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Teaching science and social justice in an interdisciplinary water course (PPT)
Teaching science and social justice in an interdisciplinary water course

Dr. Cathy Willermet
What we’ll talk about today

• My thoughts on how to:
  – Develop an interdisciplinary course
  – Assess an interdisciplinary course
  – Sustain an interdisciplinary course, and associated research
Student involvement
Water as Life, Death, and Power

• ANT 250, BIO 250, CHM 250
• No prerequisites, 3 credits
• 4 contact hours (2 lecture, 2 seminar)
• Student can sign up under any designator
• Three instructors, one for each designator
• Teaching assistant to run the seminar
Goals of the course

• Examine water-related health disparities from multiple perspectives, such as water access, water-borne pathogens, water treatment, and power relationships
• Identify the social justice issues arising from these disparities;
• Compare and contrast political, economic, and technological access to water treatment methods;
• Define a plan to develop or improve a grassroots campaign to address water issues.
Ensuring interdisciplinarity

- Interdisciplinary or multidisciplinary?
  - Everyone there, all the time
  - Faculty modeled respect for all team members
  - Lectures were integrated, showed intentionalità
  - Course materials had a common theme/look
  - Weekly meetings to integrate content
  - Assignments grounded in integrated approach
Point of the day…

• How are we teaching this course, and why are we teaching it this way?
“Interdisciplinary” means...

• Analyzing complex problems from several perspectives
• Placing problems and solutions within a larger world context
• Empathizing with multiple stakeholders
• Tolerating ambiguity and complexity
Other “points of the day”

• How does access to water influence human conflicts?
• How do pathogens live in water, and how can we fight them?
• How secure is the U.S. water infrastructure?
• How are feedback loops begun and maintained?
<table>
<thead>
<tr>
<th>Date</th>
<th>Point of the Day</th>
<th>Lecture, 12:00-12:50</th>
<th>Seminar, 1:00-1:50</th>
</tr>
</thead>
</table>
| Wed 2/4 | How does access to water influence human conflicts? | Environmental justice  
Displacement and range of responses  
Climate change and drought  
Conflict over water access, water rights  
Examples: U.S., Syria, Ukraine, Crimea | Group work on project statement, elevator pitch |
| Mon 2/9 | Library work: Shu Guo presentation in library computer lab on research projects (CONFIRMED?)  
Students must e-mail 5 citations by 2:00 pm | | |
| Wed 2/11 | How do humans impact water quality & availability? | Human activities affecting water availability  
- Household uses  
- Agricultural uses  
- Industrial uses  
- Subsidence/groundwater discharge  
Human activities affecting water quality  
- Human/animal waste  
- Fertilizer  
- Detergents  
- Pesticides, DDT | Elevator pitch presentation by group  
Revised group contract, concept map due  
Assign Reading #2 |

**Week 6**

| Mon 2/16 | Modern row crop ag. has dramatically increased yield, but at what cost to water quality? | History of modern agriculture  
Ancient v. modern corn  
- Plant cells (organelles, mitochondria, chloroplasts)  
Endosymbiotic theory  
Nitrogen fixation mutualism  
Amino acids and polarity  
Nitrogen cycle  
Fertilizer runoff, types of lakes  
Atrazine | Impacts on coral reefs  
Reading reflection #2 due |
Water as life, death, and power: Building an integrated interdisciplinary course combining perspectives from anthropology, biology, and chemistry

Cathy Willermet¹, Anja Mueller², Stephen J. Juris³, Eron Drake⁴, Samik Upadhaya² and Pratik Chhetri²
6-4-2014

An Integrated Interdisciplinary Faculty-Student Learning Community Focused on Water Issues: A Case Study

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*Central Michigan University, chhet1p@cmich.edu*
What we’ll talk about today

• How to:
  – Develop an interdisciplinary course
  – Assess an interdisciplinary course
  – Sustain an interdisciplinary course, and associated research
Assessment measures

• Increased knowledge about water issues?
  – Pre/post test, final exam

• Increased student interest in activism?
  – Pre/post survey

• Increased application of interdisciplinary thinking?
  – Final projects, final exam
Pre-post survey... some sig. results

- Participating in community action program
- Influencing social values
- Finding a career that directly benefits others
- Becoming a community leader
- Viewing social issues from multiple perspectives
- Developing a meaningful philosophy of life
- Developing leadership abilities in others
Examples of student projects

• Installation of composting toilets at CMU

• Modification of city green-lawn ordinances to reduce local water contamination

• Analysis of strategies to connect farmers to government programs promoting bioswale buffer zones along rivers

• Proposal to Mayoral Office in Copacabana, Bolivia to design totora reed beds to clean wastewater before it enters Lake Titicaca

• Proof-of-concept for time-release version of existing antiworming drug for shistosomiasis in Uganda; children’s call-and-response song
# Interdisciplinary Rubric

## Disciplinary Grounding

<table>
<thead>
<tr>
<th>Clarity: Explanation of disciplinary insights, methods, findings, mode of thinking is free from confusion and ambiguity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarity: All disciplinary explanations are clear in purpose and organization.</td>
</tr>
<tr>
<td>Clarity: All but one disciplinary explanation is clear in purpose and organization; or several miss either purpose or organization.</td>
</tr>
<tr>
<td>Clarity: Only one disciplinary explanation is clear in purpose and organization; or all miss either purpose or organization.</td>
</tr>
<tr>
<td>Clarity: None of the disciplinary arguments are clear.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Logical: Each disciplinary argument fits together well, conclusions follow from reasoning and evidence; well-reasoned; plausible, consistent, coherent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical: All disciplinary arguments are logical, coherent, and based on evidence.</td>
</tr>
<tr>
<td>Logical: All but one disciplinary argument is logical, coherent, and based on evidence.</td>
</tr>
<tr>
<td>Logical: Only one disciplinary argument is logical, coherent, and based on evidence.</td>
</tr>
<tr>
<td>Logical: None of the disciplinary arguments are logical, coherent, and based on evidence.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Complete: Includes all disciplinary information needed; lacking none of its parts or aspects thorough, whole.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete: All disciplinary information needed is presented.</td>
</tr>
<tr>
<td>Complete: Most of the disciplinary information needed is presented.</td>
</tr>
<tr>
<td>Complete: Only some of the disciplinary information needed is presented.</td>
</tr>
<tr>
<td>Complete: None of the disciplinary information needed is presented.</td>
</tr>
</tbody>
</table>

## Interdisciplinary Reasoning

<table>
<thead>
<tr>
<th>Integrative Summary: All disciplinary arguments are distilled into a coherent summary with an overall meaning or result.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrative Summary: All disciplinary information has been included in the summary in a logical manner.</td>
</tr>
<tr>
<td>Integrative Summary: Two disciplines are favored over the 3rd.</td>
</tr>
<tr>
<td>Integrative Summary: One discipline is favored over all other disciplines.</td>
</tr>
<tr>
<td>Integrative Summary: No integrative summary is attempted.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conceptual Bridging: A particular concept, instrument, skill is used in a variety of concepts resulting in a deeper understanding of the tool itself.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual Bridging: The topic is investigated from the viewpoint of all disciplines, leading to deeper understanding of the topic.</td>
</tr>
<tr>
<td>Conceptual Bridging: Two disciplines are favored over the 3rd.</td>
</tr>
<tr>
<td>Conceptual Bridging: One discipline is favored over all other disciplines.</td>
</tr>
<tr>
<td>Conceptual Bridging: No deeper understanding has been achieved.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Complex Explanation: The interdisciplinary argument is developed to a higher level of abstraction.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex Explanation: Coherent whole is synthesized to a higher level of abstraction.</td>
</tr>
<tr>
<td>Complex Explanation: Several parts of the bridged concepts are developed to a higher level of abstraction.</td>
</tr>
<tr>
<td>Complex Explanation: A few parts of the bridged concepts are developed to a higher level of abstraction.</td>
</tr>
<tr>
<td>Complex Explanation: Abstraction has not been attempted.</td>
</tr>
</tbody>
</table>
# Interdisciplinary rubric

<table>
<thead>
<tr>
<th>Pragmatic Solution:</th>
<th>Proficient (4)</th>
<th>Acceptable (3)</th>
<th>Developing (2)</th>
<th>Deficient (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A practical problem is solved by the inclusion of all disciplinary perspectives</td>
<td>The pragmatic solution plan is interdisciplinary and includes all processes of 6σ: define, measure, analyze, improve, and control</td>
<td>The pragmatic solution plan is interdisciplinary includes at least 4 of the processes of 6σ: define, measure, analyze, improve, and control</td>
<td>The pragmatic solution plan only includes only 2 out or fields or only 3 of the processes of 6σ: define, measure, analyze, improve, and control</td>
<td>The problem was not solved in an interdisciplinary manner or did not include 6σ processes.</td>
</tr>
</tbody>
</table>
Final exam (part)

- Stakeholder roleplay
  - Proposed Nestle® water bottling plant
  - Privatization of City of Detroit water treatment
  - Must stay in character
  - Must find short-term solution
  - Must find longer-term solution
  - Must vote
Student comments

“I think it’s important for different fields to come together and develop a solution to the increasingly urgent water crisis.”

“I am much more curious about water issues! I want to know more. I don’t like what I know and I want to help!”

“I didn’t realize how serious the water issue is in the US and globally. Hopefully more people take action to help slow down water depletion.”
Assessing interdisciplinary learning and student activism in a Water issues course

Anja Mueller¹*, Stephen J. Juris²*, Cathy Willermet³, Eron Drake⁴, Samik Upadhaya¹ and Pratik Chhetri¹
What we’ll talk about today

• How to:
  – Develop an interdisciplinary course
  – Assess an interdisciplinary course
  – Sustain an interdisciplinary course, and associated research
Sustainability

• Support from administrators
• Support from colleagues
• Support from students
Sustainability

• Support from administrators
  – Courses each have instructor, teaching in load
  – Teaching assistant is helpful for peer feedback
  – Give them credit and bragging rights
Sustainability

• Support from colleagues
  – Interdisciplinary research/teaching valued
  – Each field is valued as equally contributory
  – Choose your colleagues carefully
  – Educate your colleagues through collaboration
  – Respect and enforce your own boundaries
We want to avoid this...

http://xkcd.com/
Sustainability

• Support from students
  – Course counts towards student degrees
  – Enlist help from student organizations for ideas, activism: harness the expertise of students!
  – Grab all the attention you can get
My thanks to:

Dr. Joseph Heyman and the Center for InterAmerican and Border Studies

Dr. Bill Hargrove and the Center for Environmental Resource Management

Department of Sociology and Anthropology, UTEP

All my students and colleagues in the water course

All of you for your attention!
Questions?
Water as life, death, and power: Building an integrated interdisciplinary course combining perspectives from anthropology, biology, and chemistry (paper)
Water as life, death, and power: Building an integrated interdisciplinary course combining perspectives from anthropology, biology, and chemistry

Cathy Willermet¹, Anja Mueller², Stephen J. Juris³, Eron Drake⁴, Samik Upadhaya² and Pratik Chhetri²

Abstract: In response to a request from a campus student organization, faculty from three fields came together to develop and teach an integrated interdisciplinary course on water issues and social activism. This course, “Water as Life, Death, and Power”, brought together topics from the fields of anthropology, biology and chemistry to explore water rights, access to clean water, and water treatment methods. Students enrolled in the course developed interdisciplinary projects related to a variety of local and global water issues to present real-world solutions at a university-wide student research showcase. This article describes the process by which the faculty learning community designed the course as a truly integrated whole, and reflects on the challenges and rewards of teaching a course in this way.

Keywords: course design, instructional learning community, water issues, student activism.

We are not students of some subject matter, but students of problems. And problems may cut right across the borders of any subject matter or discipline. – Karl Popper (1963, p. 88)

I. Interdisciplinary Teaching is Central.

Most college courses deliver course content through a single disciplinary lens. Students taking courses such as chemistry, biology, or anthropology are introduced to each discipline’s perspectives: how do chemists, biologists, or anthropologist think about the world, and solve problems? In contrast, interdisciplinary learning encourages students to analyze complex problems from several perspectives, to place problems and solutions within a larger world context, to empathize with multiple stakeholders, and tolerate ambiguity and complexity (DeZure, 2010). Interdisciplinary thinking requires the integration of ideas from several fields or perspectives, including across scientific disciplines (Spelt, Biemans, Tobi, Luning & Mulder, 2009). Most real-world problems are fuzzy, with ill-defined boundaries, and the more students integrate several disciplines, the more successful they will be at finding solutions (Begg & Vaughan, 2011). This approach is considered essential to solving complex, large-scale problems such as global access to clean water, medicines, or food security, or other multifaceted societal issues (Barisonzi & Thorn, 2003; Eisen, Hall, Lee, & Zupko, 2009).

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² Department of Chemistry, Central Michigan University.
³ Department of Biology, Central Michigan University.
⁴ Faculty Center for Innovative Teaching, Central Michigan University.
A. The Call From UAEM Students at CMU.

Universities Allied for Essential Medicines (UAEM) is a coalition of undergraduate, graduate and professional-studies students at academic institutions worldwide dedicated to providing global access to affordable medicines. Central Michigan University (CMU) is a regional state university serving the surrounding rural areas in the central and northern counties of Michigan. CMU students formed a UAEM chapter in 2008. These students major in diverse fields such as health administration, public health, biomedical sciences, biochemistry, neuroscience, and psychology, but are linked by a common set of aims: 1) to encourage universities to insist on generic versions of drugs when patenting and licensing discoveries to pharmaceutical companies; 2) to encourage faculty research on neglected diseases; and 3) to educate and empower students on issues of global health inequities.

In April 2011, the CMU UAEM students organized a conference on global and local health disparities. Conference time included scheduled brainstorming sessions about how to further chapter goals. One of the ideas to emerge was to promote the development of interdisciplinary courses in global health. To educate their peers in global health inequities, the students argued, they first needed undergraduate courses that combined interdisciplinary teaching with solving real world problems, combining theory with activism. Three CMU UAEM faculty advisors took up the challenge to develop such a course: Stephen Juris (Biology); Anja Mueller (Chemistry); and Cathy Willermet (Anthropology). We designed this course to integrate all three disciplines around a complex problem, and encourage both interdisciplinary thinking and activism in our students.

B. Course Development.

We applied for and received modest funding from CMU’s Faculty Center for Innovative Teaching (FaCIT) to develop the interdisciplinary course “Water as Life, Death, and Power,” focusing on water issues, with the goal of inspiring activism, as part of FaCIT’s Faculty Learning Community program initiative. We wanted to intentionally integrate content and theoretical approaches from biology, chemistry, and anthropology to tackle issues of water use, water rights, and health into one course.

We proposed the following outcomes to FaCIT: (1) develop a Master Course Syllabus for an interdisciplinary undergraduate water class; (2) increase our experience with best practices in how to teach interdisciplinary courses; (3) develop interdisciplinary student group projects; and (4) plan an assessment strategy to measure change in interdisciplinary thinking and activism levels. FaCIT assigned one of the authors (Eron Drake) to our project as an instructional designer. We also partnered with several UAEM students (Samik Upadhaya and Pratik Chhetri) to help design and teach the course. Finally, we partnered with CMU Faculty Librarian, Shu Guo, to provide research support to students for the course. Thus, we created a unique instructional learning community consisting of faculty, staff, and students charged with developing, implementing, and assessing the interdisciplinary course on water. This faculty learning community (FLC) and student learning community (SLC) combined to help us develop and teach the course. Early preparation efforts included a review of collaborative learning best practices, review of interdisciplinary literature, and strategies to assess interdisciplinary learning.

We decided to split the course into two equal parts. The three-credit course was designed for four contact hours per week. Half of the course would consist of a lecture component, where
The faculty provided content focusing on the disciplinary issues relating to water. The other half would be a seminar component, where the UAEM students provided content focusing on activism and collaborative learning. In an appendix, we include the weekly outline to provide a daily list of course activities.

II. Teaching Methods.

A. Lecture component.

A difficulty in an interdisciplinary course is figuring out how three faculty from three disciplines will actually integrate their teaching. A common practice in team-taught courses is for each faculty to separately prepare lectures to be taught consecutively. This is a multidisciplinary approach, where disciplines are juxtaposed, but remain distinct. For a course to be interdisciplinary, the disciplines have to be integrated or blended (Klein, 2010). It is difficult to achieve an interdisciplinary synthesis for both the faculty and the students without a continuous modeling of the integration of fields. Indeed, language and socialization within disciplines can subtly shape teaching and learning (Woods, 2007). Therefore, we decided that all faculty would be present at all classes, and ideally teach in all class periods. This teaching model is more difficult and time consuming, but ultimately more effective in achieving interdisciplinary understanding (Krometis, Clark, Gonzalez, & Leslie, 2011).

We identified two major objectives of the course: 1) developing interdisciplinary thinking rather than focusing specifically on content; and 2) encouraging students to engage in actively solving current, real-world problems in an interdisciplinary way. Since the faculty had expertise in different aspects connected to water, we initially developed a course outline focusing on water issues. Each FLC faculty member contributed important water-related content within his or her specific disciplines. For example, over the course of the semester we wanted to discuss topics such as stratification and power relationships that develop due to differential access to water (anthropology), pathogen emergence and passage through water (biology), the chemical properties of water (chemistry), and different water treatment methods (all three fields). To tie the topics together, we focused on cholera, a water-borne pathogen with widespread effects on human populations.

The course outline reflected both the global focus of each week as well as contained details of important concepts that needed to be addressed in instructing this material. Concepts within the outline were ordered to reflect a logical flow: first, a historical perspective; second, an ecological connection of humans and pathogens; third, a discussion of the diseases associated with pathogens; finally, exploration of water sanitation methods and technologies. While all faculty developed their own material, we shared one integrated slide file per day, so we could step in and out of the lecture as appropriate. This ostensibly would ensure an interdisciplinary teaching experience and allow for open dialogue among the participants and faculty in the class. Furthermore, since the students also had a diverse set of backgrounds (anthropology, biology, chemistry) and were entering the course early in their academic career, development of the slides needed to account for the fact that some of the students in the classroom may not have ever been exposed to one or more of the disciplines or may have been exposed several years prior at a rudimentary level.

Another key element to making the interdisciplinary connections was the interactive lecture model we employed. While we utilized standard presentation software, we also integrated
questions, discussions, free writes, videos, and case studies into the class period. Connections could be more easily made, then, between content and disciplines. For example, during a discussion about how humans and pathogens interact (content), we discussed food production activities that impact water and human settlement patterns, and how that can increase certain chemicals and pathogens that humans encounter as a result. All three faculty were to talk, with active student participation, towards the goal of an interactive extended discussion.

As the outline was developed and refined, it became evident quickly that the amount of content reflected in each discipline could easily fill up a course in each one of the disciplines being covered, and that the focus should be more on connection of the material among the disciplines and less on content delivery alone. It also became apparent that the three faculty members would need to be involved in explicitly highlighting these connections throughout the course. In order to prevent saturating the course with content during each lecture period, we defined a succinct “point of the day” for each lecture period to ensure that the main point was not lost in the details of the content within the three disciplines.

“Point of the Day.” Development of the “point of the day” proved to be not only useful for delivery of the course material in a focused manner, but also aided development of the course. The “point of the day” came from the notion of essential questions, and enduring understandings, utilizing “backward design” instructional design considerations (Wiggins & McTighe, 1998). These were written in a question format. Since each faculty member brought a different expertise, and since the content needed to be connected in order to deliver a truly interdisciplinary course, the “point of the day” aided in determining which content was the true focus of the course for that day. It also aided in identifying discussion items and group work that could be presented to students in the course at the appropriate time. Finally, the “point of the day” aided in our development of slides – each faculty member had to connect the slide content to the overall point of the day. The first slide of each class was the “point of the day,” so students knew the point as well; examples include: “What are the properties of water that make it essential for life?” “How do humans and pathogens interact?” and “How can we make water cleaner?” We used the first “point of the day” to engage students in a meta-cognitive discussion of the course itself: “How are we teaching this course, and why are we teaching it this way?”

B. Active and Collaborative Learning Component.

Seminar. One key component of the course focused on the empowerment of students to become actively involved in projects centered on water issues. This component focused on students working together to research issues and develop grass-root campaigns with the goal of improving a water-issue outcome. The seminar devoted time to ideas and concepts centered on education and advocacy of global issues, and interdisciplinary group work. Guest speakers included representatives from non-profit organizations such as Take Back the Tap and the Thirst Project; librarian Shu Guo (interdisciplinary research strategies) as well as CMU professors from the disciplines of anthropology (water issues in Peru); biology (fecal bacteria in the Great Lakes); geochemistry (water collection tanks in Belize); humanitarian logistics (water treatment and education); and sociology (unequal access to water among U.S. stakeholders). UAEM graduate students and advanced undergraduate students were involved in the development of the seminar component outline. They worked closely with the faculty members to integrate the seminar and lecture material. This ensured that the two components were not separate entities but rather
integrated the overall goals of the course. While students ran the seminar, the faculty were present as well.

**Collaborative student projects.** Collaborative learning refers to learning activities expressly designed for and carried out through pairs or small interactive groups (Barkley, Cross, & Major, 2005). Based on a review of over 90 years of research, strategies that involve the instructional use of small groups improve learning outcomes relative to individual work across the board (Johnson, Johnson, & Smith, 1998). In particular, these small group instructional strategies lead to higher student achievement, higher-level reasoning skills, more frequent generation of ideas and solutions, and provide for greater transfer and retention of learning concepts. As the goals of this course were to increase interdisciplinary learning and increase activism, we felt strongly that working in groups was essential to model collaborative efforts to solve big problems. For the purposes of this project, we relied on techniques developed by Barkley, Cross, and Major (2005), who developed their techniques from the literature on both cooperative and collaborative learning.

We organized the course around a semester-long interdisciplinary project. We allowed for some choice but mostly formed groups with as many different disciplines as possible. All groups first had to decide on a group contract to set up group rules and solve inter-personal problems. Groups had to identify a project related to water, and collectively work towards a solution. The project was parsed into several pieces: a group contract, problem statement, solution concept map, elevator pitch, and abstract. The teaching team guided projects, and provided periodic in-class feedback meetings in response to progress reports. The final project was presented at a campus-wide poster presentation. This event, the Student Research and Creative Endeavors Exhibition (SRCEE), showcases student research to the entire campus community, and their abstracts are printed in a formal program. The exhibition provided a platform to not only allow for a measureable outcome of the course, but also served for students to be able to promote their advocacy issues among the CMU community.

### III. Teaching the course.

The course was offered in the Spring 2013 semester, with no required prerequisites. Twenty-nine students registered and completed the course. Of these 29 students, 12 were male and 17 were female. Students registered for the course under one of three course designators: 15 students registered under the anthropology designator, 13 students registered under the biology designator, and one registered under the chemistry designator. Students represented a broad range of majors: Anthropology, Biology, Biomedical Sciences, Broadcasting, Chemistry, Geography/Environmental Policy, Geology, History, Journalism, Music, Political Science, and Psychology.

**A. First days.**

In the beginning, many of us were anxious about the process of teaching in multiple disciplines simultaneously: how were we going to mix and re-mix disciplines in a single class period? Our strategy: during lecture periods, we all stood in front of the room at all times. By sharing the stage, so to speak, none of us were in charge. In that way, we were each out of our comfort zones. We checked and rechecked with each other about who was taking over when. We were
concerned that stepping in with a question or comment would be awkward or uncomfortable. This turned out to be an unnecessary worry. Our planning time as a learning community had fostered the essential trust needed for the smooth classroom experience.

Early on it became clear that it would be difficult to develop the course without a structure that helped keep us all on track, so each of us were responsible for specific tasks. The “point of the day” organization focused the lectures and smoothed the process of preparing truly interdisciplinary lectures. We needed weekly collaborative meetings to organize the lectures and seminars. One of us kept weekly meeting minutes, recording our decisions as well as our upcoming deadlines. Another of us amended the upcoming course calendar as it changed in response to student needs and guest lecture schedule changes. A third made sure the final draft of the slides were available on Blackboard as well as in the classroom on the right day. The seminar instructors (Upadhaya and Chhetri) made sure that we didn’t forget upcoming student deadlines, suggested content and advocacy material, and graded student work in a timely manner. We all were concerned about how much time this planning and teaching this course would take. Two of the faculty were teaching this course in addition to their regular teaching loads. Our service and research obligations were not reduced to accommodate this course.

As the course was unusual in format – lectures and discussions, some short reading assignments, and group research – some of the students early on made little effort at preparing for class. For example, written reflection prompts were assigned to course readings; students did not write very substantive answers to the first reading reflection. The initial concept maps groups prepared for their project showed little serious effort at project planning, perhaps because they were unfamiliar with the concept map format. Early on, a couple of groups had some interpersonal challenges, or difficulty in identifying an appropriate project.

B. Mid-semester.

While all of our teaching styles were different, we had relaxed into a routine whereby we could switch disciplines smoothly. A certain rhythm, humor, and sense of serendipity prevailed. One reflective example of smoothness achieved in the course was seen as we were discussing epidemics of disease. As all three faculty were engaged in lecture, we were able to discuss the biology of transmission and cause of different diseases, while seamlessly integrating anthropological and chemical connections to these same disease epidemics. Links between guest speakers and course content were complementary in unexpected ways. For example, guests from Take Back the Tap introduced problems with the Nestle Corporation’s water bottling activities in Michigan, which we were able to reference for the final exam case study; one guest speaker from a science field unexpectedly referenced material from earlier speakers regarding business’ six sigma methodology and Paul Farmer’s activism, highlighting the interdisciplinary nature of water issues.

We were doing some of the planning and scheduling for student group work deadlines as we went. This time investment, we hope, will be less burdensome the second time around. The weekly meetings were essential to keep us on track, to discuss student projects, group progress and concerns.

Another concern that surfaced mid-semester was the uncertainty about what the students were actually learning. We were all still very interested in trying to get students to think and comprehend in an interdisciplinary approach. No one expressed concern that “his” or “her” discipline was being short-changed or neglected. However, because we focused the students on
applying the material in lecture, where possible, to their group project, no midterm examinations or content quizzes were administered. We planned the final examination assessment, concerning lecture and seminar content, as a group competition. The concern was that, in focusing on the interdisciplinary aspects of water rights and treatment issues, not enough deep learning in any of the fields would be retained. Or, alternatively, we were presenting disciplinary material in too complicated a way that privileged some students over others. We were hoping that our methods were, in fact, effective. At this stage, we were keeping our fingers crossed.

The students' written responses showed improvement in terms of both length and content as the semester progressed. For instance, when assigned a reading towards the end of the semester regarding the outbreak of cholera in Haiti and the failure of the United Nations to take adequate responsibility for the outbreak, the responses from students showed genuine frustration and outrage. More importantly, students were able to provide critical analyses on both sides of the topic and suggest possible solutions to the crisis – an aspect generally lacking in previous written assignments. The written responses as well as in-class discussions indicated that the students were increasingly realizing the complexity of global issues and showed a healthy skepticism regarding the information being presented to them. As a result, some students refrained from drawing quick conclusions regarding the issues being discussed. An open ended prompt asked students to think about additional information they would like to have regarding the reading topic. In response, some students displayed enhanced critical thinking skills by demanding specific information and questions for the article’s author. The students seemed to get the general idea we are trying to convey – the issues related to water are complex, requiring several disciplines to measure, analyze, evaluate, and solve them.

We instituted progress reports and face-to-face feedback sessions to help keep students focused on their group projects. Eron Drake presented specific advice about how to present research in poster form, and how to develop a three-minute presentation about it, to help train for their SRCEE presentation. The campus newspaper ran a story on our course in mid-semester, focusing on its unusual format and interdisciplinary projects (Harrison, 2013). This positive press was very gratifying, and the course increasingly received attention from faculty and departments all over campus, and during SRCEE.

C. End of semester.

The students worked hard on their group projects (for the most part), but we needed to insist on regular updates and provide feedback to keep them on track. As a late decision, we used some of the seminar meeting times for this, which allowed us to ensure that students were meeting goals that they needed to meet. At the end of the semester, the students’ progress in their group project was clearly evident. Their SRCEE presentations showed their passion for their projects, and even the groups that started slowly ended up with results they were proud of. Student groups proposed the following:

- Development of a time-release version of an existing anti-worming drug for schistosomiasis in Uganda, along with educational call-and-response children’s song on how to avoid getting sick;
- A plastic water bottle deposit campaign to promote recycling and tap water usage;
- Installation of composting toilets at CMU to reduce water consumption;
- Community education on hydrologic fracturing to understand water contamination;
• Modification of city green-lawn ordinances to reduce local water contamination through chemical runoff;
• Analysis of strategies to connect Iowa farmers to government programs to promote bioswale buffer zones along the Mississippi River, to reduce downriver dead zones;
• Proposal to Mayoral Office in Copacabana, Bolivia to design totora reed beds that clean wastewater before it enters Lake Titicaca;
• Water disinfection techniques using solar UV radiation (SODIS) in plastic bottles in Uganda.

Some of the groups indicated that they would continue their activism beyond the end of the class. In fact, one group presented their project at a university-wide roundtable meeting on multidisciplinary education and research in global health in May 2013. Here we could see the growth of the students and what they could do when working together. Faculty member Steve Juris notes that

I have to say that was one of my proudest moments as an instructor – it’s easy to see success on exams and that students can learn and understand the material, but to see it applied in such a way and to see the students truly committed to their work is something instructors rarely get to see – I feel blessed that I was able to witness that growth firsthand.

The final exam was a mixed success. The final exam was a combination of an objective portion and a jigsaw-style hypothetical case study portion. For the case study, students were given one of eight stakeholder roles with associated facts known to that stakeholder. The students had to learn their stakeholder information, and then negotiate with other stakeholders for mutually satisfying short-term and long-term solutions for a fictional water crisis. The solutions had to be voted on by the group, and the reason for each vote had to be explained. It was evident in the process that for each proposed solution, all stakeholders were respected and taken into account, further demonstrating that the students understood that these issues are complicated and diverse, requiring a lot of disciplines to solve. All groups proposed short- and long-term solutions that all stakeholders could support (with one abstention for one group). Also, all long-term solutions weighed ecological, economic, and societal factors. This felt like a victory. Results from multiple-choice portion of the exam indicated that we may have been less effective in presenting the content itself. Students had not internalized that their learning of the content material would also be assessed in an objective way, and in-class comments prior to and after the exam indicated that they had not adequately reviewed the slide content. In subsequent offerings, we will need to be clearer in explaining that content is also important for their success in the class. A few additional assignments explicitly applying lecture content would bring that point home.

IV. Reflections on the process.

A. Faculty.

Overall, the course was a success in meeting the goals of increasing student awareness of interdisciplinary approaches through group work. We all did our very best to try and distill from our fields the relevant information without bogging down in details. However, we each were aware that we were only skimming the surface (to use a water metaphor), and each of us could teach a separate course with more depth. That tension existed internally within us individually,
but not externally to the group; there was no intragroup conflict about adding/removing content. Rather, we showed respect for each other’s disciplines and unique knowledge both at meetings and in the classroom (although some playful teasing prevailed). Without this team rapport, things would have gone much less smoothly.

The FLC was crucial for course development. This team rapport was not accidental; we developed it through the FLC/SLC course development process. Through the development process, we were able to tackle the problem of interdisciplinary assessment. Only then did we work out the content of the class itself. Using the “point of the day,” the lectures became focused; it was much easier to prepare truly interdisciplinary lectures where all disciplines were connected by a single point.

B. UAEM students/seminar instructors.

The UAEM student participants were pleased to see this course come to fruition. If not unique, the course was certainly unusual in being an inter-college interdisciplinary course. They were very optimistic that this course would set a precedent for other similar courses to be developed at CMU. Seminar instructor Samik Upadhaya remarked, “Perhaps for the first time, we, as students, were able to provide input to a course from the very early stages of planning.” They noted that most of the enrolled students seemed to value the importance of this course and the wealth of knowledge they gained at water issues from three separate disciplines. Third, they felt that the incorporation of an activism component in the course helped to develop leadership skills and group work ethics among the participant students. Students had complete ownership of the projects, which seemed to instill a sense of responsibility and togetherness in the groups. Through peer instructor mentoring, some of the groups really made significant leaps in their projects, which was really encouraging for the UAEM seminar instructors to observe. Teaching a course where multiple disciplines were integrated together to present a ‘bigger’ picture of water issues gave a unique learning opportunity to the UAEM students.

C. Enrolled students.

Students were asked to complete anonymous feedback forms with Likert-scale and open-ended feedback options. Responses indicated that the felt that the course was successful, although many students wished for greater organization or a different balance between disciplines. Anonymous student comments included:

*I think it’s important for different fields to come together and develop a solution to the increasingly urgent water crisis.*

*I am much more curious about water issues! I want to know more. I don’t like what I know and I want to help!*

*I didn’t realize how serious the water issue is in the US and globally. Hopefully more people take action to help slow down water depletion.*

*I appreciate this class taking the time and effort to tackle water issues from a dynamic perspective. Thank you.*
It is troubling that the cost of even dirty water is so high in some areas, and until everyone has access to clean, affordable water global equality will not be possible.

This course should be included as a capstone to the environmental policy major!

Students also commented on the engaging structure of the course. One student suggested a jigsaw-style approach to subject matter:

*Maybe if we split up and were taught each subject thoroughly and then combined in groups based on BIO, CHM, and ANTHRO...*

**D. FaCIT.**

FaCIT’s goal for the FLC program was to encourage formation of cross-disciplinary groups who would engage in an active, collaborative, yearlong program focused on enhancing teaching and learning. From that perspective, this FLC had very ambitious goals and, yet, was able to make great strides and significant accomplishments because of their leadership at CMU, and their commitment to each other, the UAEM students, and the goals of the FLC. By the end of the Spring 2012 semester, the FLC had developed a new master course syllabus, which was cross-listed by three departments and integrated a seminar that would be team-taught with UAEM graduate students. In addition, they presented the development of this course at two conferences and proceeded to begin work on an undergraduate multidisciplinary certificate program in social justice in global health. Finally, because of FaCIT’s involvement in this FLC initiative, Eron Drake has been able to recommend the course framework, team-based learning activities, and major course projects to other faculty interested in interdisciplinary work and enhanced student understandings.

**V. Institutionalizing the Course (the Master Course Syllabus).**

At CMU, all courses must maintain a Master Course Syllabus (MCS), which is written by faculty and must be approved through the curricular process at the department, college, and university levels. The MCS contains a description of the course, required prerequisites, goals and objectives, a bibliography, and a suggested outline, course materials, and evaluation methods. Faculty have discretion to change instructional and evaluative methodologies but may not substantially alter the scope of material covered, or the goals and objectives. Master course syllabi are used to evaluate whether a particular course will be included in the University Program, which is part of a student’s general undergraduate education requirements. Therefore, for this new course to be institutionalized, we had to develop an MCS and apply for its inclusion for general education credit.

This process was not as easy as it may appear. A major obstacle to this method of collaborative teaching is the disciplinary, silo-based structure of the university itself. While interdisciplinary education is often touted as a best practice in education (e.g., Chettiparamb, 2007; Huber & Hutchings, 2005), the institutional organization of universities often raises barriers to interdisciplinary teaching. A university is usually organized by grouping disciplines into colleges. A complex curricular process exists that affects course and program development at the department, college, and university-wide level. Some departments may have difficulty
accepting courses containing content from other fields under their designator, and this can have a dampening effect on interdisciplinary course development.

We conceived of this course as interdisciplinary from the ground up. Three disciplinary fields were involved (Anthropology, Biology, and Chemistry), which were housed in three different departments in two colleges. CMU does not have an “interdisciplinary education” course designator. At CMU, the general education requirements are called the “University Program.” Until recently, the University Program requirements for undergraduates included an integrative and multidisciplinary studies section; all students were required to take one course in this area. However, despite persistent calls for increasing interdisciplinary education in higher education as an effective practice (e.g., Huber, 2002; Klein, 1990; Scott, 2002, Sá, 2008), in 2011 CMU removed this requirement completely from the University Program, effective 2014. Any new course that is designed as interdisciplinary must fit another category, such as Global Studies or Descriptive Sciences. This meant that, despite the fact that there was only one course taught by three instructors, the three departments would need to offer separate courses that would be cross-listed across disciplines. A student would need to choose to register for the course under the anthropology (ANT 250) biology (BIO 250), or chemistry (CHM 250) course designator. However, for cross-listing to be allowed, the departments and colleges would have to approve the identical syllabus with three course designators.

The FLC team carefully wrote the MCS to incorporate course goals and essential content from anthropology, biology, and chemistry perspectives in as equal proportions as possible. We asked each department to consider the course at the 200-level, and apply it as student credit for the major. We chose this level (instead of a 100-level survey course) because, although students may not have coursework experience with each of the three fields yet, the level of critical thinking we were envisioning was more sophisticated than that usually expected in a 100-level survey course. All three departments ultimately approved the same syllabus (although each had revisions that had to be then incorporated by the other departments), but only one department allowed it to count for credit toward the disciplinary major. The two colleges then took up the courses with the shepherding assistance of the two colleges’ Assistant Deans in charge of curriculum. The course was approved in Spring 2013; however, since the curricular process was still ongoing at the beginning of the semester, we offered this course as a cross-listed special topics course in each of the three departments.

Another institutional barrier to interdisciplinary courses involves faculty compensation. Interdisciplinary courses take more time to prepare and teach; yet that is not reflected in teaching load or compensation. Under a collaborative teaching model, three faculty are doing the work for three credit hours, instead of just one, making it more expensive in a budget. Cost sharing can be even more problematic when it spans academic departments or colleges; each department and college has its own set of goals and pressures, which must be taken into consideration. For this course, the funding solution was to split the course cost equally amongst the departments, and count only one credit hour of work for each faculty member instead of the three actually performed. Two of us taught this course over our regular teaching load of three courses per semester. Teaching this course regularly outside of load will be difficult to sustain, as it increases faculty teaching load without a commensurate increase in compensation or reduction in other teaching, research, or service duties. We decided to teach collaboratively despite the structural funding challenges because we felt strongly that a diverse expertise was beneficial to our students as well as to ourselves. We will continue to work with administration to find a sustainable solution that is fiscally sounds and equitable across both colleges and all three
departments. Successful course outcomes for faculty and students can help encourage administrators to address these challenges.

VI. Future Steps.

We plan to teach Water as Life, Death, and Power every fourth semester. Since the course has been taught once, we have completed the essential work to prepare content and structure. We know and trust each other’s teaching styles, and have a familiarity with how to work together effectively both in and out of the classroom. We have worked out details about student deadlines, grade weighting, and writing assignments, and we fully expect a smoother ride next time. We will continue to explore active and collaborative activities that engage all students.

In retrospect, our approach to the course on water and activism dovetails with that of Rittel and Webber’s (1974) notion of “wicked” problems: a class of problems arising from extreme degrees of uncertainty, risk, and social complexity. A wicked problem is one in which both the problem and solutions are not known. Examples of wicked problems include obesity, aging, global poverty, global diseases, cancer, campus violence, natural disasters, racial genocide, etc.

Water resources policy problems are wicked then because they challenge us to confront water policy problems on four fronts simultaneously: (1) we must transcend our disciplinary camps and face the uncertainties that ride with combining our sciences; (2) we must integrate two types of knowledge (i.e., our scientifically processed traditions of knowledge must be adapted to site-specific circumstance with the assistance of people who know important, but different things than scientists know); (3) water resource issues simultaneously affect conflicting stakeholders and biotic complexity across multiple levels; and (4) individual rationality of particular actors must be constrained by local organizations in ways that empower people to provide themselves and wider society with sustainable common property regimes that can manage the interdependence of people, water, and biota in resource acquisition, allocation, and maintenance. All of this requires effective local organizations that can provide the social and organizational capacity for work that cannot be accomplished by individual citizens as resource appropriators or environmentalists, by central bureaucratic managers, or by scientists. (Freeman, 2000, p. 487)

For our students (and future policymakers) to be empowered to effect change, they must learn to collaborate across disciplines, since, as Freeman (2000) suggests, “our educated capacity in one discipline (or more realistically in one sub-discipline) tends to be associated with trained incapacity in other fields of relevant knowledge” (p. 484). Interdisciplinary courses focused on “wicked” problems are one way to help students, and all of us, succeed.

Acknowledgements

We wish to thank each of the department chairs, who supported our efforts in developing this course: Stephen Roberts (Biology), David Ash (Chemistry), and Katherine Rosier (Sociology, Anthropology, and Social Work), as well as Dean Pamela Gates (College of Humanities and Social and Behavioral Sciences) and Dean Ian Davison (College of Science and Technology). We wish to acknowledge the hard work and countless hours that the UAEM students have gifted to this course development. CMU’s Faculty Center for Innovative Teaching (FaCIT) supported
this project with staff, funds, instructional support, and moral support. Shu Guo, Faculty Librarian, provided essential instruction and research materials. Thank you to our guest speakers for the course: Elizabeth Alm, Sergio Chavez, Keith Helferich, Amber Kenneson, Deric Learman, Caitlin Richards, and Mariah Urueta. Thanks also to Malcolm Fox and Pat Southworth from the Mount Pleasant Water Treatment Facility for giving our class a tour. We extend our special thanks to all the students enrolled in the course, without whom this experiment would not have been possible.
### Appendix. Weekly Outline of Activities, Water Course.

<table>
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<tr>
<th>Point of the Day</th>
<th>Lecture</th>
<th>Seminar</th>
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<tr>
<td><strong>Week 1</strong></td>
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| Intro to course  | - Syllabus review  
|                  | - IRB consent forms  
|                  | - Pre-test administration  
|                  | - Show water video | - Video showcasing student leadership, student power, and development of grassroots movements |
| How are we teaching this course, and why are we teaching it this way? | - Definitions of disciplines (what are ANT, BIO, CHM perspectives?)  
|                  | - What is interdisciplinary thinking? | - Guest speaker on how to work effectively in groups  
|                  | | - Form groups |
| **Week 2**       |         |         |
| Where is water, and how accessible is it? | - Water cycle  
| | - Water reservoirs  
| | - Brainstorming: what are important things to talk about in context of water? How do humans use water? | - Discussion of group project  
| | | - Discuss seminar readings and reflection sheet  
| | | - Introduction to NGOs  
| | | - Guest speaker on Six Sigma |
| What do we use water for, and what factors affect its use and availability? | - What factors affect water use?  
| | - Biotic/abiotic factors affecting water | - Guest speaker from the Thirst Project |
| **Week 3**       |         |         |
| What are the properties of water that make it essential for life? | - Properties of water  
| | - Challenges bacterial pathogens face in water  
| | - Water chemistry | - EWB’s Failure Report video  
| | | - TED talk, David Damberger  
| | | - Guest speaker on cultural complexities in providing assistance  
| | | - Group Contract due |
| How do humans impact water quality and availability? | - Human impact on water availability and quality | - Group discussion on working to help in a culturally sensitive way  
| | | - Reading reflection #1 due |
| **Week 4**       |         |         |
| | - Group work  
| | - Concept map due  
| | - Librarian Shu Guo presents on interdisciplinary research strategies | - Group work  
<p>| | | - Open library research time: five citations due by end of seminar period |</p>
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<th><strong>Lecture</strong></th>
<th><strong>Seminar</strong></th>
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<td><strong>Week 5</strong></td>
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| How do humans and pathogens interact? | - Human ecology/Human impact on ecology  
- Epidemiological transitions  
- Human behavior and habitat selection  
- Co-evolution of pathogens with human societies | - Group work on project statement, elevator pitch  
- Revised group contract due |
| **Week 6**          |             |             |
| How do bacteria make people sick? | - Human-bacteria interface  
- Mechanisms of bacterial infection  
- Pathogenesis of bacteria in humans  
- Prevalence/examples of bacteria in water | - Elevator pitch presentation by group |
| How can pathogens affect human populations? | - History of cholera  
- Past epidemics  
- Emergence of pandemic serotypes (El Tor and Classical)  
- Cholera ecology and connection to human ecology | - Understanding region-specific problems  
- Group discussion on how to evaluate the intensity and sensitivity of an issue (local vs. global)  
- Guest speaker on developing sustainable logistical pathways |
| **Week 7**          |             |             |
| How do diseases spread? | - Epidemiology and spread of diseases  
- Spread of disease in population (kinetics of biology)  
- Kinetics of transport in the body (bacteria and drug)  
- Factors affecting bacterial infection  
- Cholera epidemiology | - Multidisciplinary approaches to addressing water borne diseases (biomedical research, socio-cultural interventions, etc.)  
- Reading reflection #2 due |
| What are epidemics, and what causes them? | - Epidemic vs. pandemic  
- Cultural/historical factors impacting development/spread of epidemics  
- Bacterial evolution  
- Connection between mode of transmission and human behavior | - Guest speaker on beach pathogen research  
- SRCEE abstract due |
| Week 8 | How do pathogens live in water, and how can we fight them? | - Bacteria-water interface  
- Cholera-human interface  
- Factors affecting bacterial survival in water  
- Bacterial/aquatic life interface, connection and impact on human health | - Teaching team meets with groups  
- SRCEE abstract revision |
|--------|-------------------------------------------------------------|------------------------------------------------------------------|
| Week 9 | Everything you ever wanted to know about cholera and your intestines | - Human activities that impact contraction/spread of cholera  
- Biochemistry of cholera  
- Cholera lifecycle, toxin action  
- Cholera virulence factors  
- Human gut biology | - NGO Case Study: Partners in Health and Cholera outbreak in Haiti  
- Guest speaker on building water storage/filtration systems in Belize  
- Group progress reports due |
| Week 10 | How is cholera treated? | - Comparison of cholera outbreaks in U.S., India, Haiti  
- Treatment and prevention  
- Indigenous approaches to disease prevention and treatment | - Guest speaker from Take Back The Tap on bottled water  
- Teaching team meets with groups  
- Group work |
| Week 11 | How can we make water cleaner? | - Municipal water treatment in global context  
- Cultural factors affecting development of water treatment  
- Overview of filtration, sedimentation, biological purification, and toxins | - Physical water treatment methods  
- Teaching team meets with groups  
- Group work  
- Guest speaker on poster preparation skills |
|        | How can we assess our success in different contexts? | - Physical water treatment methods  
- Impact of methods on local/regional populations  
- Locally sustainable methods | - Physical water treatment methods  
- Reading Reflection #3 due  
- Group progress reports due |
|        | How can bacteria treat water? | - Biological water treatment methods | - Group discussion on UN responsibility towards Haiti due to cholera outbreak  
- Reading Reflection #3 due  
- Group progress reports due |
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<th>Week</th>
<th>Point of the Day</th>
<th>Lecture</th>
<th>Seminar</th>
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<tr>
<td>Week 12</td>
<td>How can we assess our success in different contexts?</td>
<td>- Biological water treatment methods</td>
<td>- Teaching team meets with groups</td>
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<td>- Impact of methods on local/regional populations</td>
<td>- Group work</td>
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<td>- Locally sustainable methods</td>
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<td>- Field trip to water treatment plant</td>
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<td>Week 13</td>
<td>What are the power inequalities that can affect access to clean water?</td>
<td>- Structural inequalities to clean water access</td>
<td>- Teaching team meets with groups</td>
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<td>- United Nations statement on human rights to clean water</td>
<td>- Group work day</td>
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<td>- Inequalities in water supplies and contaminants</td>
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<td>Week 14</td>
<td>What are some examples of legal consequences—successes and failures?</td>
<td>- Potential legal consequences to unequal access to clean water</td>
<td>- Reading Reflection #5 due</td>
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<tr>
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<td></td>
<td>- Examples of contaminants in water systems</td>
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<td>What factors should be considered in developing new water treatment solutions?</td>
<td>- New water treatment solutions</td>
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<td>- Cultural factors affecting adoption of new technologies</td>
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<td>- Simple filtration and sterilization methods</td>
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<td>Week 15</td>
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<td>Final exam</td>
<td>Open discussions on what we have learned, what we can do</td>
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<td>Week 16</td>
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<td>Wrap-up</td>
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<td>- IRB consent forms</td>
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<td>- Post-test administration</td>
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Assessing interdisciplinary learning and student activism in a Water issues course (paper)
Assessing interdisciplinary learning and student activism in a Water issues course

Anja Mueller1*, Stephen J. Juris2*, Cathy Willermet3, Eron Drake4, Samik Upadhaya1 and Pratik Chhetri1

Abstract: In response to a request from a campus student organization, faculty from three fields came together to develop and teach an integrated interdisciplinary course on water issues and social activism. This course, “Water as Life, Death, and Power,” brought together issues from the fields of anthropology, biology and chemistry to explore water rights, access to clean water, and water treatment methods. Students enrolled in the course developed interdisciplinary projects related to a variety of local and global water issues to present real-world solutions at a university-wide student research showcase. This article reports the assessment outcomes of the course, measuring changes in both interdisciplinary learning and levels of student activism.

Keywords: Course design, interdisciplinary assessment, water issues, student activism.

Background

Universities Allied for Essential Medicines (UAEM) is a coalition of undergraduate, graduate and professional students at academic institutions worldwide dedicated to providing global access to affordable medicines. The student group at Central Michigan University (CMU) indicated that they are interested in undergraduate courses that combined interdisciplinary teaching with solving real-world problems, combining theory with activism. Three CMU UAEM faculty advisors took up the challenge to develop such a course: Stephen Juris (Biology); Anja Mueller (Chemistry); and Cathy Willermet (Anthropology). We decided to develop a course that would bridge all three disciplines around a complex problem and encourage both interdisciplinary thinking and activism in our students.

Interdisciplinary Teaching and Learning

The students requested an interdisciplinary course as a result of their involvement with UAEM, personal and professional interests, and because they understood that the complex problems their generation will have to solve would require people from different disciplines to work together and come up with a complex solution. In addition to the advantages of interdisciplinary learning identified by the students, researchers (e.g., Begg and Vaughan, 2011;
Barisonzi & Thorn, 2003; Eisen, Hall, Lee, & Zupko, 2009; Nissani, 1997) discuss the advantages of interdisciplinarity, which include the fact that often interesting research topics fall in-between fields, that interdisciplinarity may help with communication difficulties between disciplines, and that creativity and flexibility is enhanced by interdisciplinary knowledge.

To teach interdisciplinary subject matter, it is generally accepted that disciplinary grounding is required. That does not mean, though, that students have to be experts in the breadth of several disciplines, but rather that students understand concepts from several disciplines in depth so that they can use them together to develop something new (Mansilla & Duraisingh, 2007; DeZure, 2010). Faculty also do not have to be experts in a breadth of several disciplines, but in this context, need to be open to examining and encouraging exploration of diverse ways of thinking in multiple disciplines.

The students also asked to include activism into an interdisciplinary course on real-world problems, which, in our context for the course, translated into problem-solving processes. There is a large body of literature that supports problem-based learning as an effective teaching tool (e.g. Nilson, 2010; Prince, 2004). In fact, some colleges and universities are now offering interdisciplinary, problem-based undergraduate degrees (Sternberg, 2008). Thus, we decided to incorporate problem-based, interdisciplinary group work into our course as a tool to teach the students the basics of effective activism.

Interdisciplinary Course Development

We first had to decide how we would integrate the three disciplines. Universities usually teach separately in disciplines, resulting in students that are not exposed to interdisciplinary thinking. Therefore, we decided to model interdisciplinary thinking in the way we taught the lectures. The three faculty (Juris, Mueller, and Willermet) taught each lecture together and modeled interdisciplinary thinking by discussing each topic from all three points of views, then synthesizing the lecture, often in an interactive discussion with the students. (For specific details about course development, please see Willermet et al., 2013).

Utilizing a “point-of-the-day” strategy, we developed the lecture content and facilitated the lectures. This “point-of-the-day” strategy served to focus content on only the necessary facts and helped to scaffold content information into a continuous, interrelated story that aligned with the student learning objectives instead of a collection of facts. Also, by developing the content together as well as teaching it together, we were able to look at each concept that we had agreed on as important from all disciplinary viewpoints and discuss the integration in class, modeling it for the students as they were learning the concepts. Thus, we taught them how to integrate knowledge in an interdisciplinary manner (Haynes, n.d.). In brief, as one example, when we talked about how humans impact water quality and availability, we discussed the nitrogen cycle and fertilizer as a water pollutant (Chemistry), algae blooms (Biology), and aquifer depletion as an effect of human water use that affects water access (Anthropology). We asked the students what additional effects humans could have on water access and quality, eventually adding to the discussion additional examples we had prepared in advance.

Equally important, we added a seminar portion to the class, which included group work and interdisciplinary problem solving, allowing the students to practice working in a group and implementing and integrating interdisciplinary understanding to develop an activism strategy.
Interdisciplinary Course Goals and Objectives

Student learning outcomes (SLO) are sometimes challenging to assess effectively in an interdisciplinary freshmen course; for students to gain truly interdisciplinary understanding to a point that they can apply it to solve an interdisciplinary problem in a group setting, they have to first gain several skills, such as working in a group, and then synthesize and combine information from different disciplines. Since this class is designed for freshmen/sophomores, it has to be assumed that these skills need to be taught during the class as well. Thus, assignments and grading rubrics needed to consider how students will demonstrate their attainment of the SLOs related to interdisciplinary understanding in not only the final product, but the various steps that lead to this outcome.

In addition to the SLO focused on water issues, we identified two additional overarching goals for the course: 1) developing interdisciplinary thinking rather than focusing specifically on content; and 2) encouraging students to engage in actively solving current, real-world problems in an interdisciplinary way. (See the Master Course Syllabus, Appendix 1). We considered collaborative learning to be an essential goal to allow students to see how real-world complex problems can be solved in real-life.

We hypothesized that: 1) students would increase their knowledge about water and water-related issues, such as water chemistry, water-borne pathogens, and global access to clean water; 2) students would increase their desired level of social activism; and 3) students would increase their interdisciplinary thinking. These hypotheses guided our assessment efforts, as described below.

Research Design and Methods

Our research design included two separate assessment strategies: a pre-post survey to address hypotheses one and two, and an interdisciplinary project to address hypothesis three.

We obtained Internal Review Board (IRB) approval (CMU 377609-2) to collect student data assessing whether students increased their competency in interdisciplinary thinking, as well as increased their knowledge of activism and human rights. The Internal Review Board approval extended to administration of a pre- and post-course survey and application of a rubric to specific group-assigned course activities to assess interdisciplinary thinking. On the first day of class, we invited interested students to join us in a research study that would help assess how well they learned about water issues, their level of activism, and degree of interdisciplinary thinking. Students received a manila envelope that contained two copies of the consent form, a bubble-sheet response form, and two surveys, the research survey and a similar-looking alternate survey. If students wished to participate, they signed a consent form and completed the research survey; if not, they completed the alternate. Both surveys and bubble sheet were returned to the envelope. One author, Eron Drake, acted as the project’s “honest broker.” She assigned each student a randomly generated three-digit code and kept the key of student names and keys in a secure, locked location. The instructional team does not know which students participated in the study; students received the same number of points for completing either survey.

There were 29 students that registered and completed the course. Of the 29 students registered for the course that ultimately completed the course, 12 were male and 17 were female. These students registered for the course in one of three disciplines (anthropology, biology, and chemistry); 15 students registered under the anthropology designator, 13 students registered
under the biology designator, and 1 registered under the chemistry designator. Twenty-eight students completed the pre- and post-test associated with the research project.

Interdisciplinary thinking can be difficult to assess through objective means such as multiple-choice exams. Rather, interdisciplinary thinking can be better assessed through projects, essays, and discussion. To that end, we assigned a semester-long group project for which students chose a water-related problem and developed an interdisciplinary solution and a strategy for implementation. The proposed solution had to include perspectives from anthropology, biology, and chemistry. We decided to break up the interdisciplinary project development process into several steps; we needed to start groups out with a solid, disciplinary foundation for their project, before we could start them on the steps to integrate that information by bridging the concepts, integrating them into a complex discussion and finally into an interdisciplinary solution to the problem (Mansilla & Duraisingh, 2007). In this manner, the students could practice and improve their interdisciplinary understanding and implementation strategy.

We started with a group contract, to make sure that all students understood their role in the group and could solve problems within the groups more easily. One of the authors (Eron Drake) prepared the students for group work and group contract by presenting them with information about group formation, group roles, and group expectations, and giving them examples for group contracts. Students next completed a problem statement so that the groups had to decide early what exactly to work on. This problem statement needed to include how the three disciplines would be part of the solution. Students were also taught how to search for materials for their project in the library. The material was mostly disciplinary and part of the disciplinary grounding for the project.

Groups were then asked to complete a concept map to develop the connections between the different fields in relationship to their specific problem solution. Building this concept map allowed the students to bridge the different concepts into a first step towards interdisciplinary understanding. The next step was a short, persuasive pitch and an abstract to make sure the groups stayed focused and provide them a means to practice how to present their work. The final project was a poster presentation of their final complex solution strategy for a complex water problem at a campus-wide event. The final project included an interdisciplinary discussion of the problem, as well as the integrative solution the students came up with. At the same time students had to present and pitch their solution to the “general public” as any activist would have to do. We met with the groups at each stage to give them maximum feedback and opportunity for questions.

We were concerned that a heightened interest in assessing interdisciplinarity would bias us to see it more often than students were in fact presenting it. To reduce this bias, we employed a grading rubric for any assignments that required subjective assessment (see below and Appendix 2). The assessment of the group projects for interdisciplinary understanding was developed according to the steps in student learning (Mansilla & Duraisingh, 2007). The first step in this process is to have an effectively presented disciplinary argument (Disciplinary Grounding). To assess disciplinary grounding, we modified our assessment using the Universal Intellectual Standard developed by Drs. Paul and Elder from the Center for Critical Thinking (Elder & Paul, 2013). When we graded the interdisciplinary assignments, each faculty evaluated students for this section based on their discipline. We based the interdisciplinary part of the rubric on Mansilla and Duraisingh’s snapshots of interdisciplinary integration (Mansilla & Duraisingh, 2007). We used integrative summary, conceptual bridging, and complex explanation as the three consecutive steps of interdisciplinary understanding in our rubric.
The group project in this class asked specifically for a solution of a water-related problem. Therefore we needed an additional part for our rubric assessing the pragmatic solution the students proposed. We based the evaluation on Six Sigma, which was invented by a Motorola researcher and is used in industrial project evaluations (Motorola University, 1994). Our guest lecturer, Keith Helferich, presented the basis of Six Sigma to our students as several steps that have to be completed for a successful project: Define (plan), measure (do), analyze (review performance, identify opportunities, root causes, and effects), improve (prioritize actions to enhance performance), and control (implement and establish future assessment program). We wrote the solution assessment on these five steps. The full rubric can be found in Appendix 2.

As mentioned above, students would have to learn all of the steps outlined in the Interdisciplinary Assessment Rubric (Appendix 2) during the class, which takes careful planning and the allotment of time-on-task to enhance student learning. Instruction must be scaffolded to allow for students to develop and practice higher-level cognitive skills associated with interdisciplinary learning. Therefore, we decided to use the rubric in the evaluation of many of the project assignments, but we weighed the three parts (disciplinary grounding, interdisciplinary reasoning, and pragmatic solution) differently throughout the semester. We first weighed disciplinary grounding more heavily than interdisciplinary reasoning, next weighed them equally, and at the end weighed disciplinary grounding least and the pragmatic solution most. Using this redistribution of weighting, we accounted for the increasing interdisciplinary understanding throughout this course.

Two specific assignments provided an excellent opportunity to evaluate student gains in interdisciplinary thinking. The first was the concept map that each group drew at the beginning of their project, to describe how the disciplines would interact in their proposed research. The second was the final presentation that described their problem and proposed solution. We assessed the interdisciplinary understanding at these two stages of their group projects using our interdisciplinary rubric. All instructors of the course separately utilized this rubric to grade every assignment. We then averaged the grades over all instructors to finalize the assignment grade. When disciplinary grounding needed to be established, each of the instructors with expertise in the questioned disciplinary grounding provided guidance on grading criteria.

**Goal 1: Increased Knowledge of Water-Related Issues**

The student pre-post survey contained questions designed to measure overall student factual knowledge of water-related issues. Students were asked nine questions to assess their overall knowledge of water-related material. The source of the questions was the course textbook. We used the textbook mostly as a reference, with content provided from the lecture materials and supplemental readings. Therefore these questions were not a direct measure of specific fact retention.

To analyze whether factual answers improved over the semester, data were analyzed statistically in R (version 3.0.1) (R, 2013) using a generalized linear model with a binomial error distribution. Calculated probability values were deemed significant with \( a = 0.05 \) using a sequential Bonferroni adjustment for each question.
Goal 2: Increased Student Interest in Social Activism

The student pre-post survey also contained questions designed to measure a change in student familiarity with water-related issues and their interest in activism. This evaluation included questions about the student’s awareness of water issues, to assess the student’s personality, the student’s interest in volunteering within the university, and about the civic engagement and social awareness of the student.

These questions were posed on a five-point Likert scale. On questions with a Likert scale, increasing values might mean a decrease or increase of improvement, depending how the question was asked. For the statistical analysis, all Likert scales were adjusted so that increasing values meant improvement. Student responses were categorized into three different groups, students who agreed with a statement (i.e. answered 4 or 5 on the Likert scale), students who disagreed with a statement (i.e. answered 1 or 2 on the Likert scale), or students who were neutral about a statement (i.e. answered 3 on the Likert scale). Student responses were paired pre-post, and changes in student opinion in a positive (disagree/neutral stance pre-test to agree stance post-test) or negative (agree stance pre-test to disagree/neutral stance post-test) were analyzed using a McNemar’s test and calculating chi-squared. A p-value was obtained using one degree of freedom, and a value of $p < 0.05$ was interpreted as a significant change comparing pre- and post-test data.

Goal 3: Increased Interdisciplinary Thinking

To measure if the interdisciplinary reasoning of the students increased from an earlier assignment (concept map) to the final assignment (poster presentation), we compared student performance on the interdisciplinary sections of the rubric as applied to these two assignments (See Appendix 2). For each of the assignments, assigned points and weights differed due to the nature of the individual assignment. For example, points were given for staying within a 3-minute time limit for the persuasive pitch; the final presentation included a self- and peer-assessment. We needed to remove the effects of these points on the assignment grade, to isolate points related to interdisciplinary understanding and problem solving. To exclude the effect of all other rubric sections and other points that were included in the grade, it was assumed that the students obtained full points for everything but the interdisciplinary section of the rubric. These points were averaged across all groups. We then compared the remaining points assigned exclusively for interdisciplinary reasoning. This technique should, if anything, underestimate the students’ performance on interdisciplinary learning. Since the data were organized in this way, we did not perform a statistical analysis, but rather calculated the mean group performance on this measure between the two assignments.

Results and Discussion

The following discusses the results obtained in exploration of our hypotheses: 1) students would increase their knowledge about water and water-related issues, such as water chemistry, water-borne pathogens, and global access to clean water; 2) students would increase their desired level of social activism; and 3) students would increase their interdisciplinary thinking.
Goal 1: Increased Knowledge of Water-Related Issues

The data reported (Table 1) indicate that students gained a deeper overall knowledge of water-related material, although the overall increase is not significant and performance on three of the questions decreased. There was a statistically significant improvement on both the question connected to water required to make one calorie of food (21% increase in correct responses during post-test compared to the pre-test) and the question connected to which food type takes the most water to produce one kilogram of food (18% increase in correct responses during post-test compared to the pre-test). There was decline on questions related to water access, which saw a 7% decline in correct answers; however this decrease was not statistically significant.

Table 1

Student familiarity with material questions related to water (N=28)

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre-Test Correct Answer</th>
<th>Post-Test Correct Answer</th>
<th>% Change</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many people in the world do NOT have consistent access to drinking water?</td>
<td>17</td>
<td>15</td>
<td>-7%</td>
<td>0.31</td>
</tr>
<tr>
<td>How much water does it take to make one calorie of food?</td>
<td>7</td>
<td>13</td>
<td>21%</td>
<td>0.012*</td>
</tr>
<tr>
<td>How many calories of food per day are needed for an average 175-lb male to maintain his body’s basic metabolic functions at rest?</td>
<td>4</td>
<td>6</td>
<td>7%</td>
<td>0.15</td>
</tr>
<tr>
<td>How much water does it take to produce one calorie of energy?</td>
<td>7</td>
<td>6</td>
<td>-4%</td>
<td>0.59</td>
</tr>
<tr>
<td>What percentage of water withdrawals is used for agriculture?</td>
<td>4</td>
<td>8</td>
<td>14%</td>
<td>0.041</td>
</tr>
<tr>
<td>The biggest threat to our global water supply is:</td>
<td>10</td>
<td>11</td>
<td>4%</td>
<td>0.64</td>
</tr>
<tr>
<td>The ratio of people who don’t have water piped into their homes is:</td>
<td>18</td>
<td>16</td>
<td>-7%</td>
<td>0.37</td>
</tr>
<tr>
<td>In an average industrialized country, the average household uses what percentage of its water use to flush the toilet?</td>
<td>6</td>
<td>9</td>
<td>11%</td>
<td>0.10</td>
</tr>
<tr>
<td>Which food type takes the most water to produce one kilogram of food?</td>
<td>13</td>
<td>18</td>
<td>18%</td>
<td>0.015*</td>
</tr>
</tbody>
</table>

Note: * denotes significance at the p=0.05 level.

Goal 2: Increased Student Interest in Social Activism

The student pre-post survey contained questions designed to measure overall student interest in water-related issues and degree of student activism. Students were asked 48 questions to assess their agreement with statements connected to clean water access and degree of willingness to play a role in university and/or community activism. Questions were rated on a...
five-point Likert scale, for which one indicates “strong disagreement” and five indicates “strong agreement”. Students were pooled into one of two categories depending on their answers to the questions – 1) students who answered 1-3 for a question (i.e. disagreed/neutral with the question), and 2) students who answered 4 or 5 for a question (i.e. agreed with the question). The data reported (Table 2) represent percent changes in each of these two categories when comparing pre-test and post-test answers, where a negative change was scored when a student answered 4 or 5 on the pre-test and 1-3 on the post-test, and a positive change was scored when a student answered 1-3 on the pre-test and 4 or 5 on the post-test. Results indicate that students gained a deeper appreciation and understanding of water-related issues. Of note was a statistically significant greater agreement with statements concerning the potential for a water crisis in America (39.3% increase in students agreeing post-test) and a statistically significant stronger agreement on the negative impact of bottled water on the world’s water supply (35.7% increase in students agreeing post-test). Furthermore, there was a statistically significant stronger agreement in students when asked whether social problems directly affect the quality of life in their community (32.1% increase in students agreeing post-test).

Interestingly, data collected indicate that students changed their potential for civic engagement, and this change seemed to be a refocusing of student energy away from university organizations towards community involvement. There was a trend in students disagreeing with questions asking about plans to become involved in university organizations (although not statistically significant) with a concurrent increase in the importance of civic engagement issues. However, this may be an inadvertent artifact of the question text, which asks, “During this term, to what degree do you intend to…” As a pre-term question, it asks the student what he/she might do in the near future. However, as a post-term question, students might answer in the negative either as the term is over and they don’t intend to do it in the next few days, or since they know they didn’t in fact do it this term. The wording of this question might not capture student intent in the future.

Every question concerning civic engagement issues showed an increase in agreement with the statements posed, with ten showing statistically significant increases: participating in a community action program (17.9% positive increase post-test, p = 0.0253); helping promote racial understanding (25% positive increase post-test, p = 0.0082); influencing social values (25% positive increase post-test, p = 0.0082); finding a career that directly benefits others (25% positive increase post-test, p = 0.0082); giving some income to those in need (28.6% positive increase post-test, p = 0.0196); becoming a community leader (25% positive increase post-test, p = 0.0339); working toward equal opportunity for all people (17.9% positive increase post-test, p = 0.0253); viewing social issues from multiple perspectives (25% positive increase post-test, p = 0.0082); developing a meaningful philosophy of life (25% positive increase post-test, p = 0.0339); and developing leadership abilities in others (25% positive increase post-test, p = 0.0339). There were correlational increases in other questions including participating in programs to help clean up the environment (25% positive increase post-test), serving the community (17.9% positive increase post-test) and participation in voting (28.6% positive increase post-test), although these increases were not statistically significant. It is interesting to speculate that a shift from focus on involvement in student organizations to involvement in community organizations may be due to a redefined student view on the ability to affect change within the community more directly depending on the organization with which they are involved.
Table 2

Student Familiarity with Clean Water Issues and Willingness to Participate in Social Activism (N=28)

"Please rate the level to which you agree (or disagree) with each of the following statements about water issues." (1 = strongly disagree, 5 = strongly agree)

<table>
<thead>
<tr>
<th></th>
<th>% students with negative change</th>
<th>% students with positive change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to clean water is a problem all Americans face</td>
<td>10.7</td>
<td>17.9</td>
<td>0.4795</td>
</tr>
<tr>
<td>Access to clean water is something that only people in developing nations face</td>
<td>3.6</td>
<td>7.1</td>
<td>0.5637</td>
</tr>
<tr>
<td>We will face a water shortage in America in the next few decades</td>
<td>0</td>
<td>39.3</td>
<td>0.0009*</td>
</tr>
<tr>
<td>Irrigation systems are generally water wasters</td>
<td>10.7</td>
<td>21.4</td>
<td>0.3173</td>
</tr>
<tr>
<td>Drinking commercially bottled water contributes to global water shortages</td>
<td>7.1</td>
<td>35.7</td>
<td>0.0209*</td>
</tr>
<tr>
<td>We are losing lots of available water due to climate change</td>
<td>17.9</td>
<td>17.9</td>
<td>1</td>
</tr>
<tr>
<td>Cholera is a disease that people get when they don’t keep themselves clean</td>
<td>7.1</td>
<td>7.1</td>
<td>1</td>
</tr>
<tr>
<td>Participate in a student organization</td>
<td>10.7</td>
<td>3.6</td>
<td>0.3173</td>
</tr>
<tr>
<td>Hold a leadership position in a college/university student organization</td>
<td>7.1</td>
<td>7.1</td>
<td>1</td>
</tr>
<tr>
<td>Participate in class discussions</td>
<td>21.4</td>
<td>7.1</td>
<td>0.1573</td>
</tr>
<tr>
<td>Investigate current events topics of personal interest</td>
<td>17.9</td>
<td>10.7</td>
<td>0.4795</td>
</tr>
<tr>
<td>Volunteer my time to an organization or cause I care about</td>
<td>25</td>
<td>17.9</td>
<td>0.5637</td>
</tr>
<tr>
<td>I believe that every citizen has a responsibility to serve the community</td>
<td>21.4</td>
<td>10.7</td>
<td>0.3173</td>
</tr>
<tr>
<td>I am concerned about local community issues</td>
<td>14.3</td>
<td>17.9</td>
<td>0.7389</td>
</tr>
<tr>
<td>I am concerned with the rights and welfare of others</td>
<td>7.1</td>
<td>17.9</td>
<td>0.2568</td>
</tr>
<tr>
<td>I am interested in knowing and working with people from diverse backgrounds</td>
<td>14.3</td>
<td>7.1</td>
<td>0.4142</td>
</tr>
<tr>
<td>I believe that cultural diversity within a group makes the group more interesting and/or effective</td>
<td>0</td>
<td>10.7</td>
<td>0.0833</td>
</tr>
</tbody>
</table>
I feel that social problems directly affect the quality of life in my own community
I see myself as a member of a larger social fabric
I have a responsibility to serve my community
I feel that I can make a difference in my local community
I feel that I can make a difference in the world
I view myself as an active citizen
I am concerned about global community issues

<table>
<thead>
<tr>
<th>% students with negative change</th>
<th>% students with positive change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating in a community action program 0 17.9 0.0253*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helping others who are in difficulty 7.1 21.4 0.1573</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helping promote racial understanding 0 25 0.0082*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Becoming involved in programs to help clean up the environment 7.1 25 0.0956</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influencing social values 0 25 0.0082*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influencing the political structure 10.7 21.4 0.3173</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serving the community 3.6 17.9 0.1025</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finding a career that directly benefits others 0 25 0.0082*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giving some of my income to help those in need 3.6 28.6 0.0196*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Becoming a community leader 3.6 25 0.0339*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keeping up to date with political affairs 10.7 17.9 0.4795</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working toward equal opportunity for all people 0 17.9 0.0253*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viewing social issues from multiple perspectives 0 25 0.0082*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promoting social justice 7.1 21.4 0.1573</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developing a meaningful philosophy of life 3.6 25 0.0339*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developing leadership abilities in others 3.6 25 0.0339*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participating in civic duties such as voting 10.7 28.6 0.1317</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * denotes significance at the p=0.05 level.

The increased dedication of students becoming involved in a community issue was apparent based on the dedication students had of their group projects that they developed throughout the semester (connected to Goal 3 below). Several groups continued to seek outcomes of their projects after the semester had ended and had developed plans to further promote their project agenda through the formal submission of proposals or letters to their corresponding agencies/affected communities in order to affect change.
Goal 3: Increased Interdisciplinary Thinking

The students had free choice of which problem they wanted to solve as collaborative groups. The groups came up with a list of problems and solutions spanning issues at local, regional, and international levels:

- Development of a time-release version of an existing anti-worming drug for schistosomiasis in Uganda, along with educational call-and-response children’s song on how to avoid getting sick;
- A plastic water bottle deposit campaign to promote recycling and tap water usage;
- Installation of composting toilets at CMU to reduce water consumption;
- Community education on hydrologic fracturing to understand water contamination;
- Modification of city green-lawn ordinances to reduce local water contamination through chemical runoff;
- Analysis of strategies to connect Iowa farmers to government programs to promote bioswale buffer zones along the Mississippi River, to reduce downriver dead zones;
- Proposal to Mayoral Office in Copacabana, Bolivia to design totora reed beds that clean wastewater before it enters Lake Titicaca;
- Investigation of water disinfection techniques using solar UV radiation (SODIS) in plastic bottles in Uganda.

For the concept map, 32% of total points were available for interdisciplinary learning based on the rubric in Appendix 2. Students were graded on the concept maps based on development of their solution to a global problem and whether their solution contained the three disciplines associated with the course (anthropology, biology, chemistry) and was sustainable. For the final project, 45% of the points were assigned to interdisciplinary learning. The student groups’ performance improved from an average of 40.1% of the total available points for interdisciplinary learning on the concept map to 71.6% of the total available points for the final project. The standard deviation decreased between the two assignments, from 22% to 11.8%, which suggests that student groups as a whole performed more consistently on their final projects. All groups but one experienced a large improvement in performance on the interdisciplinary rubric; the remaining group (Group 5) was the highest performing group, doing very well on both assignments.

Discussion

Besides teaching anthropological, biological, and chemical facts about water, there were two overarching goals for the course that we assessed: 1) developing interdisciplinary thinking rather than focusing specifically on content; and 2) encouraging students to engage in actively solving current, real-world problems in an interdisciplinary way. Real world-problem solving often occurs in groups, combining different strengths and backgrounds. We wanted to mimic that; at the same time, benefiting the learning of diverse students in collaborative assignments and projects is also recognized as a high impact practice (Kuh, 2008). We encouraged the students to reach out to NGOs and other community groups in the process; this community connection, as well as the service rendered with the project, is considered a high-impact teaching process as well.
As discussed above, the fact-based questions might not have been an accurate measure for students’ content knowledge. Upon reflections, questions aligned with the content covered would better reflect content learning. The end-of-term Student Opinion Survey comments for each faculty did indicate that factual learning took place. Examples for the question “What are some specific things your instructor does that help you learn in this course?” are “Helped fill in knowledge for “non-chemists;” “Powerpoints – helped me learn Chemistry I had never understood before;” “There were always good examples and explanations on subjects covered for the Anthro portion of the class;” “Helped me understand biology that I had never learned before;” “For the non-bio student he explained things well so they were easy to understand.”

Table 3

Comparison of Student Group Means for Interdisciplinary Learning Portion of Group Projects, as Percentage of Total Interdisciplinary Learning Points Possible (N=8)

<table>
<thead>
<tr>
<th>Group</th>
<th>Concept Map*</th>
<th>Final Project**</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>20.8%</td>
<td>69.8%</td>
<td>48.9%</td>
</tr>
<tr>
<td>Group 2</td>
<td>50.0%</td>
<td>73.4%</td>
<td>23.4%</td>
</tr>
<tr>
<td>Group 3</td>
<td>4.2%</td>
<td>45.0%</td>
<td>40.8%</td>
</tr>
<tr>
<td>Group 4</td>
<td>37.5%</td>
<td>81.8%</td>
<td>44.3%</td>
</tr>
<tr>
<td>Group 5</td>
<td>79.2%</td>
<td>70.2%</td>
<td>-8.9%</td>
</tr>
<tr>
<td>Group 6</td>
<td>37.5%</td>
<td>72.0%</td>
<td>34.5%</td>
</tr>
<tr>
<td>Group 7</td>
<td>50.0%</td>
<td>79.8%</td>
<td>29.8%</td>
</tr>
<tr>
<td>Group 8</td>
<td>41.7%</td>
<td>80.9%</td>
<td>39.2%</td>
</tr>
<tr>
<td>Mean percentage</td>
<td>40.1%</td>
<td>71.6%</td>
<td>31.5%</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>22.0%</td>
<td>11.8%</td>
<td></td>
</tr>
</tbody>
</table>

*Note: 32% of the total points for the concept map assignment aligned with interdisciplinary learning goals.
** Note: 45% of the total points for the final project assignment aligned with interdisciplinary learning goals.

On the students’ social activism, the awareness about critical water problems increased significantly. Interestingly, the willingness to participate socially in the university decreased (although this may be an artifact of the question wording, as discussed above). On the other hand, becoming active in the community at large increased significantly; in fact, it was the largest change measured.
Interdisciplinary understanding was measured by a rubric for the group projects that assessed the three steps of interdisciplinary learning, disciplinary grounding, interdisciplinary bridging, and interdisciplinary problem solving. The students became proficient in the disciplinary information early, but it took most of the semester for them to become proficient in interdisciplinary bridging and problem solving. At the end we were able to show a significant increase in interdisciplinary learning.

Acknowledgements

We wish to thank each of the department chairs, who supported our efforts in developing this course: Stephen Roberts (Biology), David Ash (Chemistry), and Katherine Rosier (Sociology, Anthropology, and Social Work), as well as Dean Pamela Gates (College of Humanities and Social and Behavioral Sciences) and Dean Ian Davison (College of Science and Technology). We wish to acknowledge the hard work and countless hours that the UAEM students have gifted to this course development. CMU’s Faculty Center for Innovative Teaching (FaCIT) supported this project with staff, funds, instructional support, and moral support. We extend our special thanks to all the students enrolled in the course, without whom this experiment would not have been possible. We also wish to thank Kevin Pangle (Biology, CMU), Elbert Almazan (SASW, CMU), and two anonymous reviewers for help with statistical analyses.

Appendices

Appendix 1: Master Course Syllabus

Central Michigan University
College of Science and Technology
Department of Biology

Master Course Syllabus

BIO 250 Water as Life, Death, and Power 3 (2-2) Credit

I. Bulletin Description
Problems of water access, water-borne pathogens, water treatment, and power relationships in global cultures from anthropology, biology, and chemistry perspectives, via lecture and seminar. Cross-listed with ANT 250 and CHM 250. No credit on chemistry major or minor. No credit towards any Biology major or minor.

II. Prerequisites, Pre/Co-requisites, Co-requisites, Recommended
Recommended: ANT 171 or 170; BIO 101 or 110; CHM 111, 120, or 131.

III. Rationale for Course Level
This course will be taught in an interdisciplinary manner, and will include material from anthropology, chemistry, and biology. It will foster synthesis of information from all three disciplines in order to
evaluate issues and interventions related to water access rights, health issues, and water treatment, thus is designed for a more mature undergraduate student with little content background.

IV. Suggested Textbooks

The interdisciplinary nature of this course requires texts from several perspectives. Texts that will make up the readings include:


V. Other Requirements and/or Materials for the Course

Additional articles will be uploaded into Blackboard.

VI. Student Learning Course Objectives

Upon completion of the course, students will be able to:
1. examine water-related health disparities from multiple perspectives, such as water access, water-borne pathogens, water treatment, and power relationships;
2. describe the interrelationships of these different perspectives;
3. describe the life-cycle of cholera and its connection to human health;
4. describe behaviors that bring populations in contact with cholera, and provide regional examples from many global cultures;
5. compare and contrast political, economic, and technological access to water treatment methods from different global cultures;
6. summarize and analyze seminar readings related to water-related health disparities, and intervention case studies, from different global cultures;
7. define a plan to develop or improve a grassroots campaign to address water issues.

VII. Suggested Course Outline

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture topic</th>
<th>Seminar topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.67%</td>
<td>Settlement patterns and water&lt;br&gt;Food collection/production strategies and water&lt;br&gt;A: Human food collection/production strategies and their relative water needs&lt;br&gt;B: Biotic/abiotic factors affecting water cycle&lt;br&gt;C: Water cycle, Carbon cycle</td>
<td>Introduction to group work</td>
</tr>
<tr>
<td>6.67%</td>
<td>Water chemistry&lt;br&gt;A: How human activity can alter water chemistry&lt;br&gt;B: Transport of molecules across membranes&lt;br&gt;C: water properties, acid-base, pH, solubility, adsorption and ion exchange</td>
<td>Introduction to non-governmental organizations (NGOs)</td>
</tr>
<tr>
<td>6.67%</td>
<td>Human co-evolution with pathogens&lt;br&gt;Waterborne diseases&lt;br&gt;A: Pathogens common to settled v. foraging human groups&lt;br&gt;B: Host-pathogen interaction/evolution&lt;br&gt;C: dilution, adsorption</td>
<td>Evidence-gathering approaches to regional-specific diseases</td>
</tr>
<tr>
<td>6.67%</td>
<td>Cultural practices and interaction with water (food washing, bathing, food production, religious)</td>
<td>Cultural awareness and sensitivity</td>
</tr>
<tr>
<td>Percentage</td>
<td>Topic</td>
<td></td>
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<tr>
<td>------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Pathogens in water</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Human-bacteria interface</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Importance of water in life</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> Hydrophilicity/phobicity, adsorption in the body</td>
<td></td>
</tr>
<tr>
<td>Introduction to neglected tropical diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Historical context of epidemics</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Cultural/historical factors impacting development/spread of epidemics</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Spread of disease in populations</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> kinetics of transport in the body (bacteria and drug)</td>
<td></td>
</tr>
<tr>
<td>Multidisciplinary approaches to addressing water-borne diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Bacterial ecosystems</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Human interaction with bacterial ecosystem</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Bacterial survival in water</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> water systems (fresh, sea, brackish)</td>
<td></td>
</tr>
<tr>
<td>Intervention case study analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Biochemistry of cholera</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment of cholera</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Human activities that impact contraction/spread of cholera</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Cholera life cycle, toxin action</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> Ion exchange in the body</td>
<td></td>
</tr>
<tr>
<td>Intervention case study analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Cholera outbreaks in the U.S., India, Haiti</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water treatment as prevention of cholera</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Indigenous approaches to disease prevention and treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Susceptibility of cholera to antibacterials</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> Solutions, impurities, water transport</td>
<td></td>
</tr>
<tr>
<td>Intervention case study analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Municipal water treatment in a global context</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Cultural factors affecting development of water treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Action of bacteria and toxins</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> Overview: filtration, sedimentation, biological purification, toxins (e.g. Arsenic)</td>
<td></td>
</tr>
<tr>
<td>Resolutions to solving existing problems in water treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Physical water treatment methods</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Impact of physical water treatment methods on local/regional populations</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Prokaryotic cell structure</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> Filtration, flocculation, ion exchange, membranes, sterilization</td>
<td></td>
</tr>
<tr>
<td>Water conservation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Biological water treatment methods</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Impact of biological water treatment methods on local/regional populations</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Susceptibility of bacteria to biological water treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> anaerobic, aerobic, use of sludge, nutrient cycles, toxins</td>
<td></td>
</tr>
<tr>
<td>Poster and podium presentation basics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Structural inequalities to water treatment and health</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Political, social, economic power structures and clean water access</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B:</strong> Inequalities in water supplies and contaminants</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C:</strong> drinking water and wastewater systems in US and Haiti</td>
<td></td>
</tr>
<tr>
<td>Group work day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.67%</td>
<td>Human right to fresh water (United Nations)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potential legal consequences to unequal access to clean water</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>A:</strong> Political, social, economic power structures and</td>
<td></td>
</tr>
<tr>
<td>SRCEE presentation week</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
clean water access
B: Examples of contaminants in water systems
C: e.g. water in Arizona (arsenic)

6.67%
New water treatment solutions
A: Cultural factors affecting adoption of new technologies
B: Susceptibility of pathogens to new treatment examples
C: simple filtration and sterilization methods

Discussion and next steps

Finals week
Examination
Final presentations due

VIII. Suggested Course Evaluation

20% Journal entries on seminar readings (e.g., ten 1-page journal entries)
20% In-class participation/group discussion (e.g., free writes, clicker activities)
20% Written assignments (e.g., three 3-4 page essays) highlighting interdisciplinary content analysis
20% Pre/post examinations, with multiple choice/short answer questions
20% Presentation in seminar on grassroots campaign for water issues

IX. Bibliography


Appendix 2: Interdisciplinary assessment rubric.

**Interdisciplinary Project Rubric**

<table>
<thead>
<tr>
<th>Disciplinary Grounding</th>
<th>Proficient (4)</th>
<th>Acceptable (3)</th>
<th>Developing (2)</th>
<th>Deficient (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clarity:</strong> Explanation of disciplinary insights, methods, findings, mode of thinking is free from confusion and ambiguity.</td>
<td>All disciplinary explanations are clear in purpose and organization.</td>
<td>All but one disciplinary explanation is clear in purpose and organization; or several miss either purpose or organization.</td>
<td>Only one disciplinary explanation is clear in purpose and organization; or all miss either purpose or organization.</td>
<td>None of the disciplinary arguments are clear.</td>
</tr>
<tr>
<td><strong>Logical:</strong> Each disciplinary argument fits together well, conclusions follow from reasoning and evidence; well-reasoned; plausible, consistent, coherent.</td>
<td>All disciplinary arguments are logical, coherent, and based on evidence.</td>
<td>All but one disciplinary arguments are logical, coherent, and based on evidence.</td>
<td>Only one disciplinary argument is logical, coherent, and based on evidence.</td>
<td>None of the disciplinary arguments are logical, coherent, and based on evidence.</td>
</tr>
<tr>
<td><strong>Complete:</strong> Includes all disciplinary information needed; lacking none of its parts or aspects thorough, whole.</td>
<td>All disciplinary information needed is presented.</td>
<td>Most of the disciplinary information needed is presented.</td>
<td>Only some of the disciplinary information needed is presented.</td>
<td>None of the disciplinary information needed is presented.</td>
</tr>
</tbody>
</table>

**Integrative Summary:** All disciplinary arguments are distilled into a coherent summary with an overall meaning or result.

- All disciplinary information has been included in the summary in a logical manner.
- 2 disciplines are favored over the 3rd.
- 1 discipline is favored over all other disciplines.
- No integrative summary is attempted.

**Conceptual Bridging:** A particular concept, instrument, skill is used in a variety of concepts resulting in a deeper understanding of the tool itself.

- The topic is investigated from the viewpoint of all disciplines, leading to deeper understanding of the topic.
- 2 disciplines are favored over the 3rd.
- 1 discipline is favored over all other disciplines.
- No deeper understanding has been achieved.

**Complex Explanation:** The interdisciplinary argument is developed to a higher level of abstraction.

- Coherent whole is synthesized to a higher level of abstraction.
- Several parts of the bridged concepts are developed to a higher level of abstraction.
- A few parts of the bridged concepts are developed to a higher level of abstraction.
- Abstraction has not been attempted.

**For final seminar project only: Pragmatic solution**

**Pragmatic Solution:** A practical problem is solved by the inclusion of all disciplinary perspectives.

- The pragmatic solution plan is interdisciplinary and includes all processes of 6σ: define, measure, analyze, improve, and control.
- The pragmatic solution plan only includes at least 4 of the processes of 6σ: define, measure, analyze, improve, and control.
- The pragmatic solution plan only includes only 2 out of 6σ processes or only 3 of the processes of 6σ: define, measure, analyze, improve, and control.
- The problem was not solved in an interdisciplinary manner or did not include 6σ processes.
References


Haynes, C. (n.d.). *Designing and Teaching an Interdisciplinary Course*: Paper presented at Teaching Outside the Lines workshop, John Hope Franklin Humanities Institute, Durham, NC.


R (2013) *R for Mac OS X*, http://cran.r-project.org/bin/macosx/


An Integrated Interdisciplinary Faculty-Student Learning Community Focused on Water Issues: A Case Study
An Integrated Interdisciplinary Faculty-Student Learning Community Focused on Water Issues: A Case Study

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Recommended Citation

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An Integrated Interdisciplinary Faculty-Student Learning Community Focused on Water Issues: A Case Study

Abstract
In response to a request from a campus student organization, faculty from three fields came together to develop and teach an integrated interdisciplinary course on water issues and social activism. This course, *Water as Life, Death, and Power*, brought together topics from the fields of anthropology, biology and chemistry to explore water rights, access to clean water, and water treatment methods. Students enrolled in the course developed projects related to a variety of local and global water issues to present real-world solutions at a university-wide student research showcase. This article describes how we organized the learning community, composed of students, faculty, and staff, and outlines the training process of developing a sense of community, content integration, and interdisciplinary teaching techniques.

Cathy Willermet is a Professor of Anthropology at Central Michigan University.

Eron Drake is the Assistant Director of the Faculty Center for Innovative Teaching at Central Michigan University.

Anja Mueller is a Professor of Chemistry at Central Michigan University.

Stephen J. Juris is a Professor of Biology at Central Michigan University.

Pratik Chhetri is a graduate student and a member of Universities Allied for Essential Medicines (UAEM) at Central Michigan University.

Samik Upadhaya is a graduate student and a member of UAEM at Central Michigan University.

Keywords
course design, interdisciplinary, faculty learning community

Cover Page Footnote
Acknowledgements We wish to thank our supportive department chairs: Stephen Roberts, David Ash, and Katherine Rosier, as well as Deans Pamela Gates and Ian Davison. We wish to acknowledge the countless hours the UAEM students have given to this course development. FaCIT provided the structure to support this project. Shu Guo, Faculty Research Librarian, provided essential instruction and research materials. Thank you to the anonymous reviewers and editors who provided valuable suggestions for this manuscript. We extend special thanks to all the students enrolled in the course, without whom the culmination of this experiment would not have been possible.

Authors
Cathy Willermet, Eron Drake, Anja Mueller, Stephen J. Juris, Pratik Chhetri, and Samik Upadhaya

Article is available in Learning Communities Research and Practice: http://washingtoncenter.evergreen.edu/lcrpjournal/vol2/iss1/5
Responding to Student Interests

Universities Allied for Essential Medicines (UAEM) is a worldwide coalition of university students dedicated to providing access to affordable medicines. One goal of the Central Michigan University (CMU) UAEM student chapter is to educate students on issues of global health inequities.

In 2011, the UAEM students petitioned for undergraduate courses combining interdisciplinary teaching and opportunities to solve real world problems, joining theory with activism. In response, three CMU UAEM faculty advisors, Stephen Juris (Biology); Anja Mueller (Chemistry); and Cathy Willermet (Anthropology), participated in a Faculty Learning Community (FLC) to develop an interdisciplinary course (Willermet, Mueller, Juris, Drake, Upadhaya, & Chhetri, 2013). We chose water because it reflects all of our research specialties, combining access to water with water-borne diseases and treatment. In this article, we describe how we developed the learning community of faculty, staff, and students, and how we trained ourselves to teach an integrated interdisciplinary course.

The Call and Creation of Communities

The Faculty Learning Community (FLC)

In 2011, CMU’s Faculty Center for Innovative Teaching (FaCIT) launched a new initiative: the development, implementation, and support of FLCs, based on considerable evidence that effective learning communities have important benefits for students and faculty (e.g., Cox, 2004; Kuh, Kinzie, Schuh, Whitt, & Associates, 2005; Lenning & Ebbers, 1999). FaCIT defined FLCs as interdisciplinary groups who engage in a collaborative, year-long program focused on enhancing teaching practices and learning styles and assessment. A FaCIT liaison ensures that the administrative functions of an FLC are accomplished and offers assistance in recruiting members, reaching FLC goals, solving collaborative group processes, and providing resources on best practices for teaching and learning.

FLC applicants were required to propose a topic and rationale, potential members, preliminary goals, and deliverables. In response, we (Juris, Mueller, and Willermet) submitted a proposal to develop the student-requested interdisciplinary course, focusing on water issues and incorporating activism. We proposed these outcomes: (1) develop a Master Course Syllabus for an interdisciplinary undergraduate water class; (2) learn best practices for teaching interdisciplinary courses; (3) develop interdisciplinary group projects; and (4) develop assessments to measure interdisciplinary thinking and activism.
FaCIT approved the project, titled *Water as Life, Death and Power*, and assigned one of the authors (Drake) to our FLC as a liaison. The three faculty were the co-facilitators. We invited faculty member Shu Guo, Reference Librarian, to join and provide research support. This group was the core of the FLC.

**The Student Learning Community (SLC)**

Since the vision for this course came from UAEM students, we wanted to include them in course development by incorporating them into the FLC model. This resulted in a combination faculty and student learning community, the FLC/SLC. Two UAEM graduate students (Upadhaya and Chhetri) were particularly involved and eventually taught the seminar portion of the course. Additionally, four undergraduate students actively participated in the SLC. The UAEM students (mostly undergraduates) met separately to discuss and approve student outcomes. The SLC students did not have a background in pedagogy or course development; however, they had a strong sense of purpose, and training and experience in student activism. To enable students to participate as equal partners in the course development and facilitation and ensure that their learning objective of student activism was maintained in a measurable format, Drake provided the students with customized training workshops on instructional design and student learning outcomes as well as one-on-one consultations on best practices in leading a seminar course.

**Developing Community**

**Learning community**

Faculty in an FLC benefit from sharing their expertise with each other, broadening their knowledge about pedagogy, promoting active teaching, and increasing collegial trust (Lenning & Ebberts, 1999). This process is enhanced through activities that build rapport. Faculty might be intimidated by students being present while they are learning teaching skills; students might feel constrained by faculty being present when they propose and discuss content topics. To maximize a collegial, supportive environment, we divided the planning meetings into three formats: one meeting for FLC members, one meeting for SLC students, and a combined FLC/SLC meeting, where students and faculty worked on course development together.
Building team rapport

FaCIT facilitated an orientation for all FLC facilitators and co-facilitators at CMU. This orientation reviewed FLC requirements, strategies for successful FLCs, and effective leadership behaviors and group processes. Indeed, the challenge for effective FLC facilitators is to balance structure and leadership, ceding leadership and facilitation to members as they develop as a collaborative group (Ortquist-Ahrens & Torosyan, 2008).

The FLC team rapport began through a sense of shared purpose, both in supporting the UAEM student initiative and in exploring interdisciplinary teaching. Juris is a biochemist researching the water-borne disease cholera and cholera toxins. Mueller is a chemist interested in new materials for perchlorate and heavy metal water remediation. Willermet is a biological anthropologist who teaches the microevolution of human populations and diseases. Initially, we discovered several points of contact between our disciplines to explore. Mueller, as lead facilitator, provided oversight for tasks and deadlines. The SLC team was already well organized through their UAEM student activism; interested UAEM students flowed in and out of SLC activities guided by their time, passion, and experience.

In order to ensure that the FLC/SLC was a successful joint venture, we had to be sensitive to different levels of experience and institutional power. The FLC members respected that the SLC students were experts in student activism. Therefore, while FLC members, when asked, provided suggestions for seminar content, the SLC held final control over seminar topics, speakers, and readings.

Each meeting had a specific agenda and deliverables; during the meetings specific tasks were assigned. All FLC/SLC members respected the mutually agreed-upon deadlines, which helped build a foundation of trust.

Increasing curricular integration

While increased curricular integration is a benefit associated with participation in FLCs (Lennings & Ebbers, 1999), the challenge for this interdisciplinary course was figuring out how faculty from three disciplines would integrate their teaching. Interdisciplinarity requires the disciplines to be integrated or blended (Klein, 2010). We felt it necessary to continuously model the integration of fields to our students to support a synthesis of ideas. Therefore, we decided that all faculty would be present and teach during all classes. While this teaching model is challenging, and requires a great deal of trust and cooperation on the part of the faculty involved, it can be more effective in achieving interdisciplinary understanding (Krometis, Clark, Gonzalez, & Leslie, 2011).
Preparing to teach in an interdisciplinary way

For this undertaking, we had two issues to address: what to teach, and how to teach it in an interdisciplinary way. As the overarching goals of this course were to increase interdisciplinary learning and activism, we felt strongly that group work was essential to model collaborative efforts to solve complex problems (e.g., Johnson, Johnson, & Smith, 1998; Prince, 2004). We studied best practices for designing and assessing group projects in an interdisciplinary context.

*Faculty Center for Innovative Teaching workshops and instructional design support*

Mueller shared materials from a comprehensive FaCIT workshop series on effective collaborative learning strategies. We discussed and expanded these to create a Blackboard cache of best practices in collaborative techniques, interdisciplinary teaching strategies, and assessment resources (e.g., Newell, 1994; Mansilla, 2008; Mansilla, Duraisingh, Wolfe, & Haynes, 2009).

The SLC students asked Drake to facilitate a workshop on developing a master course syllabus at CMU and effective course design. Utilizing a combination of instructional design strategies (e.g., Fink, 2003; Wiggins & McTighe, 1998), SLC students brainstormed student learning outcomes that supported interdisciplinary learning and activism. Drake consulted with Upadhaya on collaborative learning strategies and techniques to implement in the seminar to enhance student learning and awareness of social justice and disciplinary thinking.

*Course framework and content*

A framework for the course emerged out of our discussions. We decided to structure the course as both lecture and seminar. The lecture section would be interactive and would cover specific anthropology, biology, and chemistry content; the seminar would focus on group work and strategies for activism. While FLC faculty were the primary developers of the lecture part and SLC students were the primary developers of the seminar part, we worked together to build a cohesive course.

Within this framework, FLC faculty developed student learning outcomes and content for the lecture portion, and SLC students developed them for the seminar portion. We then discussed the proposed outcomes and content in joint FLC/SLC meetings. These back-and-forth discussions distilled a long list of learning outcomes to a shared set, with the overarching theme of interdisciplinary problem solving and engaging students in activism.
Interdisciplinary assignment and assessment

Our discussions culminated in developing a key assignment: a collaborative project on a water-related issue with a social justice component. The project’s scope was broad, but it required students to include these key pieces: (1) identification of a problem with anthropological, biological, and chemical factors; (2) a proposed interdisciplinary solution; and (3) an action plan for implementation. FLC member Guo developed a course-specific online library student research guide to support student water research. Chhetri and Upadhaya loaded resources onto the course’s Blackboard shell to aid students in researching activism.

Since one of the major goals of the course was to increase interdisciplinary thinking in the students, we developed a rubric to measure it. Before designing the rubric, we reviewed articles and sample rubrics in interdisciplinary assessment. The rubric was used to assess different stages of the students’ group projects, and is discussed in detail in another article (Mueller, Juris, Willermet, Drake, Upadhaya & Chhetri, in press).

Faculty learning Community member self-assessment

To evaluate FLC members’ potential growth as a result of the FLC, members assessed their own familiarity with collaborative and interdisciplinary concepts before designing the course and after teaching the course. The self-assessment data indicated that the co-facilitators expanded their knowledge of collaborative learning strategies during their work with the FLC. The greatest change was an increase in skills related to rubric development and group product assessment. Other significant changes included increased skill in developing self-assessments and rubrics to assess individual products, structuring a collaborative learning assignment or task, and assigning effective roles for group assignments or tasks. One interesting finding was a significant decrease in FLC members’ assessment of their skills in facilitating student group decision-making. This could be related to challenges faculty members faced managing conflicts and facilitating problem solving within student groups, coupled with an initial over-confidence in their ability to effectively guide and direct effective group decision-making processes.

Teaching and assessing the course

Water as Life, Death, and Power was taught as a special topics course in spring 2013. This three-credit course was designed for sophomores, with no required prerequisites. Twenty-nine students registered for the course under anthropology, biology, or chemistry designators. The course met twice a week in two-hour blocks. Faculty taught one hour of integrated, interactive lecture;
following this, the seminar instructors led discussions and activities for developing student advocacy of global issues for another hour. Faculty and SLC seminar instructors were present for all sessions. Due to its unusual organization, the course generated some buzz within student and faculty groups, and was even highlighted in the student newspaper mid-semester (Harrison, 2013). A full description of the course and its instructional challenges and rewards has been published (Willermet et al., 2013).

Students presented their final projects at a campus-wide forum highlighting student research. Examples include:

- developing a time-release version of an existing anti-worming drug for schistosomiasis in Uganda, along with an educational call-and-response children’s song on how to avoid getting sick;
- proposing a modification of city green-lawn ordinances, reducing local water contamination through chemical runoff;
- analyzing strategies to connect Iowa farmers to government programs to promote bioswale buffer zones along the Mississippi River, reducing downriver dead zones; and
- proposing to administrators in Copacabana, Bolivia that totora reed beds be designed to clean wastewater before it enters Lake Titicaca.

We assessed group projects using the interdisciplinary rubric generated through the FLC/SLC activities. Additionally, we assessed students’ attitudinal shifts about advocacy. Students showed improvements in both areas (Mueller et al., in press).

Reflections on the Process

Faculty Learning Community members

Through the FLC process, each of us gained perspectives on our colleagues’ disciplines as well as the scholarship of teaching and learning. As the FLC was focused on interdisciplinary pedagogy and assessment, the faculty needed time to learn strategies for teaching complicated subjects in a collaborative and interdisciplinary way. We also needed to include the UAEM students as experts in student activism. Students determined to make a difference in the world write compelling learning outcomes—notably, for students to “define or improve a grassroots campaign to address water issues.” Originally, faculty members did not include this objective, but everyone agreed it was an important student learning outcome.

Faculty members’ time commitment for this course was significant. FLC members needed to prepare in advance for the meetings; this included reading, and content and assignment development. This time was needed to complete the
work and to build relationships that would survive the classroom challenges. It takes confidence and trust to allow other faculty to watch you teach and teach with you. The FLC process allowed us to build solid relationships as well as a solid course design. We will implement the skills and techniques in group work and assessment that we learned in the FLC in other courses we teach.

**Student Learning Community members**

The UAEM students held separate meetings to maintain their own focus about course objectives. As they progressed, they developed metrics to assess student learning outcomes. UAEM students report that the formal instruction about developing student learning outcomes allowed them to communicate more clearly with faculty about their goals and aspirations. As a team, we worked the SLC members and the goals and objectives they developed into the class. Through the FLC/SLC partnership, both groups learned more about the importance of consistent, meaningful dialog around important social issues and how to explicitly communicate and align them with course goals.

**Faculty Center for Innovative Teaching**

This FLC was one of the first in FaCIT’s initiative to develop and support FLCs. Working with FaCIT’s organized reporting structure meant that we kept meeting logs and minutes, which were emailed to members and to Drake promptly after each meeting and posted to the FLC’s Blackboard resource site. This record was invaluable in keeping track of decisions and required tasks; it also kept everyone informed and accountable.

The key to the success of this faculty-staff-student collaboration was members’ openness to new ideas and approaches. The beginning stages involved identifying common goals and building trust. Upadhaya, one of the UAEM students/seminar instructors, stated,

I personally think that there had to be a “perfect storm” for all of this to work—the UAEM students were passionate about empowering undergraduate students about global issues via education and activism, and the faculty were open and flexible to work alongside the students. Both groups showed no reluctance in embracing new ideas and learning from each other. There were mistakes and oversights but a strong sense of community prevailed and we kept striving for the ideals we had set to meet.

The future of *Water as Life, Death, and Power* is secure. It has been accepted into CMU’s curriculum as an elective course in the Departments of
Biology; Chemistry; and Sociology, Anthropology, and Social Work. It is also listed as an elective in the proposed Environmental Studies major in Geography.

Faculty and students found it helpful to have FaCIT facilitate the development of this course by providing coaching; workshops; and $1,000 for the purchase of teaching/reference materials, field trips, guest speakers, or faculty development. It is certainly possible that the faculty and students would have come together to develop and teach this course regardless of the FaCIT program. However, it was efficient to have resources and advice on collaborative and interdisciplinary teaching easily at hand. Faculty development programs provide the learning community faculty needed support and structure (Eisen, Hall, Lee, & Zupko, 2009; Friedman et al., 2010). We encourage interdisciplinary teaching teams that integrate student-centered learning strategies. Through our curricular integration of faculty and students, we developed a sense of community and shared purpose, and a fresh look at our own disciplines, which keeps us engaged and enthusiastic as teachers.

References


Harrison, A. (2013, April 8). New course at CMU hopes to educate on clean water access issue globally. Central Michigan Life, p. 5B.


interdisciplinary perspective for first-year students. *College Teaching, 59*(2), 73-78.


