Journal of the Scholarship of Teaching and Learning, Vol. 13, No. 5, December 2013, pp. 106 – 124.

Water as life, death, and power: Building an integrated interdisciplinary course combining perspectives from anthropology, biology, and chemistry

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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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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.

Point of the Day	Lecture	Seminar
Week 1		
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 - Open library research time: five citations due by end of seminar period

Point of the Day	Lecture	Seminar
Week 5		
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

Point of the Day	Lecture	Seminar
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
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 on building water storage/filtration systems in Belize - Group progress reports due
Week 10		
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	Guest speaker from Take Back The Tap on bottled water
What basic physical methods treat water?	- Physical water treatment methods	- Teaching team meets with groups - Group work
Week 11		
How can we assess our success in different contexts?	- Physical water treatment methods - Impact of methods on local/regional populations - Locally sustainable methods	- Guest speaker on poster preparation skills
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

Point of the Day	Lecture	Seminar
Week 12		
How can we assess our success in different contexts?	- Biological water treatment methods - Impact of methods on local/regional populations - Locally sustainable methods - Field trip to water treatment plant	- Teaching team meets with groups - Group work
Week 13		
What are the power inequalities that can affect access to clean water?	- Structural inequalities to clean water access - United Nations statement on human rights to clean water - Inequalities in water supplies and contaminants	- Teaching team meets with groups - Group work day - Reading Reflection #4 due
Week 14		
	- SRCEE – self-and peer evaluation	
What are some examples of legal consequences—successes and failures?	- Potential legal consequences to unequal access to clean water - Examples of contaminants in water systems	- Reading Reflection #5 due
What factors should be considered in developing new water treatment solutions?	- New water treatment solutions - Cultural factors affecting adoption of new technologies - Simple filtration and sterilization methods	
Week 15		
	Final exam	Open discussions on what we have learned, what we can do
Week 16		
	Wrap-up - IRB consent forms - Post-test administration	

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