Given the cross-disciplinary nature of natural resource management, integrating fields of knowledge in natural resource curricula has become an important challenge for universities. We developed three models for integrating ecological and social science courses. The models varied in the degree to which they achieved integration in process, disciplinary content, methods of analysis, and relationship of integration to disciplinary distinctions. They were implemented sequentially, and course structure, pedagogy, and content were altered to emphasize particular aspects of integration and respond to students’ comments and administrative concerns.

By Clare Ginger, Deane Wang, and Louise Tritton

As the need to relate different disciplines to one another has become important in natural resource management, teaching “integration” in university curricula has become essential. At the 1991 Symposium on Forest Resource Management, participants called for a broader forestry curriculum and identified integration as essential (SAF 1992).

Integrating disciplines is sometimes cast as an issue of depth versus breadth (Hosner 1993; Perry et al. 1994; Fox et al. 1996; Jensen et al. 1998): educators risk producing graduates who lack either the depth of skills needed to work in their profession or the broad foundation needed for solving problems in today's world (Perry et al. 1994; Egan 1996; Fisher 1996). But integration can actually be defined as achieving both depth and breadth: one set of courses ensures depth within one discipline and another ensures breadth of exposure to other disciplines. Integration can also mean bringing multiple disciplines together in a block of courses (Fox et al. 1996).

We sought to achieve integration within a three-course block in the School of Natural Resources core curriculum at the University of Vermont. In developing courses to teach ecological and social sciences together with problem analysis, we addressed tensions between disciplinary and integrative thinking and sought to define integration in specific terms.

Curricular Goals

The School of Natural Resources offers degrees in environmental sciences, environmental studies, forestry, natural resources, recreation management, resource economics, and wildlife and fisheries biology. The 35 faculty and 500 students are distributed across these fields. The school's mission includes emphasis on integrating natural science and cultural perspectives to reflect the interdisciplinary nature of natural resource issues. Accordingly, integration has been part of the undergraduate core curriculum since 1986 (Manning 1998). In addition, students meet distribution requirements (e.g., social science, humanities, biological...
science, physical science) and requirements in their major.

In the core curriculum, integration intensifies as students progress through seven courses over five semesters. The first two courses (Natural History and Field Ecology; Nature and Culture) provide a contrast between learning the natural history of local sites and the history of environmental thought. The next three courses, which are the focus of this paper—Ecology, Ecosystems, and Environment; Social Processes and the Environment; Environmental Problem Analysis—are taken concurrently and are the first integrative component. The final two courses (Ecosystem Management; Environmental Problem Solving) address integrated natural resource management.

The content of the ecology course included concepts spanning spatial scales from individual organisms to landscapes (e.g., autecology, population dynamics, intraspecific and resource competition, community ecology, and island biogeography). Social science content came from political science, economics, and sociology and included government institutions, policy processes, cost-benefit analysis, and social movement theory.

Our goal was to combine ecology with social science to convey how these fields represent essential and potentially complementary but sometimes conflicting ways of understanding natural resource issues. Over time, we developed a framework for defining integration. It includes four elements: process, content, methods of analysis, and relationship to disciplinary distinctions.

The process element of integration refers to how the courses are taken by the students and delivered by the instructors. The requirement that students take the courses concurrently opened up such possibilities as joint assignments and cross-course grading. In addition, instructors of any one course could participate in the sessions for the other courses.

In content, integration means bringing together ecological and social science knowledge to describe natural resource issues. To achieve this, we used case studies with both ecological and political, economic, or sociological aspects. For example, endangered species issues provide an opportunity to examine species dynamics and reserve design as well as law and politics. Through the study of such cases, students could see how different fields of knowledge could lead to conflicting approaches for action.

For methods of analysis, integration means identifying links among analytical and conceptual frameworks from the social and ecological sciences. For

Table 1. Description of models.

<table>
<thead>
<tr>
<th>Model 1: Merged</th>
<th>Model 2: Shared lab</th>
<th>Model 3: Linked courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One 7-credit block</td>
<td>Two 3-credit disciplinary courses*</td>
<td>Two 3-credit disciplinary courses*</td>
</tr>
<tr>
<td>Eco. and social elements of 2 case studies</td>
<td>Disciplinary courses: social science and ecology frameworks with analysis of natural resource issues</td>
<td>Disciplinary courses: social science and ecology frameworks with analysis of natural resource issues</td>
</tr>
<tr>
<td>Instructor facilitated; topics within cases chosen by students</td>
<td>Instructor driven</td>
<td>Instructor driven</td>
</tr>
<tr>
<td>Case study; group projects</td>
<td>Disciplinary courses: lecture, small group work, open-forum discussion</td>
<td>Disciplinary courses: lecture, small group work, open-forum discussion</td>
</tr>
<tr>
<td>Mixed format: open-forum discussion, outside speakers, lectures, work group meetings, consultations with faculty, role-play exercises, debate</td>
<td>Shared lab: case materials analysis, integrative questions.</td>
<td>Integrative lab: case study; integrative questions; group projects</td>
</tr>
<tr>
<td>Full participation by two instructors in all sessions</td>
<td>Disciplinary courses: one instructor for each course</td>
<td>One instructor for each course</td>
</tr>
<tr>
<td>Group projects using criteria identified by students, individual responses to short answer and essay exams, by discipline</td>
<td>Exams, assignments, and exercises from individual courses, Grades for responses to integrative questions for each case shared across courses</td>
<td>Exams, assignments, and exercises from individual courses, Grades for responses to integrative questions for each case shared across courses</td>
</tr>
</tbody>
</table>

*Ecology, Ecosystems, and Environment met in two 75-minute sessions per week. Social Processes and the Environment met in two 75-minute sessions per week. Environmental Problem Analysis met for one 2-hour session per week.
example, benefit-cost analysis (used to assess economic impacts of policy choices) and energy optimization models (used to assess foraging strategies in animals) are based on the same conceptual approach and use similar quantitative skills. Concepts useful for creating bridges include scale, hierarchy, structure, function, and process. These concepts are important in both the social and the ecological sciences and provide a basis for making connections.

Finally, integration can be defined through its relationship to disciplinary knowledge. The idea of integration stands in contrast to disciplinary distinctions and challenges us to bring together such areas of study as ecological and social sciences. When we recognize both the parts and the whole, integrative thinking can be seen as more than a sum of the parts.

Models for Achieving Integration

We used three models for integrating social and ecological sciences (table 1). The models were taught sequentially over three semesters to groups of 60 to 70 sophomores and juniors from all majors by instructors with backgrounds in forest ecology and environmental policy. Instructors met regularly to coordinate activities, discuss ideas, and respond to shifts both in our understanding of integration and in the teaching resources available. What we report is more a case history that describes the models and our experience than a designed experiment.

Model 1. All teaching resources were merged into a seven-credit course built around case studies and small group projects. The cases included regional planning for forest issues and state regulation of water withdrawal from streams for snow-making. A collaborative teaching approach was used, in which students chose topics within the cases. Two instructors worked with three teaching assistants to develop and deliver material through various classroom activities. Students worked in small, multidisciplinary teams (based on majors in the school) on projects of their choosing (e.g., newsletter, brochure, talk show script) to integrate social and ecological knowledge about the case with portfolios of supporting information.

Model 2. Two separate courses focused on ecology and social sciences, each taught by one instructor. Students did readings, homework assignments, exams, and analytical papers. A lab served as the bridge course and focused on the analysis of three cases from both disciplinary and integrated perspectives. Cases included endangered species legislation, town decisions about water withdrawal from streams for snow-making, and regional planning for forest issues. The lab was developed and delivered by the instructors from the disciplinary courses plus a course assistant and four teaching assistants. Each case began with a panel of experts followed by small group analyses using frameworks from ecological and social sciences and ending with integrative role-play exercises. In addition, students responded individually to integrative questions.

Model 3. Three courses, each taught by a single instructor, were linked through common topics. As in Model 2, ecology and social sciences were taught as disciplinary courses, with the same expectations for student work. The lab integrated ecological and social sciences through case studies and small group projects; a third instructor was brought in to establish connections between the discipline-based courses. Cases included regulation of timber cutting and mercury contamination in rivers. As in Model 1, students worked in small, multidisciplinary teams on projects to integrate social and ecological knowledge about the cases. In addition, they responded individually to integrative questions for the cases.

Comparison of Models

As we proceeded, we defined integration more specifically and made changes in the courses to adjust for our experience. This was an iterative process of learning and theorizing in which we incorporated both our evolving ideas and student responses. The varied levels of integration achieved for each aspect of the concept are compared in table 2.

Integrating course process. Model 1, the fully integrated seven-credit course in which two instructors worked together, provided the most integrated process. Full participation by instructors grounded in different disciplines forced us to become aware of disciplinary distinctions and similarities.

Model 2, with two discipline-based courses bridged by a shared lab, resulted in a lesser degree of process integration. However, course process remained linked because the instructors worked together on lab sessions, coordinated activities with the disciplinary courses, and shared teaching assistants; also, some assignments in the lab contributed to grades in the disciplinary courses.

Model 3 resulted in the least amount of process integration because a third instructor handled the lab, making each course the responsibility of a single person. To achieve process integration, the lab instructor attended most sessions of the disciplinary courses and made contributions to connect them when opportunities arose, all three instructors met regularly to coordinate activities, some teaching assistants were shared, and some assignments in the lab contributed to grades in the disciplinary courses.

Integrating content from different disciplines. Model 1 integrated the ecological and social sciences the most because all sessions used case studies that reflected the multifaceted aspects—ecology, politics, economics—of natural resource issues. Students saw how these issues were interrelated, and in defining areas for closer study, they asked questions about both ecological and social aspects of the cases. Model 1 paralleled the experience of such issues outside the classroom as involving con-

| Table 2. Ranking of course models based on integration criteria (1 = most; 3 = least). |
|----------------------------------------|----------------|----------------|----------------|
| Integration criteria                  | Model 1 | Model 2 | Model 3 |
| Course process                        | 1       | 2       | 3       |
| Disciplinary content                  | 1       | 2       | 2       |
| Analysis                              | 3       | 2       | 1       |
| Integration and disciplinary           | 3       | 1       | 1       |

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tent across disciplinary fields.

Models 2 and 3 resulted in lower degrees of content integration, given the course structure. Ecological and social science concepts were taught in separate courses, and opportunities for integrating this material arose primarily through case study in the lab. Content integration in lab sessions was achieved through three mechanisms: multidisciplinary panels of experts provided a window for students to see how natural resource issues involved both ecological and social processes; role playing required students to use material from ecological and social sciences; in preparing projects and responding to integrative questions, students drew on their ecological and social knowledge.

Integrating methods of analysis. Model 3 provided the greatest degree of integrating methods of analysis across disciplinary boundaries because the lab focused on integrating the frameworks from the discipline-based courses through case study analysis. Thus, ideas for integration were emphasized. During lab sessions, in journal writing, in group projects, and in responses to integrative questions, students examined how the frameworks could be used in concert to understand natural resource issues.

Model 2 provided fewer opportunities for integrating methods of analysis because of the way the lab sessions were structured. Models 2 and 3 both emphasized analysis, but in Model 2 the analyses were often defined in disciplinary terms, with frameworks taken directly from the discipline-based courses and used in exercises during lab sessions. Integration of analysis occurred in the final session for each case and through responses to integrative questions. The integration of analysis through group projects that was a part of Model 3 was absent.

Model 1 produced the fewest opportunities for integrating analyses from different disciplinary perspectives, not because of its structure but because of the content of class sessions and assignments. In Models 2 and 3, the instructors defined content and focused on frameworks of analysis. In Model 1, students identified questions to address during class. They were inclined to describe the specific content of a case from various perspectives rather than analyze the general political and ecological processes under way. Because they defined their projects, their work reflected this focus on description. We inserted material on frameworks of analysis during some sessions, but comprehension of this material was oriented around exams and short assignments defined in disciplinary terms. Thus, in Model 1, because of how we conducted the class, we did not achieve integration of analysis across disciplinary boundaries.

Integration with distinctions among fields of inquiry. Models 2 and 3 provided more opportunities for recognizing the distinctions between disciplines. Students examined phenomena through distinct disciplinary lenses, then brought the pieces together and responded to the complex character of natural resource issues; they saw the social and ecological elements intertwined in ways that made it difficult to tackle one aspect of an issue without also accounting for the others.

In Model 1, even though students learned that social and ecological elements of natural resource issues were intertwined, they had less opportunity to examine the relationship between integration and disciplinary distinctions. The idea of bringing together separate ways of understanding the world (e.g., ecological, political, economic), though present through case study, was not paralleled through course structure. Lacking discipline-based courses, Model 1 did not communicate the idea of integration as joining fields of knowledge that have been separated through tradition and practice.

Students' Responses and Insights

Overall, students supported the idea of integrating ecological and social sciences. In one semester’s evaluations, 59 of 60 students indicated that integrating material across disciplinary fields was worthwhile. In addition, they found the case studies helpful. Responses to specific forms of integration were apparent in classroom dynamics as well. In describing students’ responses, we do not quantify them because ideas expressed by one student can lead to useful insights. Responses to Model 1 contributed to the development of our framework of integration and helped us develop Models 2 and 3.

When choosing what to study in Model 1, students focused on describing case content from multiple perspectives, this drew our attention to the difference between integration through description and integrated analysis. At the same time, not all students were comfortable with choosing what to study, and some saw a lack of structure in Model 1. In the classroom and written evaluations, students expressed uncertainty about what they were expected to learn. This raised the possibility that understanding disciplinary distinctions is critical to finding meaning in integration. Further, it was likely that sophomores did not have enough grounding in each discipline to have something to integrate.

Thus, in developing Model 2, we established clearly defined disciplinary courses, shifted our pedagogical approach to instructor-chosen topics and exercises, and created a structure for case analysis that included both disciplinary and integrative work.

In response to Model 2, students appreciated the multiperspectival panels and role-playing exercises in the lab. Question-and-answer periods during the panels were lively and students appreciated the range of views. They also debated issues during role-playing exercises. However, students found the discipline-based analysis exercises in the lab sessions redundant: they indicated they were already familiar with the ideas in the exercises. Several students thought the faculty did not fully represent the difficulty of integrating disciplinary perspectives; perhaps we had overemphasized disciplinary distinctions and not spent enough time on integration. Thus, in Model 3, we restructured the lab sessions to better capture the complexity of integration.

In response to Model 3, students thought they had to work too hard to integrate material across disciplines. For some, the work appeared to be too much for the seven credits in their schedules: they complained about the difficulty of the lab material and the demands on their time outside class. It is important for instructors to discuss,
among themselves and with students, the complex nature of integration and its relationship to discipline-based learning. They should also consider carefully what can be accomplished in one semester.

Other Issues

Integrating material across disciplinary boundaries makes demands on instructors. First, as noted by Fox et al. (1996), it requires time and goodwill to define content, arrange schedules, and establish teaching assignments. Second, it requires an intellectual commitment to understanding the frameworks used outside one’s own discipline, to explore what it means to cross disciplinary boundaries, and to define integrative thinking in systematic ways.

Fox et al. (1996) also noted the need for administrative support. Administrators who support the concept of integration can take the lead in curriculum development, and it was through this type of support that the faculty in the School of Natural Resources developed the idea of joining ecological and social sciences through an integrative lab. Support for the additional resources needed to teach integrated courses is also critical. These courses required more time than traditional discipline-based courses in both development and delivery.

In our case, we addressed differences in understandings between instructors and administrators about the meaning of integration and team teaching. Although instructors focused on developing bridges through simultaneous treatment of disciplinary ideas, administrators had assumed that disciplines would be treated sequentially. Different expectations about the time required to teach the courses were the result: the instructors’ collaborative approach took more time than the sequential team-teaching approach. We discontinued the seven-credit block in Model 1 in response to discouragement from administrators, who were responding to institutional incentives for efficient instructional methods and a balance between research and teaching.

A third issue we faced was pedagogy. The standard approach of the life sciences at the undergraduate level is lecture and information transfer; in the social sciences discussion and debate are preferred. Bringing these pedagogical approaches together can be a challenge. Moreover, using a collaborative teaching model that includes students in making decisions about what to study can affect the focus of integration; in the case of Model 1 that led to an emphasis on description rather than analysis.

Findings

In confronting the challenge of integrating ecological and social sciences for undergraduates, we derived several benefits. Bringing our disciplines together helped us gain familiarity with one another’s fields. The shared assignments and grading provided a focus for discussion among instructors while communicatng to students that the courses were linked. In letting students choose material to study, we saw the difference between describing an issue from various perspectives and analyzing it. Finally, as we balanced disciplinary material and integrated material, we saw how integration gains meaning through its relationship to disciplinary distinctions.

With each model, we altered course structure, pedagogy, and content to better achieve particular aspects of integration. Our choices were affected, in part, by the goals of the core curriculum. We were expected to provide students with a foundation in ecological and social sciences while introducing ideas about integrating these fields. Model 1 was a good learning opportunity, but given its position in the curriculum and the level of students, it did not provide a clear enough structure for teaching the analytical frameworks of our disciplinary fields. In Model 2, therefore, we emphasized disciplinary frameworks, dropped the collaborative teaching approach, and addressed integration in the structured environment of a shared lab.

In Model 3, we used the lab to emphasize the integration of analytical frameworks from the disciplinary courses. This increased the level of difficulty in the lab. Although problematic for some students, it better represented the challenge of integration.

With different levels of students and curricular goals, different choices may be appropriate. For example, Model 3 seems to provide disciplinary depth and interdisciplinary breadth appropriate for sophomore and junior majors in natural resources, but Model 1 could be suitable for seniors or graduate students who have a foundation in their majors.

Although natural resource professionals have generally identified integration as an important goal, educators are just beginning to define the concepts, develop the frameworks, articulate the trade-offs, and assess the outcomes in translating this goal into viable undergraduate curricula. Developing a deeper understanding of integration can help clarify goals and approaches for achieving integration in single courses, blocks of courses, and entire curricula.

Literature Cited

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