented, "When it became challenging, it felt great to overcome those difficulties." Another student added, "We had to learn how to best work with each other, manage our tasks, and not get too frustrated when things went 'bump'."

A second key skill for wicked problem solvers is communicating well to multiple audiences with different areas of expertise (Weber & Khademian, 2008). HERO students strengthened their communication skills throughout the program. From the beginning of the program, students worked in small groups to analyze and process information and present it to their peers. For example, to familiarize themselves with relevant literature at the beginning of the program, students read academic articles in small groups and created presentations to teach their fellow students what they learned from their particular papers. Throughout the program, students refined and practiced public speaking through a series of presentations. Undergraduate students served as an audience for one another, and received feedback from each other and from graduate students and faculty on both content and delivery throughout the summer. For the end of the program, students created and delivered a final presentation to share the research findings with stakeholders in the community and the broader university community. "Skill in how to give an effective oral presentation" received high ratings in the SURE survey, particularly in the second and third years. A student from 2014 commented, "Having to present each week and receive criticism was SO helpful because I have never been that critically evaluated before in my presentation skills … on presentation day I felt so at ease and ready to present because of this."

Building communication skills was challenging as well. Finding time to explicitly build peer-to-peer communication skills was difficult, yet in retrospect would be advised for interdisciplinary research teams. Peer mentoring was a critical aspect of the learning process, and the HERO team structure is purposely scaffolded to assign specific roles to undergraduate, graduate and faculty participants. Much of the day-to-day training and guidance is overseen by graduate students with faculty guidance. At times, a tension existed among undergraduates and first-year Master degree students. The latter were given the responsibility to teach particular content and assert themselves among the undergraduates who often saw themselves as equal peers. Undergraduate and graduate students privately expressed frustration and faculty worked to build empathy among all. Some undergraduate participants struggled to fully respect the roles of the graduate mentors and this group dynamic hindered research progress. At these junctures, faculty played the important role of validating the leadership role of graduate students while clarifying direction and facilitating progress. When graduate students praised undergraduates by taking seriously their ideas, peer mentoring greatly advanced the research process.

Thirdly, wicked problems are often interdisciplinary in nature (Brown et al., 2010). Through HERO, students got hands-on practice in interdisciplinary investigation. Students worked in separate methodological research streams (spatial analysis and qualitative methods) to build substantive expertise, but these streams did not work in isolation. Through a dynamic community of effective practice, students regularly presented their ideas, methods, and findings to the other methodological research stream on a regular basis, and gave each other feedback throughout the program. For example, students learning qualitative analysis sought feedback on their survey instruments from the spatial analysis team. While students in the spatial analysis stream spent most of their time analyzing remotely sensed data, they also learned how to conduct interviews and code qualitative data via formal presentations from their peers in the social science stream. Similarly, students in the social science stream also learned basic GIS skills through formal weekly workshops and training and informally from their mapping science stream peers, and workshops on spatial analysis. This presented both challenges and benefits; for example, a student in 2012 commented, “I learned a love for interdisciplinary work. I think it is so important in any academic field that different perspectives unite to investigate and solve problems. The world isn’t black and white, so science shouldn’t be either.” The same student noted: “Despite the rewards of interdisciplinary work, it can be challenging to acknowledge or understand different viewpoints when you are tied to your particular field.”

Finally, wicked problem solvers must be able to work collaboratively (Weber & Khademian, 2008). Through HERO, all participants built what Lave and Wenger (1991) have termed a “community of effective practice” through the process of using interdisciplinary methodology in order to tackle a complex, multifaceted problem as a group. HERO students entered with a range of disciplinary training and real-life experiences; this diversity became a strength for collectively understanding complexity through the process of working in groups. This is a particular strength: as a student in 2014 commented,

> The program taught me about group dynamics and working as a team. This is maybe the first time I have worked in a large group. It was a challenge for me to work with different personalities and backgrounds. I am happy to say that I do come out with better skills in working with a group.

Another student noted, “There is something very satisfying about working shoulder to shoulder with friends and colleagues – everything belongs to everyone and all are motivated by the group.” Through the HERO program, a shared repertoire of approaches and a shared identity developed as students and faculty worked through the complexity of the problem (Wenger, 1998). The success of HERO in training an effective community of researchers is evident in the high ranking of “Readiness for more demanding research” on the SURE survey. “Becoming part of a learning community” also ranked highly on the survey.

Best practices for wicked problem-solving using active learning

As others have noted, juggling the multiple educational, research, and community goals involved in research-based learning with community participation aspects can be challenging (Kindon & Elwood, 2009). One cannot underestimate particular constraints, such as time and funding, which interfere with the ability to fully build students' capacities for the skills discussed earlier.

Time constraints present one major challenge. To be successful, the program demands a significant time investment by faculty year-round, although most intensely in the summer months (see Figure 1 for a timeline of key year-round program elements, and see Figure 2 for a timeline of the summer program). Faculty were able to realize their investment through the substantive engagement with students on topics of mutual interest, which generated scholarly publications (Hostetler, Rogan, Martin, DeLauer, & O'Neil-Dunne, 2013; Palmer et al., 2014; Rogan et al., 2013). We also addressed time constraints by meeting multiple goals simultaneously. For example, the interview process served simultaneously as a data collection method, learning experience, and network-building tool. Similarly, the annual community stakeholder presentation provided students an opportunity to present their research, and also allowed researchers to stay familiar with constantly evolving community concerns and policy goals. Finally, graduate student mentors played an important role in addressing faculty time constraints: graduate students supervised the daily work throughout the summer, and in doing so developed their own skills in mentoring and project management.

Funding is also a constraint of the HERO program. As others have noted, the HERO program is expensive to run (Polsky et al., 2007; Yarnal & Neff, 2007). The NSF REU program, which provides financial support for undergraduate research, could be a resource for other US-based geography educators at a variety of institutions. Other funding resources could include partnerships with university extension agencies, or other grants from either community or university institutions oriented toward supporting community-based research.

Even without funding, it is possible to do hands-on, participatory, community-based research with students – which is how the HERO program worked before receiving funding, and how the program currently works during the school year. During the school year, students who participated in the summer program receive course credit for continuing their research projects with faculty serving as mentors. Projects draw upon group data, but each student conducts analysis and writing on an independent project that typically becomes an honors thesis. Following the practice from summer, students and faculty meet regularly as a group throughout the semester to check in, which facilitates peer learning and helps build community. Research-oriented classes and group studies offered during the school year can help address barriers of time and funding that may limit summer research opportunities. In a classroom setting, the same principles apply: together students and faculty can build a community of practice through interdisciplinary investigation and group work, and can learn to handle the obstacles that arise when addressing wicked problems. These procedures allow students to develop problem-solving skills and to learn to take multiple perspectives on an issue.

Creating relationships with local officials or other outreach with local stakeholders is a great way for faculty to learn of the pressing issues that could benefit from more research. Stakeholders often do not have the time or financial resources to conduct needed research on a wicked problem. In our work, we were able to conduct field work and analyses that our stakeholder partners did not have time to conduct themselves. These activities helped to legitimate and provide a public forum for resident emotional responses to tree loss (Palmer et al., 2014); evaluated and documented temperature impacts from tree loss (Rogan et al., 2013); and assessed tree mortality among replanted cohorts (Hostetler et al., 2013).

To summarize, we suggest that the following lessons from HERO can be applied more widely across geography programs. First, "wicked" human–environment problems can be identified by working together with community partners and can serve as an interesting and relevant basis for student-oriented community-based research projects. Second, students can investigate these problems in a way that helps to build wicked problem-solving skills. Students can develop interdisciplinary thinking and teamwork skills through a team-based approach involving multiple research methodologies. Through this group work, students can develop a supportive community of practice and improve their ability to overcome obstacles. Students can strengthen their communication skills during the research process through frequent oral presentations given to the research group and to the broader public. Third, to address time-related challenges, faculty can publish collaboratively with students, use research-related activities to meet multiple goals (such as education, community connections, mentorship, research) simultaneously, and utilize graduate students or peer mentors (such as seniors in a capstone seminar) to assist with the daily activities of research. Finally, while funding is helpful, it is not absolutely necessary for programs like this to exist: educators can use courses and for credit independent and small-group studies during the school year to host research projects and foster community among student researchers without the need for paid stipends.

Conclusions

In this paper, we have described the importance of training undergraduate students to address complicated, real-world wicked problems, using an example of an applied interdisciplinary research project situated within a geography department. The HERO program emphasizes interdisciplinary investigation, team building and communication, and improving tolerance for obstacles in the research process. Through this approach, faculty are able to advance a substantive research agenda while providing a meaningful training experience for undergraduate students.

Every community, urban or rural, small or large, has human–environment issues that can serve as useful learning tools. Many environmental problems can be considered wicked problems that demand a range of expertise and contain a plurality of values, interests and variables. Locally important issues (such as water quality, local land use planning, or development of climate action plans) can be identified in collaboration with community-based partners and addressed through research involving undergraduate students using multiple methods, including mapping, interviews, focus groups, surveys and mental mapping techniques. Many elements of the HERO program could be implemented by other educators, including communication with stakeholders about local issues, and employing small group work as a way to develop community among faculty and student researchers. In the HERO program, the university is one stakeholder among many and we can offer our expertise, and ultimately data that can be used for decision-making. Human–environment geographic issues hold excellent potential for interdisciplinary, community-based, learner-centered research projects, and provide a platform for students to learn not only research methodology, but interdisciplinary inquiry, communication skills, handling complexity, and tolerating obstacles – skills essential for addressing twenty-first century wicked problems.

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