
TEACHING WATER

CONNECTING ACROSS DISCIPLINES AND INTO DAILY LIFE TO ADDRESS COMPLEX SOCIETAL ISSUES

Arri Eisen, Anne Hall, Tong Soon Lee, and Jack Zupko

Abstract. A central problem in higher education is how to best develop in students interdisciplinary thinking and application skills necessary to work and engage effectively in the twenty-first century. Traditional university structures make addressing this problem especially challenging. Using as a model courses with diverse perspectives on water taught by teams of interdisciplinary faculty, we explore one successful approach. We highlight the importance of institutional infrastructure and pedagogical strategies that nurtured our approach and allowed it to work.

Keywords: *interdisciplinary teaching, pedagogy, societal context, water*

I now look at water in a whole new way, whether it is listening to the flow in music or reading about water crises in the news, or even taking a shower, I associate everything I do with water now to ideas brought up in class.

I no longer see things in only black and white, but shades of grey. This class has taught me to use knowledge from different aspects to make good decisions.

—Students in water courses

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How should we engage students with the complex moral issues of our time—racial and ethnic conflict, environmental sustainability, optimal health care, genetic engineering?

Few would disagree with Nobel laureate Richard Feynman when he said, “You can know the name of a bird in all the languages of the world, but when you’re finished, you’ll know absolutely nothing whatever about the bird. . . . So let’s look at the bird and see what it’s doing—that’s what counts” (Feynman 1968). Providing context—disciplinary, interdisciplinary, and societal—is vital. Education, psychology, and neuroscience literature is filled with evidence demonstrating that

the richer the context, the better we learn (for an overview, see Bransford et al. 1999). It is equally clear to researchers in many fields that human beings learn better if knowledge emerges from pedagogies that are both diverse and interactive.

This makes it all the more ironic that universities are still organized to train students in only one major discipline, which is usually presented in only one or two pedagogical formats. Although there are historical reasons why our system of higher education evolved in this way, keeping it as is requires further argument, especially when younger faculty with interdisciplinary interests encounter little incentive or support for innovative teaching and virtually no facilitating infrastructure to teach across departments. Thinking again about our students, we need to worry about whether we are creating a serious mismatch between the graduates we produce and the needs of a world in which discipline-based knowledge is used in creative, interdisciplinary ways.

To address this irony and these challenges, we recount the story of two interdisciplinary courses, built around the topic of water, as models of how to synthesize disciplinary perspectives around a unifying theme. We first discuss the four elements into which we integrated our courses—a strong university-wide context and commitment, interdisciplinary engagement, diverse pedagogies, and campus and community life—and then turn to the syllabus and evaluation of our work.

Building Strong Institutional Foundation and Context

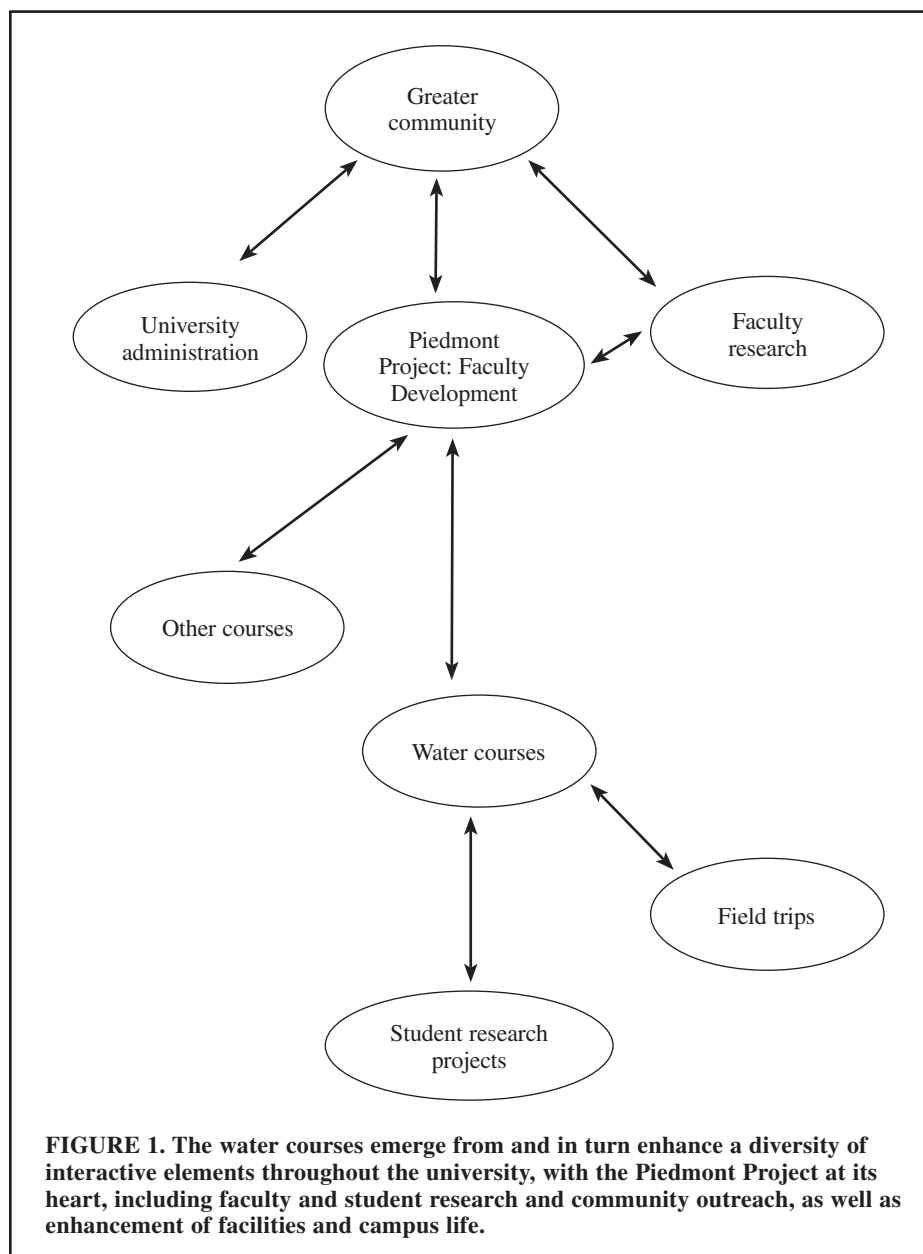
Developing and teaching an engaging interdisciplinary course is never a trivial exercise, but to sustain such a project, a network of conceptual resources and financial support is needed. The interdisciplinary water courses grew from a grassroots and now university-wide commitment to sustainability across our institution.

The movement started about a decade ago with a recommendation from an ad hoc committee on environmental concerns that quickly found roots in a curriculum and faculty development effort called the Piedmont Project. This ongoing project and its impact have been discussed in detail elsewhere (Barlett 2004), but briefly, each summer for the past seven years, twenty faculty members from different disciplines across the various schools of Emory University (Emory and Oxford Colleges for undergraduates, and the professional schools of Business, Public Health, Nursing, Medicine, Theology, and Law) propose to teach a new or redesigned course integrating the concept of sustainability and a sense of *place*. The group meets for an intensive, two-day workshop, a daylong field trip, and a follow-up dinner. These faculty participants—now numbering well over 100—have taught their integrated courses to thousands of students and have grown a strong cross-institutional community. The momentum created by the project and its related activities has produced tangible results, most notably the appointment of a Campus Environmental Officer and the establishment of an Office of Sustainability with a Director of Sustainability Initiatives. These groups work together to address ecological issues across the university, from helping to assess the environmental impact of new building plans and encouraging the use of local and sustainable food sources to promoting alternative transportation and efficient energy use. In general, the aim has been to integrate these issues and challenges as much as possible into the daily life of the university, both inside and outside the classroom. Sustainability has become a central tenet of Emory's mission (Emory University 2009).

During a Piedmont Project field trip to a local wastewater reclamation plant, one faculty member who studies the Romantic poets had the idea to co-teach an interdis-

ciplinary course on water. He was soon joined by two other faculty members—a geologist and a philosopher—to develop and teach this new course, “Water: In Science, Philosophy and Literature.” Piedmont organizers received internal funding to support a weekend retreat for a dozen faculty members to help the three lead teachers develop the course, and the first version of it was taught the following academic year, in the spring semester of 2005. The geologist taught a second version of the course in the spring of 2007 with two other faculty members, a musical anthropologist and a biologist. Appropriately enough, this version was titled “The Science and Sound of Water.”

Developing and teaching interdisciplinary courses on complex topics across several disciplines is hardly an easy task, but the evolution of these two courses was greatly facilitated by the network of faculty, ideas, and infrastructure such as the Piedmont Project community already in place at Emory. The faculty members teaching the courses then were able to draw on a wealth of knowledge from these communities: a database of courses, collegial expertise, field trip-leaders, guest lecturers, and many other resources (Emory University Program in Science and Society 2009). The rich context in which we developed our water courses is summarized in figure 1.



Interdisciplinary Engagement

Clearly, in addition to focused research in one's own field, taking on major societal problems requires interdisciplinary collaboration. DeZure defines true interdisciplinary engagement as "a process to construct knowledge in which students and instructors come together to analyze differences in disciplinary approaches to a problem and to work toward a synthesis—a new, more comprehensive view than allowed by the vision of any one field" (DeZure 1999). This was the explicit goal of the water courses.

The Piedmont Project's emphasis on the comprehensive viewpoint and its nurturing of faculty relationships and scholarship across disciplines made the integration of diverse disciplinary perspectives much easier. It is fair to say that those of us who taught these courses would simply never have met each other without the Piedmont Project experience, let alone worked closely with each other, and in each other's disciplines, for an entire semester. We are each located in different parts of the campus, both geographically and intellectually. Like other research universities, we are a campus with thousands of faculty members and virtually no history of interdisciplinary interaction—until recently.

Needless to say, we each brought our different training, classroom practices, and perspectives on the world to the water courses, but we always tried to integrate what we were doing with our teaching partners rather than succumbing to serial lecturing. This meant that we all attended every class session and went on every field trip, working to complement each other's presentations throughout the course. We also learned to model perplexity for our students by helping each other when we got stuck on unfamiliar material. There is no better response to students complaining bitterly about having to do some mathematical calculations (e.g., the amount of time it will take a leaking underground fuel tank to pollute a nearby drinking water well) than for their professor from a humanities discipline to do them too.

On a metacognitive level, we asked the students to consider the following questions throughout the course:

- What counts as evidence in the different disciplines and why? What kinds of questions get asked by different disciplines?
- How can interdisciplinary exploration enhance or hinder discovery and communication?
- What pedagogical approaches best lend themselves to interdisciplinary learning?
- Does water succeed as a topic for exploring these questions?

How did we show that all of this information matters? We are literally immersed in water every day. So the question becomes how to get young people—who, like most of us living in developed countries, tend to take water for granted—to consider the true value of this limited resource and to reflect on how their actions today might affect not only themselves but their children's children. We wanted to use the information and course activities not only to help students become better thinkers and ana-

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Diverse Pedagogies and Real-Life Applications

Establishing a sense of place—i.e., getting to know our campus, city, and environs—has always been a goal of the Piedmont Project and of many of the courses growing from it that were revised to incorporate the notion of sustainability. In the 2007 course, the fact that the three faculty members specialized in molecules, natural resources, and Asian music made it easy to vary classroom activities with this sense in mind. It has been well established that good education means first understanding how students differ in their particular learning styles, approaches to learning, and intellectual development, and then adjusting how we teach to accommodate such differences (see Felder and Brent 2005). In addition to the usual lectures and guest speakers, students participated in field trips, performed Korean farmers' dance-drumming, created various forms of water art, watched and discussed documentaries, researched and presented original research projects, participated in full-group and small-group discussions, and completed writing assignments both in and out of class.

lyzers but also to make them better, more aware citizens.

Two Water Courses

Table 1 summarizes and contrasts our two different but thematically related courses. Both courses sought to engage students and faculty across disciplines by using diverse pedagogies, encouraging an appreciation of other disciplines, asking questions outside of the students' majors and the faculty member's expertise, and investigating the role of water in our own lives and within our institutional, civic, regional, and national communities. Both courses were cross-listed and satisfied a general education requirement. "Water: In Science, Philosophy, and Literature" (which was taught first and will be referred to as course 1) satisfied a writing requirement, meaning that it counted as one of four writing intensive courses every Emory undergraduate must complete before graduation. "The Science and Sound of Water" (course 2) satisfied an advanced seminar requirement, also required for graduation.

Course 1 had forty-five students and thus lent itself more to a lecture format,

TABLE 1. Comparison of the Two Water Courses

Course Feature	Course 1: "Water: In Science, Philosophy, and Literature"	Course 2: "The Science and Sound of Water"
Taught by	Geologist, philosopher, literature professor	Geologist, anthropologist, biologist
Cross-listing	Environmental Studies/ Philosophy/Interdisciplinary Studies	Environmental Studies/Music/Biology
Meeting times	Two 75-minute meetings per week	One 3-hour meeting per week
Student profiles	45 sophomore, junior, and (mostly) senior students from 11 different majors	17 sophomore, junior, and senior students from 8 different majors
General education requirements addressed	Writing requirement	Advanced seminar
Topics addressed	<ul style="list-style-type: none"> • The Hydrologic Cycle • Water as an element: Greek, Roman, and medieval philosophers • Geology of surface and ground water • Watershed protection • Water and the human body • Water, global health, and equity • Physics of water • Water supply and quality • Landscape development • Representation of water in art • Writing on water • Local water issues 	<ul style="list-style-type: none"> • The Hydrologic Cycle • Neuroscience of hearing • Biophysics of water • Water and philosophy • Surface water resources • Water quality and supply • Effects of dam construction and irrigation • Landscape development and its expression in art • Water-related objects in ancient American art • Romance poetry and water • Water and healing
Pedagogical approaches	<ul style="list-style-type: none"> • Lecture • Guest speakers • Out-of-class reading • Discussion • In-and out-of-class writing • Response papers • Field trips • Journals • Individual research papers on peer-reviewed topics, with revisions 	<ul style="list-style-type: none"> • Lecture • Guest speakers • Out-of-class reading • Discussion • In- and out-of-class writing • Response papers • Field trips • Online journals and reflections • Hands-on music/sculpture/writing art projects • Small-group research projects and presentations
Grading basis	<ul style="list-style-type: none"> • Journal entries • Field trip participation • Midterm exam on scientific processes and principles • Write-ups of water-related activities • Research paper with revisions 	<ul style="list-style-type: none"> • Participation (class discussion, online communication between class meetings, field trips) • Writing assignments (online journal entries and reflections) • Research project and presentation

although smaller discussion sections met regularly with the faculty and the two graduate student teaching assistants (one of whom was a participant in a graduate-student version of the Piedmont Project). Course 2 was a seminar course with an enrollment of seventeen students. Small group discussion was essential to synthesize and evaluate the wide range of topics and ideas explored in each course. For the first eight weeks of course 1, students wrote weekly water journals. Some of the topics for particular entries were assigned, such

as students' reaction to an ice storm that closed the university early in the semester, but most of the topics were left up to the students. We wanted to help our students think about the impact of water in their daily lives by making them write about it early and often. The journals covered a wide range of styles and ideas. Several students wrote about childhood memories of water, another about the scarcity of water during his tour of duty in Iraq, another about water in the Jewish faith. In course 2, online water journals were kept for the

entire semester. Students and faculty had access to posted journals and responses. The online posting created a way for students and faculty to interact during the time between our once-a-week class meetings. In both courses, we found that journal writing fostered a more connected learning experience for the students since their writing created links between course topics and their personal experiences.

In course 1, the students completed individual research papers, which went through a revision process. Paper topics

were left up to individual students, but we insisted that they be peer reviewed to broaden each student's thinking (student reviewers were required to have a different major than the paper's author). Research paper topics ranged from "Water in Venice: Hydrology and Culture" to "The Microbiology of Red Tides and Their Environmental and Economic Impact." If the paper topic focused on a water-related problem, the student typically offered a multidisciplinary solution.

In course 2, group projects were completed in place of individual research papers. Students participating in different projects offered each other interesting references and links, contacts, and general advice. The projects included a collaboration between a business major and an environmental studies major evaluating the use of permeable pavement options in future construction on campus and a documentary on storm-water management plans for our campus.

Several field trips were scheduled in both courses: students visited an Atlanta wastewater reclamation facility, conducted general environmental assessments of water quality at a state park and a campus green space, and collected water quality and stream discharge data in a protected watershed. In course 2, students created sound or video recordings of a field trip to a local stream. Other outside activities included attendance at water-related talks, films, art exhibits, poetry readings, and other events. These activities greatly enhanced the experience of both students and teachers on the topic of the course.

We made an explicit effort to demonstrate the integrated nature of our fields. This was challenging, but essential. Although usually evident to instructors, true interdisciplinary connections within and between class sessions are often difficult for students to grasp. This is partly because of the silo-like specialization of their previous educational experiences, but also because of pedagogy, even in these cases in which we were being so intentional about integration across fields. Along these lines, perhaps our most effective approach demonstrating interdisciplinarity were joint discussions in which two professors from different fields literally integrated the class period. In course 2, for example, the biologist and musical anthro-

pologist together discussed water and healing—the biologist from the perspective of spas and physiologic change and the connected anthropologic perspective of the role of water in healing rituals in the Malaysian rainforest (Roseman 1993).

Evaluation and Analysis

The students for course 1 completed written course evaluations. Comments included positive feedback on small discussion groups (they "allowed students to get more involved in discussions/debates"), field trips ("we actually got to apply the stuff we were learning," and the trips "stimulated thinking about water"), and assignments ("they sparked independent thought").

Indicative of students' substantive engagement in and understanding of the course and its emphasis on the interrelatedness of different perspectives on water were student suggestions for topics to add in the next offerings. These included adding a sociologist because discussions revolved around "our use" of water and developing new courses on the other ancient elements using the same approach.

We evaluated course 2 in a number of formal and informal ways, including a "town hall" meeting with students and instructors playing Central Javanese gamelan music amidst discussion to allow everyone to talk about how the course had affected them. Students also completed formal university evaluations of the teachers and the course and a course-specific written evaluation addressing the interdisciplinary goals of the course in addition to other course-specific features.

Nurturing Interdisciplinary Thinking

Did the course successfully develop and integrate interdisciplinary thinking? Strikingly, all but one of the students felt strongly that the course worked effectively in this regard, despite the fact that "thinking interdisciplinarily" was often not easy for them. They mentioned not only viewing water "in a whole new way" and from "a broader context," but also how different perspectives allowed them to see more "grays" and fewer "black-and-whites" in their understanding of the issues, how the experiential aspects of the course helped, and how they were in

general more able to see and make connections than previously. Here are two typical student comments:

It helped connect a lot of topics/disciplines that I ordinarily would not have associated together and made me learn how to view issues related to water from multiple/different perspectives rather than solely from one side.

I admit this course was very challenging at first because it forced me to think outside of the box. Now I'm really glad I did.

The students were unanimous in saying that water is an excellent topic for interdisciplinary engagement. We hope that participation in our water courses helped these students break out of the constraints of the disciplinary thinking that a college major requires, preparing them for the multidisciplinary approaches demanded by so many of the professions they will eventually practice.

Despite our efforts, the most common complaint about the courses was still their tendency toward choppiness and lack of clear connection or organization. Although some of this is because these are new offerings, more attention should be paid and more time given to explicit integration of disciplinary perspectives both in class and in assignments.

Faculty Development Ripples

Participation in the water course has also changed the way we teach our own more traditional courses. The co-teaching experience made it possible for us to learn from each other on a regular basis. We are also more sensitive to the disciplinary thinking students have absorbed from their majors and try to work with them to help them move beyond it. The fact is that it is no longer possible for us to teach our regular departmental courses without making cross-disciplinary connections, connections to our daily lives, and connections beyond the university. Teaching interdisciplinary courses has changed the way we think about our own academic vocation.

Because disciplinary thinking operates in narrow grooves, it will always be a challenge for students to place topics such as the biophysics of water on the same page as the use of water in healing practices. But it can be done. Despite the difficulty of evaluating business decisions related to campus development while keeping in

mind the impact of stormwater runoff on stream ecology, the sustainable solution requires us to do so. As we taught the courses, all of these ideas were discussed. By the end, students were more adept at recognizing connections between seemingly disparate disciplines and were able to use information from different fields to develop better, more comprehensive solutions to water-related problems.

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