Introducing Transdisciplinary Problem Solving to Environmental Management Systems and Geology Students Through a Case Study of Disturbed Coastal Systems

By Maud M. Walsh and Carol Wicks

Researchers, educators, employers, and policy makers have stressed the need for educational practices that prepare students to solve problems through critical thinking and collaborative multidisciplinary teamwork (American Association for the Advancement of Science, 1993; Clark et al., 2011a, 2011b; Rutherford & Ahlgren, 1990). Employers are seeking graduates who can work as members of a diverse team. Problem-based and case-study learning are promising strategies for developing these needed skills (Duch, Groh, & Allen, 2001; National Research Council, 2011). Environmental problems, which present scientific, social, and technical challenges, may be addressed most effectively by a transdisciplinary approach (Scholz, Meieg, & Oswald, 2000). Transdisciplinary problem solving encompasses the space among disciplines, so it differs from multidisciplinary approaches, which maintain disciplinary boundaries, and interdisciplinary strategies, which blend approaches from different disciplines (Scholz, Lang, Wiek, Walter, & Stauffacher, 2006). Transdisciplinary scientific training is aimed at producing scientists who can synthesize and apply theory and technique from various disciplines to address a problem (Nash, 2008). It commonly incorporates feedback from stakeholders and results in practical actions (Baumgartner, Becker, Frank, Muller, & Quaas, 2008).

Transdisciplinary course Context—Louisiana’s disappearing coastline

Globally, coastal land loss poses a major challenge as large population centers are increasingly threatened by sea level rise (Nicholls, 2011). The disappearance of coastal wetlands over the past several decades has posed numerous problems including damage to commercial and recreational fisheries, diminished protection from hurricanes, and increased vulnerability of infrastructure of the energy industry (Couvillion et al., 2011; National Oceanographic and Atmospheric Administration, 2011; National Research Council, 2006). Louisiana’s coastline is particularly vulnerable (see http://www.nwrc.usgs.gov/upload/landloss8X11.pdf). Addressing the problem of loss of up to 40 acres per year of coastal wetlands in Louisiana provides a unique opportunity for problem-based and case-study transdisciplinary learning.

The analysis of the multiple factors contributing to coastal land loss and the evaluation of methods for reducing the loss and mitigating its effects require expertise of many disciplines and a perspective that is outside any one of those disciplines. To provide students with experience in working in transdisciplinary teams tasked with ad-
dressing a complex problem, classes in environmental management, geology, and landscape architecture were linked to focus on an integrative approach to wetlands restoration in Coastal Louisiana. This article discusses the transdisciplinary class from the perspectives of the two science classes, Applied Environmental Management and Seminar in Geophysics: Hydology of Coastal Ecosystem Restoration.

Development of the course

The idea for a combined case-study class originated from discussions between the authors about collaborative class projects that could involve environmental management and geology students. Because one of us had a successful experience in a learning community of English composition, landscape drawing, environmental engineering, and environmental management classes focused on lake restoration (Walsh, Jenkins, Powell, & Rusch, 2005), we felt that bringing in a nonscience discipline might be valuable. We were encouraged to submit a proposal for financial and logistical support for the class from the Louisiana State University Coastal Sustainability Studio and were subsequently introduced to a professor in landscape architecture who was interested in working with us. We three faculty members submitted a proposal requesting travel support for class field trips and a stipend for a graduate assistant; we received only enough money for a graduate assistant, a landscape architecture graduate student. We did not receive any additional compensation or any course releases to facilitate class planning and teaching. The Department of Geology and Geophysics provided vans and fuel for the field trip.

Planning for the combined courses

The semester before the courses were offered was allotted for planning of the individual courses, for integrating the individual courses into one transdisciplinary course, for designing the pre- and postassessment surveys, and for designing the transdisciplinary project. The three instructors and the teaching assistant met weekly and made trips to the possible field sites and to document libraries. During the weekly meetings, the order of disciplinary lectures, selection and order of guest lecturers, and discussion of the discipline-specific miniprojects were addressed. Ensuring that the courses were scheduled for the same two 75-minute sessions per week was also critical.

One course goal was for the students to spend time at the site that would serve as the basis of the class project. Prior to the start of the semester, we made contact with two land managers for properties on Chenier Caminada near Port Fourchon, Louisiana, and received permission to visit their sites with the students.

The implementation of the class

For the first 8 weeks of the semester, the disciplinary classes met once a week, and the transdisciplinary (combined) class met once a week. The disciplinary class meetings were used to ensure that the students had mastered the needed background knowledge that was specific to their discipline. The transdisciplinary class periods were used for lectures (from guest speakers and from each of three faculty members) and for working on three miniprojects in a studio in the Landscape Architecture building that was dedicated to the course. Guest speakers for the transdisciplinary class meetings included the director of the Coastal Sustainability Studio, a geologist researching Louisiana’s deltaic systems, a wetland ecologist specializing in coastal restoration, and a landscape architect working on Louisiana’s 2012 Coastal Master Plan. During the last 6 weeks of the semester, the class sessions were devoted to group work on the major transdisciplinary project. The 24-hour availability of the studio space allowed the student groups to collaborate both during regularly scheduled class time and at any other times to work on projects.

For the discipline-specific miniprojects, teams were formed from students representing each of the classes. Teams were reconfigured for each miniproject. The three miniprojects served as an introduction to landscape architectural approaches, geological data interpretation, and environmental assessment (Table 1). The students in the appropriate discipline were expected to provide expertise for their teams.

The final project was a challenge related to the Chenier Caminada field site: The teams were charged with developing plans for Chenier Caminada for 5, 25, and 100 years into the future that addressed owner priorities, community needs, and geographical changes through time. The geologists were responsible for providing understanding of the delta cycle, of the hydrogeologic

| TABLE 1 |
| Miniproject lead and goals. |
| Miniproject lead | Goal |
| Landscape Architecture students | Introduce visual information and the concept of “privileging” |
| Geologists | Introduce students to data collection and error analysis |
| Environmental Management students | Introduce environmental assessment plans |
framework, and of groundwater/surface water interactions. The environmental managers brought their science and policy expertise to environmental assessments and legal considerations. The landscape architects were expected to take the lead in the phased design propositions using the physical framework and environmental policies articulated by the other students. To prepare for the final project, the class visited Chemier Caminada to gain perspectives that maps and photos could not provide. They also heard from land managers and owners about the challenges faced in maintaining coastal properties.

**Assessment and results**

A knowledge survey (see appendix) containing questions from all three disciplines was completed by all students during the first lecture and the last lecture to determine whether the course was effective in increasing student knowledge about coastal land loss and improving student perceptions of the value of transdisciplinary teams. Although the completion of the surveys was part of participation credit for the class, student scores were not used as part of the class grade. This might have made a difference in student scores (Liu, Bridgeman, & Adler, 2012); the use of the postsurvey score as part of the class grade might have improved the quality of the results.

The miniprojects for each discipline provided formative assessment in the three disciplinary areas. The project reports or products were reviewed by the instructor, who developed the assignment and feedback provided to the teams. Student presentations and written reports on the final project were the primary summative assessment for the transdisciplinary course. Students presented the plans to a jury of faculty not associated with the class, guest lecturers, faculty members of the class, and the other students at

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**FIGURE 1**

Percentage of students who answered the knowledge survey correctly (see appendix for complete survey), shown according to class. EMS = Environmental Management Systems, LA = Landscape Architecture, G&G = Geology and Geophysics. For the precourse assessment, none of the G&G students answered Questions 2 or 6 correctly (0% correct). Note overall improvement in students’ understanding of disciplinary-specific and transdisciplinary concepts.
the end of the semester. This juried presentation included both a poster (usually a physical poster, but one group developed a digital poster) and an oral presentation in which each member of the team was expected to talk, at least briefly. The final plans were diverse in approach and in emphasis. Some plans focused heavily on a construction approach to restoring/maintaining coastal wetlands and others focused on using the naturally degrading environment for environmental research projects or experimental landscape designs.

The students in each of the courses, particularly in the Environmental Management Systems and Landscape Architecture classes, showed improvement in their understanding of disciplinary-specific and transdisciplinary concepts (Figure 1). The student responses to the true–false question, “I work well with other students to complete team class projects,” are shown in Figure 2. Interestingly, the students, except the Geology students, were less confident of their ability to work in teams after this class. As graduate students, the Geology students had the most experience with teamwork, so were better prepared for working in a transdisciplinary team. The Geology students were also well prepared to handle the scientific content of the course. The Landscape Architecture and Environmental Management Systems students had less experience with teamwork, in general, and quite limited experience working with a transdisciplinary team. Additionally, the amount of science knowledge needed to design a coastal restoration project was significant. The Landscape Architecture students, who reported the largest drop in confidence, were the greatest learning curve regarding the underlying scientific concepts. The reported decrease in confidence of working in teams was likely a combination of struggles with teamwork and scientific content.

**Conclusions**

The planning and implementation of the Disturbed Coastal Systems class was an outstanding learning experience for the instructors and for the teaching assistant. Student products and feedback indicate that they greatly benefited from the opportunity to learn about other disciplines and about transdisciplinary approaches to addressing coastal protection and restoration.

Students in the science courses were asked to comment on the transdisciplinary experience as a means to help provide guidance for future collaborative classes. Specifically, they were asked to describe what made their Disturbed Coastal System miniprojects and final project “transdisciplinary” rather than simply interdisciplinary or multidisciplinary and to discuss what they learned about the other disciplines and disciplinary approaches during the semester. Comments were positive, indicating an appreciation for the opportunity to be part of a transdisciplinary group. One student wrote: “Overall I thought this class was a huge success. Students of various yet related majors successfully came together to generate unique and interesting ideas about how to restore our coast. . . . I think this is a great way to approach problems for real world situations because it is not just going to be one individual working on a project; you have to work as a team.”

Students in all of the classes improved in their understanding of discipline-specific and transdisciplinary concepts. For instance, students in the Geophysics seminar commented on the “change in attitude” of the nongeology students when the nongeology students developed a real understanding of the delta cycle (Roberts, 1997). The final plans were truly transformative and integrative. The students understood how to link across disciplinary boundaries (maybe even better than the faculty did!). Each of the final plans showed the work of individual students and specific disciplines, as well as transdisciplinary work. There were certainly difficulties (expected and unexpected) in bringing the three classes together, and things that we recommend for anyone contemplating a transdisciplinary course. The
main challenges and suggestions for avoiding (or at least minimizing them) are summarized in Table 2.

We have no plans to offer an identical class in the near future but anticipate using a similar model for future courses that may combine different disciplines. The university’s Sustainability Curriculum in Education Committee is made up of faculty members from many departments and provides an arena for discussions about future class linkages. Environmental challenges require contributions from many disciplines outside of the basic sciences, including law, political science, sociology, economics, and engineering, so interdisciplinary approaches to planning for sustainability are essential.

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**References**


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**TABLE 2**

**Challenges and recommendations.**

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Recommendations</th>
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<tbody>
<tr>
<td>There were distinct cultures among the disciplines, including emphasis on visual design in Landscape Architecture and on scientific data in Geology and Environmental Management Systems.</td>
<td>In addition to discussing general disciplinary approaches, faculty should exchange and discuss syllabi for typical courses.</td>
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<td>There were unstated assumptions about knowledge and understanding.</td>
<td>Preassessment should be used to evaluate whether fundamental assumptions in each discipline need to be addressed explicitly.</td>
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<td>Teaching assistant was not familiar with scientific approaches and literature so had difficulty assisting with material collection and student assistance for Geology and Environmental Management class.</td>
<td>If teaching assistants are involved, make sure that there are separate assistants for each class.</td>
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<tr>
<td>There was disparity in knowledge level and maturity among the students, with students at different academic levels and, even within disciplines, having diverse backgrounds and strengths.</td>
<td>For transdisciplinary courses, we recommend partnering classes of similar levels. Use a peer-evaluation system, mandatory attendance policy, and formative assessment rubrics to ensure that students are making the most of learning opportunities and that the faculty are addressing student needs (Turgeon, 2007).</td>
</tr>
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<td>Communication problems among group members were spotty—some students failed to respond to e-mail messages or to attend group meetings.</td>
<td>Class time should be devoted to discussing effective teamwork, and a contract among team members outlining expectations and responsibilities should be required for major group projects.</td>
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Introducing Transdisciplinary Problem Solving


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### Appendix

#### Disturbed Systems Knowledge Survey

1. You are a/an:
   - geologist
   - environmental manager
   - landscape architect

2. An approach that involves several disciplines, as well as the space between them to allow for new perspectives outside disciplinary boundaries, is considered:
   - interdisciplinary
   - ultradisciplinary
   - transdisciplinary
   - multidisciplinary

3. Louisiana’s coastal land loss has resulted from:
   - oil and gas exploration and production activities
   - sediment diversion into wetlands
   - natural compaction of sediments
   - a combination of a and c
   - c only

4. I work well with other students to complete team class projects.
   - true
   - false

5. Which of the following federal acts provides funding for coastal restoration?
   - CWA
   - CWPPRA
   - NEPA
   - CAA
   - NOAA

6. The presence of *Spartina patens*, with few to no other species present, is characteristic of what type of wetland?
   - swamp
   - freshwater marsh
   - brackish marsh
   - chenier
   - saltwater marsh

7. Biomagnification refers to:
   - plant enlargement caused by contaminants
   - an optical illusion caused by the presence of objects such as trees in the field of view
   - increase in concentration of an element at successively higher levels in a food chain
   - distortion of light in a water column

8. Which is an empirical relation that describes flow in porous media?
   - Bernoulli’s Equation
   - Darcy’s Law
   - Reynolds Equation
   - Ohm’s Law

9. Transport of sediment parallel to a coastline is driven by:
   - longshore current
   - tides
   - rip currents
   - undertow

10. Along the Mississippi Delta Plain, which mineral do you think will dominate the sediment composition?
    - muscovite
    - quartz
    - biotite
    - calcite
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