The Extended Classroom Framework for Teaching Systems Analysis of Food Systems

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ABSTRACT  To further synthesize Systems Action Education (SAE) and adventure learning (AL), a new education framework is presented called the Extended Classroom Framework (ECF) for teaching systems analysis of food systems. Extended Classroom Framework integrates SAE and AL with the circulatory system of science to describe how the classroom interacts with society. In the fall of 2012, the ECF was utilized to design a hybrid course at the undergraduate level that explored four different international agroregions through the perspective of on-the-ground collaborators. By utilizing online geographic information systems and an online social network, students digitally explored these agroecosystems as open-ended cases. A pre- and post-test of the Intercultural Development Inventory was given to the students. Students also wrote four reflective journals that were coded and thematically analyzed. Six of seven of students showed positive shifts in their developmental orientation (p < 0.05). Four of seven students showed decreases in their intercultural orientation gap. Every student ended the course similarly or less culturally disengaged to a primary cultural group, with six students in the resolved category compared with four at the beginning of the course. Student reflective journals illustrated growth in considering agroecosystems contextually and as coupled human–environmental systems. These results show that the ECF offers a viable framework for developing student capacities to engage “wicked” problems.

Impact Statement  The Extended Classroom Framework (ECF) provides a means to synthesize online GIS and social networks to allow students and instructors to experientially learn about human–environment interactions in multiple international contexts in a cost-effective manner. By providing preliminary evidence documenting the framework in action, this article shows the ECF’s potential to increase students’ ability to think systemically and work across differences, essential skill sets for practitioners working within “wicked” problems.

Agroecology has a history of using experiential and participatory learning to teach systems thinking in order to prepare students to address wicked problems (Bawden, 1991; Pretty, 1995; Jordan et al., 2008; Warner, 2008; Lieblein et al., 2012; Francis et al., 2011). Wicked problems differ from traditional problems in that they are ambiguous, poorly defined, context dependent, escape disciplinary solutions, and do not have answers that are right or wrong, only better or worse (Rittel and Webber, 1973; Batie, 2008). Because wicked problems cross multiple sectors and scales of coupled biophysical and social systems, they create management dilemmas (Foley et al., 2011; Polasky et al., 2011; Scheffer and Carpenter, 2003; Tilman et al., 2011). Additionally, with the ever increasing complexity of coupled human–environmental systems, great concern exists surrounding “unknown unknowns” and system tipping points that could result in undesirable alternative steady-states or systemic collapse (Robertson et al., 2012; Dai et al., 2013). Agroecologists have proposed solutions to guide society through wicked problems, and simultaneously acknowledge that we currently do not have the human capacity to fill positions required for these solutions (Dale et al., 2010; Francis et al., 2012; Jordan et al., 2013). As a result, agroecological education must continue to build student capacities in coupled human–environmental systems in order for solutions to be enacted and succeed.

Capacity building can be defined as “the process used in education to improve students’ abilities to work effectively with challenges they will face in agriculture and food systems development and research programs” (Francis et al., 2012). The capacities future agroecologists need are as complex and diverse as the problems these students will seek to navigate. Building from experience, students form capacities internally and externally. Capacity building from experience requires: multiple types of internal dialogs (i.e., reflective, abstractive, and visioning thought) (Francis et al., 2012). Agroecology has a history of using experiential and participatory learning to teach systems thinking in order to prepare students to address wicked problems (Bawden, 1991; Pretty, 1995; Jordan et al., 2008; Warner, 2008; Lieblein et al., 2012; Francis et al., 2011). Wicked problems differ from traditional problems in that they are ambiguous, poorly defined, context dependent, escape disciplinary solutions, and do not have answers that are right or wrong, only better or worse (Rittel and Webber, 1973; Batie, 2008). Because wicked problems cross multiple sectors and scales of coupled biophysical and social systems, they create management dilemmas (Foley et al., 2011; Polasky et al., 2011; Scheffer and Carpenter, 2003; Tilman et al., 2011). Additionally, with the ever increasing complexity of coupled human–environmental systems, great concern exists surrounding “unknown unknowns” and system tipping points that could result in undesirable alternative steady-states or systemic collapse (Robertson et al., 2012; Dai et al., 2013). Agroecologists have proposed solutions to guide society through wicked problems, and simultaneously acknowledge that we currently do not have the human capacity to fill positions required for these solutions (Dale et al., 2010; Francis et al., 2012; Jordan et al., 2013). As a result, agroecological education must continue to build student capacities in coupled human–environmental systems in order for solutions to be enacted and succeed.

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et al., 2012; Kolb, 1984); an open stance to difference (Taylor, 1994); the ability to act observantly and responsibly across disciplines (Kuh, 2008); and the ability to utilize multiple data types in ambiguous situations (Moncur and Francis, 2011; Francis et al., 2012). Developing these capacities plays an essential role in fostering “adaptive learners” who will be able to become the “adaptive managers” of coupled human–ecological systems. Reflectiveness in particular plays an essential role for further growth and life-long learning (Zimmerman, 2002). By combining reflectiveness with deep observation and the ability to abstract problems, adaptive learners can be visionaries of a more sustainable agriculture (Francis et al., 2012).

Directly connected to reflectiveness, a student will need an open stance toward difference, also known as an ethnorelativism, in order to work with people of diverse perspectives. Ethnorelativism is an advanced intercultural capacity. It is not simply working across geopolitical or racial boundaries, but rather reflects an individual’s posture toward all that is culturally different; therefore, ethnorelativism is an essential skill for working between urban and rural contexts, or between groups that adhere to different ideologies (Batie, 2008). Experience that occurs with close observation, deep reflection, future visioning, and responsible action—outlined within Systems Action Education (SAE) (Francis et al., 2012) and Kolb’s Learning Cycle (Kolb, 1984)—along with advanced intercultural capacities, will allow future agroecologists to utilize understanding from multiple disciplines and their technical capacities. These technical capacities (particularly in digital and online collaborative environments) utilize diverse data types—spatial, multi-scale, biophysical, and social—with the multiple groups of stakeholders in situations that will require unique solutions to context specific problems.

The task of developing these capacities within tomorrow’s agroecologists is guided by “systemic” and “systematic” thought and action (Lieblein et al., 2007; Lieblein and Francis, 2007; Francis et al., 2012; Ison and Russell, 2000). Systemic study seeks to understand inter-related and reacting components of a system, whereas systematic study pauses and looks at an individual component through a specific “way-of-knowing” to understand its inner-workings more deeply (Francis et al., 2012). Students then shift back-and-forth between these two types of study as they consider agroecosystems. Interestingly, not only is the process of shifting between these two types of study a skill in and-of-itself, but it is a skill that builds other the skills listed above. Such skills are impossible to teach through lecture and reading, but must be learned through active engagement and practice within authentic contexts. Authentic contexts result naturally in open-ended cases that provide the opportunity for ideas envisioned within the learning process to impact reality, which further deepens and increases impact for students (Simmons et al., 1992; Francis et al., 2009). However, open-ended cases within authentic contexts can also present financial, logistical, and legal problems (Francis et al., 2012).

Information communication technologies (ICT, e.g., Web 2.0 and mobile computing) could provide a means of delivering open-ended cases with even more impact and fewer challenges because of data-rich experiences of reality in online contexts compared with open-ended cases without ICT. Information communication technologies have been developed within agroecology education (Francis et al., 2009; Lieblein et al., 2004). Within the general realm of sciences education, much work has been done surrounding adventure learning (AL) (Doering, 2006; Doering and Miller, 2009) through an online context, which has informed work done within agroecology (Francis et al., 2009). As argued in Porter et al. (2015), AL and SAE are synergistic educational frameworks with similar theoretical backgrounds. However, although they are synergistic, a more cohesive framework developed for an online context could better inform online design of open-ended case study education. Additional evidence for further developments within the frameworks came through reflective discussions with the adventurers and course instructors. It became apparent that these trips, while powerful for learning (Doering et al., 2010; Porter et al., 2015), were not necessarily sustainable at the personal or institutional level because of the toll such adventures can have on the adventurer’s body and the financial costs associated with such trips. Similar concerns have been reported by other AL adventurers (Miller et al., 2008). Additionally, the merger of SAE and AL were successful from a theoretical standpoint, but the process of bicycling cross-country was not ideal for exploring agricultural systems because it lacked the longer-term temporal perspective required to understand an agroecosystem. According to instructors from the delivery of the Porter et al. (2015) courses, students stated in group discussions that they desired more interaction with locals in situ so they could gain a first-hand perspective to compare with the readings and the adventurer’s perspective. Another concern is the ease of replicating an instructor bicycling cross-continentially for other agroecology instructors.

To more fully address these areas of concern, further extensions were made to existing frameworks with the addition of perspectives from the science studies literature (Latour, 1999; Warner, 2007) to explicitly state the different spheres that a classroom could and should interact with in experiential agroecology education in order to maximize the authenticity and effectiveness of the systemic and systematic study (Francis et al., 2012). Additionally, Francis et al. (2012) in a review of SAE stated that an opportunity exists for open-ended cases in agroecology classrooms to be further expanded and enhanced through multimedia integration within online environments. Given recent advances in the power of online geographic information systems (e.g., Google Maps, ArcGIS Online) and online social networking systems (Ning, Egg), the time was perfect for the envisioning enhancements. In response, the Extended Classroom Framework (ECF) was developed to explicitly integrate SAE, AL, and the circulatory system of science (CSS), which further builds on Lieblein et al. (2012) in describing the stakeholder groups necessary to engage in the agroecology education process (Latour, 1999; Warner, 2007).

The Extended Classroom Framework

The ECF was developed by combining CSS, AL, and SAE (Fig. 1). The goal in combining the frameworks was to offer a way to understand how an agroecology classroom moves about and interacts in society in general, but particularly in a digital environment. With the prevalence of online teaching and learning, online networks can be quite transparent (Brown and Adler, 2008). Students can interact with the general public freely, and the general public can interact with students. Given the permeability of the
In the ECF, the next circulating conceptual level contains “narrative” and “collaboration” (Fig. 1a). Both of these concepts build on each other through group activities and class community building that result in stakeholders’ and students’ narratives merging. This merging occurs as the class community experiences collective experiences of complex situations as students inquire about issue and place. Issue, place, narrative, and collaboration form the nuclear core of the ECF.

The next “energy state” circulating around the nucleus of the ECF informs the learning of the complex experiences through integrated social and biophysical data, data visualizations [e.g., interactive online geographical information systems (GIS) and graphs], which are housed in a flexible common curriculum that holds all of the components in motion around the nucleus. As the class community interacts with data and collaboratively asks questions, the process evolves ("Evolving Process," Fig. 1a). Fundamentally, ECF places all members of the classroom as co-learners, where students are as likely to dictate the process of questioning as much as the instructor.

The outermost ring of the ECF builds predominantly from CSS and describes the necessary groups of stakeholders to include in the classroom community when exploring an issue and place (Fig. 1a). The “General Public” consists of those who are not necessarily directly invested in agricultural production or the scientific exploration of agriculture, but have a stake within an issue and place. This group of people could range from those who live within a region and are impacted by the use of public...
ecological services such as water, or those who consume market or non-market goods coming from the agroecosystem. Students often fall into this category of general public in their day-to-day lives. “Agriculturalists” include those who are directly involved with landscape management (e.g., farmers, landowners) or who are directly working to impact landscape management (e.g., seed companies, fertilizer companies, nonprofits, governmental organizations). The “Scientific Community” consists of scientists who are working on the basic and applied scientific problems (issues) associated with a place. The “Scientific Community” also includes course instructors. The “Natural World” is primarily included through direct experience of it as the place of inquiry. It’s important to note that an individual can be a member of multiple spheres and can change spheres from moment to moment, depending on the primary role an individual is playing. For example, if the issue were nitrate pollution and the place were southern Minnesota; an undergraduate student could be from a farm located in southern Minnesota that applies synthetic nitrogen to the fields. Additionally, the same student could be performing undergraduate research considering the impacts of different nitrogen rates on corn yield and nitrate pollution across soil types. This would mean the student was a part of the agriculturalist sphere as well as the scientific community sphere while being a student in the course. Finally, the entire framework is housed in the collective, social-learning process (Bandura, 1977; Francis et al., 2012; Kolb, 1984). The steps of deep reflection, rich observation, future visioning, and responsible participation, although deeply individual, can also be a collective, social-learning process (Bandura, 1977; Francis et al., 2012; Rogers, 2010). By including a temporal component with the collective and individual perspectives, it is apparent that different individuals could be at different points in their individual learning cycles and that subgroups of learners may have overlapping learning cycles as time progresses (Fig. 1b). This process of individual and collective reflection occurs within the constructs of the ECF and engages the class community in moving into deeper levels of “systemic” and “systematic” understanding.

The ECF seeks to codify the above-listed disparate realms of thought to more fully guide instructors in the facilitation and integration of different aspects exploring “wicked” problems from multiple perspectives. Ideally, the framework would result in learning experiences that would prepare learners to work across cultures, scales, and digital and analog contexts in order to build the capacities of agroecologists. To test the framework, a pilot hybrid course was developed in the fall semester of 2012 at the University of Minnesota (UMN) entitled Agroecosystems of the World.

Research Objectives

The goal in designing and implementing a pilot course with ECF was to test if the framework:

- successfully instructed undergraduate students in agroecological inquiry across multiple global contexts through systematic and systemic inquiry
- caused students to increase their ability to work within complex situations in relation to difference
- successfully integrated online geographic information systems and online social networks to engage students in exploring open-ended case studies systemically and systematically

MATERIALS AND METHODS

The fall semester of 2012, a 3-credit course Agroecosystems of the World (AGRO 3305) \((n = 7)\) was offered through the College of Food, Agricultural and Natural Resource Sciences (CFANS) at the UMN. The enrolled students were primarily upper-level CFANS undergraduates who enrolled in the course out of interest in the topic as an elective. The course sought to teach students how to: (1) describe important biophysical and social/cultural dimensions of agroecosystems and their interdependence and use this understanding to guide inquiry into agroecosystems; (2) access a wide variety of information sources and understand ways they can be used; (3) understand and use different inquiry approaches to study and characterize agroecosystems; (4) appreciate the significance of different perspectives, especially disciplinary, scale, and cultural perspectives, in studying agroecosystems; and (5) recognize and appreciate their own cultural perspectives in relation food production and the environment, and communicate and work effectively across cultural differences.

These objectives were chosen with the goal of creating a course that could fulfill certain requirements of a new major centered on food systems at the UMN. After determining the learning objectives, the teaching team selected the places of inquiry for the course. Our criteria for selecting the places of inquiry were (1) the places would build on existing relationships within CFANS at the UMN, (2) the places showed opportunity for relationship growth beyond the initial contact, (3) the places collectively represented a diversity of agroecoregions globally to provide students with interesting points of comparison and contrast, and (4) communication with the collaborator was possible via the internet.

For the first iteration of the course, the teaching team’s goal was to establish one strong connection with a principal collaborator at each location, with the future vision of expanding the number of people involved locally within each agroecosystem of inquiry so that a fuller exchange of agroecological thought could occur. This vision acknowledges the teaching team’s place in the progression of intercultural education laid out by Burford et al. (2012). The practical aspects of the process of identifying places and collaborators involved talking with the Office of International Programs within CFANS as well as working with other college administrators and faculty members who had connections abroad. Because of the extensive connections with CFANS to varied international locations, we were typically only one to three social network connections removed from the person who eventually became our principal collaborator in each location. To be considered an acceptable principal collaborator, the individual had to be enthusiastic about engaging, have a strong base of knowledge related to an aspect of agroecological inquiry, and had to be actively engaged in agroecosystem management or research. We valued practical experience as much as formal education, and wanted to select a diverse group of people to
engage with the classroom community. The final locations of our collaborators were Watonwan County, Minnesota, United States (agriculturalist, farmer); Guacimo, Costa Rica (general public, agronomic English instructor at EARTH University); Meknes, Morocco (scientific community, soil scientist); and Sauraha, Nepal (scientific community, agriculturalist). Students represented the "general public," and the "natural world" was represented through the online geographic information systems (GIS), the academic literature, and the narratives of the class community.

After formalizing agreements, UMN instructors and the primary collaborators of each location jointly identified the issues and designed learning activities for the course. Core issues included perceptions on climate change, population pressure, water management, gender equity, and social and physical infrastructure specifically involving (1) reliance on the dominant corn–soybean rotation in Minnesota, (2) small-scale diversified farming systems and monocropped plantations in Costa Rica, (3) water-use management and sustainability in Morocco, and (4) balancing agricultural expansion and natural resource preservation in Nepal. The design process varied for each location, but resulted in a set of exploratory labs that utilized media-rich online geographic information systems to guide students through different aspects of the agroecoregions (Fig. 2a and 2b). The only major variation in the laboratory exercises was for Costa Rica, where a companion class at EARTH University for learning agronomic English was associated with our principal collaborator at that location. In that instance, we co-designed a set of collaborative learning activities that required students from each university to interact through exchanging multimedia on the course content management systems (CMS), which in this case was a Ning social network. The primary learning objective for the EARTH University students was to learn spoken and written agronomic English, which was complementary to the UMN students’ objectives. The online laboratories were developed to provide a baseline understanding for students in the biophysical and social aspects of the agroecoregions as well as allow students opportunities to practice systemic and systematic inquiry using agroecosystem analysis theory (Conway, 1985; Francis et al., 2003; Gliessman, 2004; Power, 2010; J. Visser, Dordt College, Sioux Center, IA, unpublished, 2000).

For example, students could systematically analyze individual data layers such as crop yield, precipitation, or market access, or systemically consider the relationships between the layers by turning two or more layers on simultaneously.

The course was delivered as a hybrid course with approximately half of the learning time spent online in the course CMS, and the other half occurring face-to-face (F2F) in class each week. For the CMS, we selected a Ning social networking environment because of the generally easy usability, dynamic integration of multimedia, and its design focus on online communities (Fig. 2c). All of these aspects were believed important to enhance the ease of collaboration and the creation of a community narrative through authentic learning.

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Fig. 2. Online geographic information systems (GIS) were designed utilizing a variety of free tools ranging from (a) ArcGIS Online and (b) the Google Maps Javascript API with embedded YouTube Videos. The Ning content management system not only provided a (c) media-enriched place for the learning community to collaborate and build narrative connections, but it also provided a place to (d) clearly organize the course each week.
Development Inventory (IDI) measures (adapted from Bennett et al., 2003).

Table 1. An overview of the Developmental Model of Intercultural Sensitivity (DMIS), which directly corresponds to what the Intercultural Development Inventory (IDI) measures (adapted from Bennett et al., 2003).

<table>
<thead>
<tr>
<th>General orientation</th>
<th>Specific orientation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnocentric or Monocultural</td>
<td>Denial</td>
<td>Orientation recognizes observable cultural difference (e.g., crop selection), but may overlook deeper cultural differences (e.g., implicit cultural values surrounding management) and may avoid or withdraw from cultures</td>
</tr>
<tr>
<td>Ethnoreal/ethnocentric or Mono-/Multi-cultural</td>
<td>Minimization</td>
<td>Orientation that highlights the commonality of human experience, but may mask deeper recognition and appreciation of cultural differences</td>
</tr>
<tr>
<td>Ethnoreal or Multicultural</td>
<td>Acceptance</td>
<td>A view that recognizes and appreciates cultural differences in one's own and other's cultures</td>
</tr>
<tr>
<td></td>
<td>Adaptation</td>
<td>An orientation that is able to shift perspectives and behavior based on cultural situation in appropriate and authentic ways</td>
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The Intercultural Development Inventory (IDI) at the beginning and end of the course (pre- and post-test, respectively) with an individualized F2F feedback session and a group feedback session with trained IDI qualified administrators. The IDI is a 50-item instrument in its third version as of the course timing. It was developed by Hammer et al. (2003) to assess "orientations toward cultural difference" as described by the Developmental Model of Intercultural Sensitivity (DMIS) (Bennett, 1993). The underlying assumption of the DMIS is that "as one's experience of cultural difference becomes more complex and sophisticated, one's potential competence in intercultural relations increases" (Hammer et al., 2003). This assumption assumes that knowledge of the world is constructed as one experiences events (Kelly, 1963), and that the more tools an individual has to utilize in perceiving the world, the more complex the construction of the world, and thus, the more completely one can construct and understand culture. The DMIS also assumes that construing cultural difference on an on-going basis can become a part of one's worldview. The DMIS consists of six categorical worldviews that describe how someone is oriented toward cultural difference. Three of the orientations are "ethnocentric" or "monocultural" in nature and three are "ethnorelative" or "multicultural" in nature. For a full list of DMIS orientations measured by the IDI, and their definitions, see Table 1. The IDI has undergone extensive validation and reliability testing (Hammer et al., 2003; http://www.idiinventory.com) and can be used to assess group or individual intercultural development. In addition to measuring one's cultural orientation, the IDI also provides measures of cultural disengagement (CD) or how connected one feels to a primary cultural group on a scale of 0 to 5, with anything four or higher indicating that the individual is resolved and feels connected (Hammer et al., 2003). Because of the importance of agroecologists to inquire systematically and systematically across cultures, success in systemic and systematic inquiry requires students to perceive multiple nuances of cultural difference. The IDI directly measures this skill.

University of Minnesota student reflective journal prompts were administered through the course CMS in experiences resulting in artifacts. The online GIS were integrated with the CMS through either direct incorporation or external links. Each week, a weekly to-do list was posted with course tasks outlined clearly for students, including all of the needed resources and links to relevant online places of interaction such as the discussion boards (Fig. 2d).

The 15-week semester course was divided into five predominant sections: 3 weeks to introduce students to the concept of agroecosystem analysis and to practice the analysis of an agroecosystem within a familiar context (Minnesota), 6 weeks to explore each of the other three locations and further refine their ability to inquire systematically and systematically through the online GIS and interactions with the collaborators on the CMS and Skype conference calls, 5 weeks for students to guide the class community through an additional aspect of an issue within one of the four already studied locations, and a final week for group reflection and synthesis. Each section was designed utilizing the nucleus of ECF: issue, place, narrative, and collaboration (Fig. 1). Class discussions focused on either systemic or systematic questions guided by all members of the class community at different points during the semester. The online GIS and media-enhanced CMS allowed students to explore and manipulate data at multiple scales (field to global) and across biophysical and social contexts. A common curriculum was created utilizing the weekly to-do lists that oriented the community through self-guided explorations of the data. Each week, the process evolved as students posed questions in discussion. The climax of the course evolution occurred when students took charge of focusing the class on a specific issue and place. During this time, students provided all supplementary data.

Throughout the semester, students were asked to reflect individually and collectively. Individually, students wrote four reflective journal entries during the semester, and were prompted to reflect broadly on their learning in the course as well as specifically on their intercultural development, and experiences of the online learning environment. Collectively, students reflected during F2F discussion and through asynchronous discussion forums. In addition to the reflective journals, students were given the
the weekly to-do list; students used a word processor to respond and then emailed their responses to the course teaching assistant. The IDI pre- and post-course tests were taken via an online survey tool by the UMN students outside of class. All seven students completed the IDI pre- and post-tests, and 86% of the reflective journal entries were submitted. Reflective journal entries were coded and thematically analyzed according to Richards (2009). Journal responses related to the online GIS and CMS were additionally coded numerically on a 10-point scale from 0 (highly negative) to 5 (neutral) to 10 (highly positive) according to Svensson (2001). Statistical analyses using Pearson’s chi-squared and a paired *t*-test were performed according to Snedecor and Cochran (1989). Ninety-five percent confidence intervals and standard errors were calculated according to the standards for within-subject calculation (Morey, 2008). All data were analyzed using the R Statistical Environment (R Core Team, 2013), managed using reshape2 (Wickham, 2007), and visualized using ggplot2 (Wickham, 2009).

**RESULTS**

A paired *t*-test of the IDI scores revealed no statistical difference between the group’s average pre-test developmental orientation (DO) and the group’s post-test DO. The DO measures someone’s intercultural development. At the individual level, a move of 7 points or greater has been found to be significant for the full-scale IDI items (Bennett et al., 2003; http://www.idiinventory.com). Confidence intervals were calculated according to Morey (2008) to be ±6.75, which are similar to the recommendations of true difference at the individual level by Bennett et al. (2003; http://www.idiinventory.com). At the individual level, six of seven students showed significant increases in the DO and one student showed a significant decrease (Fig. 3). Four out of seven students showed significant decreases in their orientation gap (OG) between the post-test and the pre-test (Fig. 4). The OG is the difference between someone’s perceived orientation (PO) and their DO. The OG illustrates someone’s internal reflective capacity and awareness (Fig. 4). Every student ended the course the same or less culturally disengaged to a primary cultural group, with six of seven students in the resolved category where they feel engaged with their primary cultural group (Fig. 5). This compares with four of seven at the beginning of the course (data not shown).

Numerical coding of students’ reflective journals related to the online GIS revealed that students perceived the GIS positively aided their learning. A chi-squared test revealed students perceived the online GIS to significantly aid in their learning compared with neutral (*p* < 0.01). Qualitative
Coding and thematic analysis revealed that students perceived the online GIS positively because of its ability to allow them to consider scale, multiple perspectives, fact check readings from collaborator discussions, and juxtapose the interactive data with information in course readings. Students also reported frustration because of technical difficulties related to slow loading times and “buggy” interfaces. Illustratory comments include:

…I especially liked the fact that the videos didn’t last for too long (they were only 2 min long) so they kept my attention and they also consisted only the essential information we needed.

As we focus on a sliding scale from global to local, the GIS systems have helped extraordinarily in learning the ecological functions, topography, etc., of the different areas that we are studying. This is a great visual aid in furthering my understanding of an area and being able to relate more with local issues.

The GIS maps provided a good juxtaposition against the articles and the direct information from the collaborators and EARTH students. It was a good way to get a sense of the geography and natural features in each location.

For a first time user the GIS systems are extremely frustrating, but after I get things figured out, the information I get from them is valuable.

It worked well enough. Some of the interfaces were buggy. It might help if there were a lower threshold for software/apps.

Students perceived the Ning online social network mostly positively and as a beneficial way to organize their learning; however, students reported that the discussion forums could be difficult to follow because of the design. A Pearson’s chi-squared test of numerically coded responses showed no significant difference from neutral in their responses. Student reflective journals revealed that students mostly found the Ning CMS novel and useful, particularly when combined with other in-class activities like distance discussions using Skype or conference call with our primary collaborators. However, this sense was not unanimous with some students feeling “it didn’t work well for [them].” A common response was that it took students time “to get used to”:

I think that all aspects of this course have helped contribute to my learning including the online Ning community, collaboration with professionals from these countries, and the GIS applications that were used.

It didn’t work well for me. Seemed to work better for other students. Granted, my participation with Ning was limited, but I felt there was a disconnect between the forum discussions and the class meetings.

The Ning site works pretty well. There are a few elements that are tricky. For instance, it was sometimes challenging to follow the online discussion in the beginning. Also, most recently, when putting up the page for the group project, it was tricky trying to create a new page. Those are minor elements; overall the Ning site is a good component of the class.

I think that Ning is a great tool for classroom instruction. Besides the fact that it is easy to use and understand it provides students with a different classroom experience. I will admit that it took a little while to get used to and feel comfortable with but now I am convinced it is a very effective tool.

Fig. 5. Every student was more culturally resolved at the end of the course than the beginning, with six of seven students reaching the resolved (>4) category.
Additionally, the theme of confidence in culture emerged through time in the reflective journals. Students became more confident in their ability to describe culture and their intercultural development. In the first reflective journal:

Every time I am confronted with this question, I am never sure quite how to respond.

Broadly, I identify myself as a White Midwestern 21st Century Male that is more defined by my beliefs and dreams, than by a title. As a 7th generation American, I do not reflect my ethnicity, yet my culture is a smorgasbord of other collective ideals that have become mass marketed.

In later reflective journals:

I realized that I have at many times exhibited elements of the minimization in that more often than not I have a tendency to focus on the common humanity of people.

I’ve started at stage called denial. Sometimes I still feel like I am there and sometimes I feel like I improved. I am open to different cultures and I am very interested in other countries’ tradition but I still find myself surprised in some situations.

I feel like being aware has helped me the most in making progress in this area [intercultural development]. However I do believe that have the real interactions with the collaborators was the most helpful for the progress. Especially being able to hear the different viewpoints and discuss them afterwards.

Simultaneously, students reported being less judgmental of different methods of agroecosystem management through time. Students specifically stated that interactions with the principal collaborators and EARTH University students through online discussions, qualitative GIS layers, and synchronous Skype and conference calls played a significant role in their change in perspective. Students expressed the importance of online and in-class discussions in-spite of technical difficulties with both the GIS and the Ning. Interestingly, students perceived the online GIS having a significant role; and thirdly, students acknowledged the importance of online and in-class discussions in spite of technical difficulties with both the GIS and the Ning. Interestingly, students perceived the online GIS more positively than the Ning when coded numerically. Assuming methodological soundness, Kirschner et al. (2004) provide the lens of “affordances” to interpret this result through. Affordances are “different opportunities provided by a learning environment...for action” in technological, social, and educational contexts (Kirschner et al., 2004). Technological affordances of an object are linked to its usability (Norman, 1988). For human–computer interaction, this primarily comes down to whether or not the computer efficiently and effectively satisfies the user’s goals. In the case of both digital tools, they operated at less-than-ideal. It could be, however, that the end goal of accessing novel data and questioning assertions within academic publications provided a more important end goal than discussing articles with fellow students—particularly in light of the potentially transferability of affordances from the Ning to other forms of social affordances that offer social interaction, such as F2F or video and telephone conferencing. The online GIS did not have a similar, replaceable technology. Under the final lens of educational affordances, we could imagine a similar logic applying: the self-guided...
knowledge that could be gained within the online GIS was more novel than the Ning, and therefore, despite difficulty, the potential outcomes were perceived as so valuable that they motivated students to work through the technological difficulties.

The IDI revealed that the affordances of the learning environment impacted the intercultural capacity significantly, either negatively or positively. Based on the reflective journals, it appears that this increased ability to approach difference allowed students to more fully consider agroecosystems “systemically” facilitated by the online multimedia and GIS. This result aligns with the view that “the crux...is the ability to construe (and thus experience) cultural difference in more complex ways” (Hammer et al., 2003).

CONCLUSIONS

The development of the ECF responded to the need for a fuller integration of SAE and AL, and utilized CSS in the process. The pilot course showed promising preliminary results that the framework can successfully design learning environments that build capacity in future agroecologists. This study looked at the multifaceted aspect of capacity building from multiple, mixed methods perspectives, and it seems to show a promise. The area where students revealed the most concern was in the ease of use of the technology. The problems with the technology seemingly occurred either as a result of a learning curve, poor design, slow internet speeds, or a mixture of all of the above. Although these technological problems were unfortunate, they can be addressed in the future to minimize their occurrences and their impacts when they do occur. The ECF’s potential to build student capacity is encouraging, but these results are still very preliminary with a small sample size and should be interpreted cautiously. Work needs to be done to more fully test the framework, and to do so with adequate controls. More research will need to be conducted to know whether or not the framework would be worth implementing on larger scales, but these preliminary results indicate that ECF would be valuable to further explore.

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REFERENCES


Kuh, G.D. 2008. Excerpt from “High-impact educational practices: What they are, who has access to them, and why they matter”. Assoc. of Am. Colleges and Univ., Washington, DC.


