

Chapter 9

Learning Interdisciplinary Problem Solving and Leadership Skills: A Comparison of Four Designs

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ABSTRACT

We describe four venues for teaching interdisciplinary methods and skills: classroom, workshops, field trips, and applied appraisals. Interdisciplinary method and skill are essential for successful leadership and conservation at all scales in today's complex, dynamic world. Formal university courses that systematically teach the method and skills and their application through cases are very helpful. Workshops are an excellent way to introduce interdisciplinarity to working professionals, who can make connections between concepts and their own experience. Field trips are ideal vehicles to help participants develop problem-solving skills without the real life costs of being wrong, although they are not conducive to systematic teaching of interdisciplinary method. Similarly, applied appraisals can help real life participants to identify their role and influence in the social and decision processes in which they are involved, but are not designed for systematic exploration of the methods or skills. Learning interdisciplinarity is easy for some people, but difficult for others. Many professional and institutional incentives work against learning interdisciplinarity and applying it in practice. Nevertheless, many former students and professionals in these four designs have told us, and have demonstrated through their professional work and experiences, that interdisciplinarity has been invaluable to them.

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Key words: *Interdisciplinary, problem-solving, leadership, skills, education, policy, common interest, policy sciences*

INTRODUCTION

Those who are skilled in interdisciplinary method offer a mix of expertise, analysis, sponsorship, authority, leadership, process management, and decision-making experience to help address important problems (e.g., large scale conservation, Chrislip and Larson 1994, Ryan 2001). They have a highly sought after “value added” skill set that is sometimes also called the policy sciences. We use the terms policy sciences and interdisciplinarity interchangeably. This interdisciplinary skill set is an explicit, systematic package of problem solving, contextual operations, an analytic habit, and critical mindset as described below (see Clark 2002). This skill goes far beyond disciplinary and multidisciplinary approaches, or merely possessing an aspiration, desire, or predisposition to be interdisciplinary or even a sense of one’s self as an “interdisciplinary.”

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Furthermore, interdisciplinarity is unlike views held by conventional problem solvers (e.g., disciplinarians, multidisciplinary, positivists and post-positivists). In contrast, effective interdisciplinary problem solvers exercise skills in critical thinking and judgment, integrating diverse knowledge and experience in unique contexts, large and small, in order to influence and improve policy-making. Individuals can learn interdisciplinary skills in university programs, on their own, on the job, through workshops or other specialized training, or in some other way. No matter how they learn the skills, skilled interdisciplinary problem solvers ensure that decision processes are appropriately managed, technical credibility is achieved, and problem-solving groups are enabled to produce reliable and persuasive decisions that are supported by a broad audience and work in practice. Brunner et al. (2002, 2005) use interdisciplinarity in this sense in their treatment of adaptive governance in natural resource conservation (see Chapters 1, 2, 3, this volume). This is how enduring solutions to large scale conservation and other problems come about.

Effective leaders show good timing, respond to clear needs, and may or may not be highly visible to the public. They inspire commitment and action, lead in problem solving, encourage broad-based involvement, and sustain hope and participation. Chief among their skills is helping to clarify goals, map events and social interactions, identify the underlying conditions that drive these events, project future outcomes, and select practical alternatives. Leaders understand the value demands and identities of potential followers, and use this knowledge to fully engage and meet the needs of participants. In

short, they raise people and themselves to a higher level of motivation by empowering others and providing a new sense of perspective and energy. Finally, effective leadership includes promoting and safeguarding the process of deliberation in the common interest.

In this chapter we review our 40+ years' combined experience in teaching, learning, and applying the method of interdisciplinarity in diverse applied and academic settings, focusing largely on environmental studies, science, and management and policy problems. We examine the goals and challenges of our teaching, describe four complementary pedagogic designs (i.e., classrooms, workshops, field trips, and applied appraisals) that we have used, and offer recommendations to more effectively teach, learn, and apply the method.

EDUCATIONAL GOALS AND AN INTRODUCTION

Harold D. Lasswell conceptualized the interdisciplinary method and characterized a skill set more than 60 years ago (Lasswell and McDougal 1943). Lasswell (1971 and earlier) called this skill set the policy sciences. He had a pragmatic view of the way the method should be used: a skilled problem solver must be problem oriented and analyze social and historic contexts in order to understand policy processes, which are actually political/value phenomena. His analytic framework, a logical and comprehensive model, touches on the key parameters in social and decision processes. The method offers a way to see problems and solutions that are practical, macroscopic as well as microscopic, and sometimes radical, and they offer an overriding goal for policy making—human dignity in healthy environments for all people (McDougal et al. 1980, Lasswell and McDougal 1992).

The interdisciplinary method, developed by Lasswell and colleagues last century, offers an analytic framework, a set of concepts, and a vocabulary that can help people solve problems (see Lasswell 1971, Lasswell and McDougal 1992, Clark 2002). Teaching the method and fostering these problem-solving skills is challenging. It is sometimes hard to coach people in the “pragmatic and heuristic attitudes” embodied in the interdisciplinary method and to focus them on better understanding policy problems and solutions in the context of serving common interests (Marvick 1977: 66). The challenges are, first, to encourage people to examine contexts thoroughly and to base their learning and action on evidence (as time and resources permit), and, second, to clarify for them the paramount significance of their own standpoints and perspectives in directing their inquiry of problems and solutions. Learning and applying these skills present an easy reach for some people, yet can be beyond the grasp of others. Command of the method and skills is influenced by students' predispositions and preparedness, their focus of attention (e.g., “boundedness”), the dominance of conventional (i.e., technical, positivistic) outlooks and traditional disciplines, the difficulties of clarifying their standpoint, the challenges of integrating knowledge and action, experience levels, and confusion about the nature and significance of interdisciplinarity and problem-solving. However, our experience has shown that most people can improve their problem-solving through even a little exposure to

interdisciplinarity. Using parts (e.g., contextual mapping, problem orientation, decision process appraisal, standpoint clarification) selectively can be invaluable.

The interdisciplinary approach focuses on structuring problems and finding solutions. It is also a way to address problems of meaning (Brunner 1997a,b,c). It is particularly useful for large scale, seemingly intractable problems, but useful at all scales. The method helps people develop skills in critical thinking, observation, management, and technical matters (summarized by Arnspiger 1961, Muth and Bolland 1983, and others). The analytic framework can be represented as in Figures 1 and 2 (see page 180, and the skills can be described as in Table 1 (see page 182).

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Teaching goals

We teach interdisciplinarity in formal classes, workshops, field trips, and applied appraisals (see Patton 1997). Our broad teaching goal is to help students, professionals, government authorities, and advocates, through the rigorous application of interdisciplinarity's skills and perhaps new ways of thinking, to become leaders in real-life problem-solving contexts, to equip them with a method and skill set to address problems, regardless of the form they take or their personal or geopolitical location. We have developed our educational goals specifically in arenas for conserving, managing, and sustaining natural resources and allied social and policy arenas.

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Thus our work is in keeping with Lasswell's later work, in which, in Marvick's (1977: 4) understanding, Lasswell was preoccupied with pedagogic questions, such as how to "equip a cadre of modern intellectuals so they can significantly help to cushion the shocks in store for humankind, as a world of cosmic complexities comes inexorably into being." For Lasswell, these shocks and complexities involved problems in modernity, democracy, and economy, as well as personal freedom and social justice. Degradation of the biosphere, climate change, globalization, and security issues (both national and international) might also be added to this list, as described, for example, by Dahl (1998), Turner et al. (1990), Sandler (1997), National Research Council (1999), Harper (2001), and Brezinski (2007). These forces, factors, and accelerating rates of change could lead to horrendous social disruptions,

psychological stress, and irrational or maladaptive behavior that could threaten public and civic order everywhere (see Muth et al. 1990). Interdisciplinarity was invented to help people meet these kinds of policy problems—small and large, personal and global.

The goals of students are diverse. (For the purposes of our discussion here, we will use the term “students” to include not only college and university students, but also participants in workshops and field trips from government, advocacy, and professional backgrounds.) Graduate students in the Yale School of Forestry and Environmental Studies program, where Clark teaches, for example, come from a highly selective and self-selected professional and admissions process in the School. About one-third of the students are international, and come from several dozen countries. As a group they present a diverse profile not easy to summarize. At the risk of oversimplifying their perspectives, we have observed that on entering the school many students believe that improving policy for managing natural resources means learning positivistic science through a specific discipline (such as economics, political science, or biology), presenting objective findings to decision makers and the public, and trusting that policy will automatically be improved as a consequence (see Pielke 2007). They see their basic job in graduate school as acquiring scientific knowledge (positivism and facts) and skills in, for example, communication, cost-benefit analysis, conflict resolution, geographic information systems, computers, public relations, or some other set of disciplinary methods—a mix that they assume will provide them with a complete tool kit for effective professional leadership. Their views, however, often change over their university careers, especially those who take courses in interdisciplinary studies, including the policy sciences. This is evidenced in what they say, how they write, and how they conduct their work.

Wallace teaches interdisciplinarity as part of his curriculum at Ursinus College where the student population is much more homogenous than Yale’s. As well they are younger and tend to enter the academic realm with less of a bias toward positivistic or disciplinary problem-solving strategies. However, the explicitly interdisciplinary critical method and thinking approach of interdisciplinarity is a new experience for them too, and the (anecdotally observed) cognitive changes that occur during their education show that they accept the tenets of interdisciplinarity’s problem-solving tools. They perceive how interdisciplinarity works, and they leave their undergraduate years with an understanding of the importance of its goals and skills.

Workshop and applied appraisal participants, however, are quite different from university students. Participants are between 30 and 60 years old and have positions with nongovernmental organizations, state and federal agencies, and appointed or elected jobs. A few are retired from business, law, or some other profession. Most have between a decade and several decades’ experience on the job after college or graduate school. They are often mired in the details and complexity of everyday work and have little time to reflect, clarify their standpoint, or stand back from the blizzard of daily minutiae in order to gain an overview of the social and decision processes of which they are a part. Many are solidly conventional, but many are also open to hearing about and learning interdisciplinarity.

This diversity of motivation, knowledge, and experience has prepared many students to engage themselves with interdisciplinarity. Some students are strongly predisposed to shift from conventional to a more self-reflective understanding of themselves, problem-solving, and their world. Nonetheless, there are educational challenges that must be met.

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Educational challenges

First among the challenges in teaching and learning interdisciplinarity is the fact that students do not yet share a “stable frame of reference” (e.g., the policy sciences analytic framework). People come with diverse backgrounds, disciplinary knowledge, and expectations. Some are quite experienced and seem predisposed to appreciate interdisciplinarity, and may even have invented a partial set of equivalencies on their own. The concepts and terms come easily to these individuals. Most students, however, are not prepared to engage interdisciplinarity fully or directly in the beginning. Some resistance is expressed. By the end of their educational experience, however, most are receptive to interdisciplinarity and knowledgeable about what is required of them to apply the method skillfully. Regardless of their initial receptivity, most students pick up interdisciplinarity’s ideas selectively when first exposed to them. For instance, the concept of problem orientation appeals to some people, whereas others seem to “get a handle” on it through an understanding of social process, and for some the notion of decision process gives them access to the whole. In an instance, based on his professional experience, one individual was at first taken by the termination function and through his exploration of that category subsequently came to embrace interdisciplinarity. This was because, as an agency professional, he was charged with closing down a successful captive breeding center for rare species. In the face of much resistance to his assigned task, he learned how to think about the task, proceed in a humane, ethical way, recognize and reward the good faith contributions of employees, and smooth a transition that worked for everyone involved. Resources and personnel were used elsewhere to great conservation advantage.

A second challenge is overcoming “convention.” Many students are decidedly “bounded” because of their restriction to ordinary, everyday concepts, language, and method. Many, perhaps most, students come with a conviction, based on their educational and personal experience, that solving problems means carrying out positivistic, disciplinary operations (e.g., cost-benefit analyses, ecological surveys, social assessments, legal analyses, statistical calculations, see Schön 1983, Brunner and Ascher 1992, Morcol 2001).

Students’ bounded focus of attention, and thus their problem-solving efforts, are generally limited to selected situational factors and specific biophysical entities (e.g. soils,

water, plants, animals, atmosphere), the people present (“politics”), or organizational “imperatives” (e.g., authority relations, structures, values). When adopting a problem-orientation, for example, students tend to describe and analyze trends and conditions in ecological variables while neglecting to clarify goals, make projections in social and decision process, or devise workable, context-specific alternatives. In all cases, they overlook the importance of clarifying their own standpoint.

Typically, many students believe that improving decision making is a matter of increasing the amount of scientific (factual) information available to the decision process. According to Pielke (2007) and others, this “linear science-to-policy” model, in which scientific information always feeds into policy decisions, has been shown to be misleading in practice. The other misleading model students typically possess is the “public deficit” view, in which the public is seen as ignorant or lacking in knowledge, and the job of the problem solver is to generate information to give the people. Both models seek to upgrade the substantive rationality in policy making. In mapping social process, students tend to focus on people, organizations, and the “personalities” and “politics” of the situation while failing to explore systematically the full range of perspectives, the base and scope values at play, participants’ strategies, short- and long-term outcomes and effects on value institutions, or other factors.

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When it comes to decision process, students tend to focus on formal laws, positivistic science, advocacy, and the courts, while paying less attention to the value shaping and sharing process and the interrelated functions and standards that constitute a complete decision process. They pay attention to different functions of the decision process to varying degrees, usually overlooking some altogether and ignoring the recommended standards of quality decision making. They often express the notion that poor decision making results from too much “politics” and too little “science.” In short, some students conventional, bounded outlook predisposes them to understand the policy process in selective and misleading ways. They thus fail to perceive the blind spots and omissions that impede their own comprehensive understanding of policy process (e.g., large scale conservation), including their own standpoint biases.

In describing their goals, many students claim that they want to gain skills in how to translate ideas into solutions, empower people, strategize, and encourage constructive technical and social change. They want to be holistic in their approach and keep the “big picture” in mind. They envision themselves bringing together coalitions of people to solve problems collectively and hope to learn integrative skills. Highly optimistic, smart, sociable, and articulate, they have a sense of purpose and are dedicated workers. They often strive to develop good ideas, learn to listen, maintain open minds, pay attention to context, and become self-reliant. They seek to be

inclusive of diversity, realizing that there are lots of ways to achieve good conservation outcomes and that they must thus be flexible, experimental, and “learning” oriented. They understand the importance of cooperation, and they find ways to work together by talking with people, setting good examples, mobilizing others to solve problems, and gaining broad support. They seek applications in a wide variety of terrestrial, aquatic, and marine situations all over the world. Many are highly skilled in positivistic science and the disciplines, GIS, and computers. Their experience is also broad, including the Peace Corps, the United Nations, governments across the globe, high-profile as well as small-scale NGOs, and a multitude of national and international projects in rural and urban communities. Few aspire to be leaders in the command-and-control mode of simply telling followers what to do. They strive to understand the needs and interests of people. Finally, they want hands-on experience and want to do the needed work on the ground themselves. In many ways they are seeking interdisciplinarity and the skills it fosters, but often do not know it.

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Many students, including participants in workshops and fieldtrips, show a conventional understanding of themselves and their world in the beginning. They accept the received set of ordinary, everyday conditions surrounding them as commonsense, normal, and natural, which leads them to see complex social and decision process problems in conventional terms too, for example, merely as conflict among personalities, as interpersonal and inter-group politics, as institutional territoriality, or as funding limitations. In contrast, an interdisciplinary approach introduces a functional understanding of the problems that arise from social process, decision process, competing myths, differing problem definitions, values and institutions, and other dynamics of social relations. The interdisciplinary framework that we use serves as a “stable frame of reference” that permits users to see and analyze any social and decision process at the level of functional relationships.

A third challenge is that students find it difficult to clarify their standpoints and integrate what they know into a judgment for which they are willing to accept responsibility. They tend to assume at first that they are more or less objective, neutral, and operating in ways that serve the common interest, and some are surprised to discover their own biases. This disconnect between the personal theories of action that people espouse and those they implement is common (Argyris 1993). Many students find it difficult to confront their own epistemology, cognitive status, disciplinary prejudices, and conventional notions about policy processes, other people, values, and politics. It is, in fact, possibly the most difficult part of learning interdisciplinarity. They are also typically unable to articulate how they understand what problems are and how to solve them and to integrate knowledge for decision purposes (see Schön 1983). Interdisciplinarity courses, workshops, field trips, and

applied appraisals all ask people to learn a new way of thinking and a new view of themselves as individuals, problem solvers, and leaders. When students are asked to think differently, they are really being asked to *be* different. Some students are open, flexible, predisposed, and more than ready to “shift gears” and embrace interdisciplinarity. Others resist for many reasons, some of which we have described above.

Finally, there is confusion about what interdisciplinarity is. In the university setting, students are bombarded with models, theories, and methods, and they often assume that interdisciplinarity is just one among many more or less equally valid or useful competing theories, approaches, or paradigms about the world. In addition, many partial “equivalencies” of interdisciplinarity have been invented in the various disciplines, and the authors of each of these promote their approaches as new or revolutionary. Students have no basis intellectually or experientially to compare the theoretical coherence or practical utility of various constructs, old or new. This is confusing to some students, who may lose their way or orientation, but after they gain enough knowledge of interdisciplinarity they often come to see that this approach systematizes their understanding of problems and contexts, gives them a way to understand all the other models, theories, and methods, opens up the possibility for them to understand their own standpoint, and provides them with a more practical way to address problems of concern.

These challenges are similar to those described by Brunner and Ascher (1992), Brunner (1997a, b,c), Clark et al. (2000b), Clark et al. (2002), and many others. Brunner (1997a: 219-221) observed that (1) students “misunderstand interdisciplinarity as merely one of many parallel approaches to public policy,” (2) “were concerned that their intellectual control depended upon a choice among partial approaches,” and (3) “often presumed that theory in the social sciences was inadequate for policy purposes.” His students requested that his seminar provide (1) “more examples of knowledge application in interdisciplinarity,” (2) “more emphasis on knowledge integration,” and (3) “more explicit attention to self-orientation in the policy areas selected for individual term papers” (p. 222-23). Our students make the same requests. These challenges are more or less remedial with appropriate instruction and experience.

Educational designs

Interdisciplinarity can be taught, learned, and applied through diverse designs. Semester-long classes offer the most time to learn interdisciplinarity more formally and to conduct case applications. Short workshops combine theory and cases focused on specific problems and skills. Field trips are more “hands-on” experiences that bring students into direct contact with problems, the people involved, and their situations. They are more salient in personal terms. Applied appraisals can take many forms, varying from a single day of discussion to a series of meetings over time in which an explicit exploration of methods is possible and excellent command of the method and skills is required. Although the goals and challenges in teaching and learning interdisciplinarity are similar across all four venues, each has unique features. There are other ways, of course, to learn (e.g., from reading and experience on one’s own or

discussion with others who are already skilled). We focus on these four approaches here based on our experience with them and because they have utility.

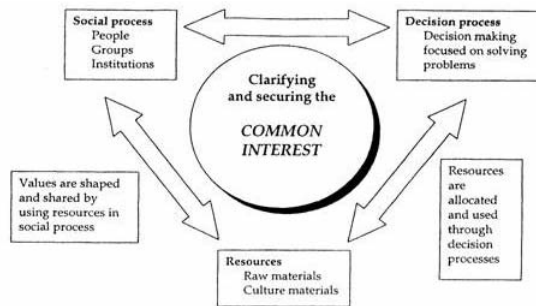
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Basic content design

No matter what the educational setting, in all cases we try to teach the interdisciplinary framework in one way or another (Figures 1 and 2). Our means vary depending on the audience, time, and educational design. In the classroom we can address the method, concepts, vocabulary, and the framework's elements in sequence, whereas in workshops, field trips, or applied appraisals we tend to focus on "problems" first and bring in social and decision process considerations as the problem is explored. We emphasize standpoint clarification in all cases.

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Figure 1 A generalized view of the natural resource management policy process. People carry out decision processes in order to allocate and use resources, which affects how values are shaped and shared in society. The process is the means by which people clarify and secure their common interests



Source: Clark 2002: 15

Figure 2 The principal dimensions, categories, and terms of interdisciplinary approach to problem-solving organized into a framework



Source: Clark 2002: 10

We generally begin by describing the challenges that confront professionals in the complex context in which the students are working or will work. If possible, we offer an overview of social science theory about individuals in society (i.e., social process) and then list, describe, and illustrate the categories of problem orientation, social process mapping, and decision process mapping, along with values, the maximization postulate, and the principle of contextuality (only in applied appraisal does this step sometimes become implicit, or “coded,” depending on the background and preparedness of the students). Regardless of the context, it is essential to present all this material in light of the overriding goal of human dignity. We employ problem orientation to define problems and help students to clarify their standpoints, examine methods available to map, analyze, and present results, and examine human rights and common interests. The manner in which we cover this material varies, depending on the context, from a methodological and explicit exploration in a semester-long class to an applied appraisal’s more limited opportunity to identify the relevance of human dignity, values, and common interest in a narrow context.

In all our educational designs we focus on the concept of human dignity and common interest. We emphasize that human dignity begins with individual people. Individuals are valuable in themselves; they are not means for some other end (e.g., labor/economics). Dignity concerns both the individual (an identity with patterns of loyalty and desire for respect and well-being) and society (the community collective in which individuals live). According to Kelman (1977: 48-49), human dignity is about the individual in a community context, wherein the person is “part of an interconnected network of individuals who care for each other, who recognize each other’s individuality, and who respect each other’s right.” It is also about the basic notion that individuals are entitled to live their own lives around their own goals and values, and whether they are capable of making free choices.

¹ Basic values are power, wealth, enlightenment, skill, respect, affection, well-being, and rectitude.

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We stress that a common interest is one that is widely shared and embraced by people in a community, and that a common interest is at stake in most cases because people with their special interests are interacting in a community. Common interests are difficult to clarify and secure in advance or in the abstract. There is no single formula for deciding a common interest in any or all situations. There are, however, three tests—procedural, substantive, and practical—that can be used to help us make informed judgments about common interest processes and outcomes in specific contexts useful to appraise social and decision process (Brunner et al. 2005). For example, it is known that voluntary approaches to community problem-solving serve common interests better than coercive approaches. We try to assess whether programs are inclusive and allow for responsible participation, whether they take into consideration valid and appropriate concerns of the participants, and whether they uphold the expectations of those who participated in good faith. This approach

increases our capacity to appraise policy processes and improve them to better serve the common interest.

One way that we introduce interdisciplinary problem-solving concepts is as a basic four-part set of skills (critical thinking, observation, management, and technical matters; see Table 1) that can be represented with questions, analytic categories, and operations (Table 2). *Critical thinking* involves carrying out the five intellectual tasks of problem orientation. *Observation* and *management* focus on what to observe, research, and manage. *Technical* skills include qualitative and quantitative expertise in the natural and social sciences that provide professionals with distinctive tools for addressing problems, especially those requiring a procedural disciplinary focus. These skills target social and decision processes and the observer/researcher/manager (i.e., the analyst). Mapping social and decision processes in any policy problem will typically suggest productive lines of investigation and alert students to aspects of the political landscape that can help in solving problems.

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Table 1 Skills essential for interdisciplinary problem-solving (after Lasswell and McDougal 1943).

Skill	Description
<i>1. Skills of Thought (Critical Thinking)</i>	
Goal-Thinking	Normative standpoint. Value clarification. ¹ Basic values of democracy and how to relate them operationally to people and concrete situations.
Trend-Thinking	Historic standpoint. Past trends appraised according to the degree of goal attainment and the distribution of basic values.
Scientific-Thinking	Scientific standpoint. Identification of variables that condition the democratic value variables.
Future-Thinking	Projective standpoint. Creative thinking about future probabilities appraised according to the degree of goal attainment and the distribution of basic values.
Alternative-Thinking	Practical standpoint. Invention, evaluation, and application of alternatives or solutions to overcome problems and achieve goal.
<i>2. Skills of Observation</i>	
Extensive Procedures	Professional observes a particular situation for a brief time and uses simple methods, such as rapid assessments, brief surveys, and cursory reports of a situation.
Intensive Procedures	Professional observes a particular situation for a long time and uses complex methods, such as individual behavioral studies, population or community studies, and detailed ecological and human studies of historical or current situations.

<p>3. <i>Skills of Management</i></p> <p>Primary Relations</p> <p>Public Relations</p> <p>4. <i>Skills of Technicality</i></p>	<p>Persons with whom a professional deals individually.</p> <p>Persons with whom a professional deals as members of a larger group (e.g., the public, students, bureaucrats).</p> <p>The distinctive skills of the professional, such as evolutionary and ecological theory, qualitative and quantitative methods, statistical and computer skills, theoretical and applied social skills, including social process or context mapping and communication skills, both written and oral.</p>
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Table 2 Interdisciplinarity can be taught as a four-part set of skills for effective problem-solving. These are listed in the first row, followed by a set of questions, and then by the operations and/or categories to be researched and managed and examples of methods that might be used. These concepts and terms are described in Lasswell (1971).

Critical thinking	For both: Observation Management		Technical concerns
How to be both procedurally and substantively rational?	What to observe and research?	What to manage?	What disciplinary-based tools are needed?
<p>Tasks in problem orientation</p> <p>Goals (value task)</p> <p>Trends (historical task)</p> <p>Conditions (science task)</p> <p>Projections (futuring task)</p> <p>Alternative (practical task)</p>	<p>Social process – context</p> <p>A. Others</p> <p>Participants experts authorities special interests “unknowledgeable” nonhuman life forms</p> <p>Perspectives identity expectations demands myths</p> <p>Situations (arenas) ecology (space/time) institutions crises</p> <p>Base Values well-being, power, wealth, affection, skill, respect, rectitude, enlightenment</p> <p>Strategies educational diplomatic economic force</p> <p>Outcome-Decision Process intelligence – planning promotion – debating prescription – deciding invocation – enforcing application – admin. appraisal – evaluating termination – ending</p>		<p>Theory/methods/tools</p> <p>Knowledge system positivism post-positivism</p> <p>Discipline(s) anthropology ecology economics history literature political Science philosophy psychology sociology others</p> <p>Interdisciplinary</p> <p>Theories evolution relativity others</p> <p>Qualitative, quantitative open-ended surveys questionnaires sampling mathematics statistics others</p> <p>Technology microscopes remote sensing computers GIS others</p> <p>Methods cases</p>

	Effects – Decision Process innovations – practices diffusion – restriction B. Self (Clarify Standpoint) Role(s) tasks factors orientation lens (social process, decision process, values)	correlations experiments prototypes
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Interdisciplinarity can be taught as a four-part set of skills for effective problem-solving.

Active learning design

In all educational settings, we use an active, cooperative learning approach (Cooper et al. 1990). “Active learning” engages students in activities other than listening to lectures and taking notes. There is less emphasis on transmission of information to passive recipients and more emphasis on students’ development of understanding, skills, and self-awareness. This approach helps motivate them to become more engaged with the subject and gives them immediate feedback from the instructor and classmates. Employing active learning requires flexibility in ways to achieve individual and cooperative learning (Herreid 1998) and integrating academic learning with on-the-job application (Batchelder and Root 1994, Banner and Cannon 1997). Abundant research shows the benefits of active learning. For example, student concentration declines during lectures after 15 minutes by about 25 percent. The AAC Task Group on General Education (1988) found that active learning encourages students to hear, understand, interpret, and integrate ideas better. Astin (1985) noted that students learn by becoming involved, which active learning accomplishes more effectively. Chickering and Gamson (1987) concluded that students learn best when they are required to talk about a subject, write about it, and apply it. Finally, the Study Group on the Conditions of Excellence in American Higher Education (1984) stated that active modes of teaching should be used wherever possible, since they require students to take greater responsibility for learning.

In all educational settings, we use an active, cooperative learning approach.

Among the different levels of cognitive activity involved in education (Perry 1985), active learning in particular requires a “high order” of thinking (e.g., analysis, synthesis, and evaluation) very similar to interdisciplinarity. Understanding and applying interdisciplinarity also requires a high order of thought, a special kind of “disciplined rationality” that depends on memory, comprehension, application-analysis synthesis, and evaluation (Sheppard and Gilbert 1991).

We employ a variety of active learning methods. In the classroom, we give students questions, short exercises such as “mind mapping,” critiques of newspaper and other articles, and videos. We also use guest speakers to relate how they have used interdisciplinarity and to demonstrate specific applications. As part of this, we ask students to describe an example of one of the value categories, or we ask groups of three or four to come to an agreement on a definition of a value or indices of how well it is shaped and shared in particular situations. Such questions lead to productive discussions and standpoint clarification. We often focus on the respect value. We also have students read short news articles, analyze them on the spot (e.g., for the values involved), report to the class, and discuss them. The two page “Policy Forum” articles from *Science* magazine are useful for analysis and may be discussed in the subsequent session. In-depth discussion leaves students with much greater retention of information, more problem-solving skills, and higher motivation than lectures (Hyman 1980, McKeachie et al. 1987, Cross 1999). Student involvement in the learning exercises means, however, that we cannot cover as much lecture material as we might otherwise present. We keep class sizes between five and twenty-five students. Active learning is best accomplished in smaller classes. In fact, it has been shown that most learning takes place in small groups (Tiberius 1990).

Good teachers, according to Wilen and Clegg (1986), try to phrase questions clearly, ask questions that are primarily academic, yet practical, and pose a lot of questions at low cognitive levels as well as at higher levels. This combination seems to produce effective learning. Some students volunteer answers readily, but we try to balance their participation by inviting responses from those who seldom volunteer. At first, we ask simple questions that encourage a high percentage of correct responses from students and help with incorrect responses. We acknowledge correct responses promptly, and encourage exploration of responses that miss the mark. We often probe student responses to get more complete responses and to gain insight into how they arrived at their answers. Any student resistance to active learning must be overcome; for example, shy students require more encouragement. Some of our international students, in fact, come from educational settings in which they have never entered into open classroom discussions or given presentations before their classmates.

Student presentations, either individually or in small groups, permit each student to make a unique contribution, to learn and share complex material (often from multiple sources), and to exercise skills in evaluation, application, analysis, synthesis, conflict resolution, and presentation (Bonwell and Eison 1991). Group efforts provide experience in team building and collective problem-solving, participation by all members, interdependence, status equalization, involvement, and listening (Jacques 1991, Westberg and Jason 1996). In addition to oral presentations, our students are required to write substantial analytic papers (see Chapters 4, 5, 6, this volume).

Courses, workshops, field trips, and applied appraisals

Interdisciplinarity represents a new way of thinking, analyzing, and understanding problems for many students, and mastering these needed skills makes new demands on them. In all cases, we try to tailor classroom experiences, workshops, and field trips

to students' foci of attention, backgrounds, and perspectives at the time they begin, but move well beyond those by the end of the exercise. We describe interdisciplinarity as a tool for integrated problem-solving in real world contexts requiring particular skills. All students are expected to engage themselves with the materials and with each other, and to participate actively throughout the semester, workshop, or field trip. We encourage them to assess and discuss their evolving understanding of interdisciplinarity, the policy process, and their applications. Analytic case studies keep their learning grounded and relevant to their interests. We spend considerable one-on-one time with most students and groups. No two classes, workshops, or field trips are identical, and, in fact, they often vary considerably. We feel that a mix of the four designs best allows students to learn and apply new methods and skills to the practice of conservation.

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Courses

One of the best and easiest ways to teach and learn interdisciplinarity is through a formal college or university course that systematically illustrates interdisciplinary skills and their application. A semester allows time to develop the concepts and methods and demonstrate their application, and gives students a chance to analyze and present a case of their own using the analytic framework, either individually or as part of a team. Using interdisciplinarity's framework and skills goes far beyond conventional examination of cases, which are commonly part of more traditional courses too. Selected supporting materials (e.g., readings, exercises, videos, guest speakers) aid the instructional task. We regularly offer three graduate courses (SGC) and one undergraduate seminar (RLW) that teach interdisciplinarity overtly, and our other courses include aspects of interdisciplinarity. We have taught many courses over the last 25 years that illustrate what is involved.

Using interdisciplinarity's framework and skills goes far beyond conventional examination of cases, which are commonly part of more traditional courses too.

First is "Species and Ecosystem Conservation: An Interdisciplinary Approach." This course is designed as a full introduction to the policy sciences. We have found that students' initial interest is as much about biological conservation as it is about applying interdisciplinary problem-solving to the problems of declining species and ecosystem loss and their restoration, conservation, and sustainability. We spend considerable time in problem orientation, examining goals, trends, conditions, projections, and

alternatives. This class, which Professor Clark has taught more than fifteen times since 1990, reaching over 300 students, is an opportunity for students to integrate their course of graduate study with their experience and interests and to develop a broad range of key problem-solving skills for their future conservation work.

Second is “Foundations of Natural Resource Policy and Management,” which Professor Clark has co-taught at various times with Andrew Willard, a research fellow formerly at the Yale Law School, and with David Mattson, of the U.S. Geological Service. Team teaching greatly strengthens this course. In Clark, Willard, and Christina Cromley’s (2000) book of the same title, which is based on their experience teaching this course, the authors describe the course’s background and format and their view of natural resources, introduce interdisciplinarity, give their own and student evaluations of the course, and list the topics that students have researched and presented (Clark et al. 2000b). A valuable outline for researching and writing on any topic is given. Students can use the outline to see how the interdisciplinary method and framework are woven into a format that is easily communicable to lay audiences. This course focuses explicitly and systematically on interdisciplinarity as a basis for investigating ways to improve any policy process and to clarify what sustainability of natural resource policy and management means in practice. The notion of sustainability is illuminated by the interdisciplinarity theory central to the course. The purposes of the seminar are, first, to introduce students to comprehensive and integrated methods for thinking about and proposing solutions to problems in natural resource policy and management and, second, to help students gain greater control over these methods by applying them to particular problems and writing and lecturing about their case studies. The course is limited to 18 students. This course has been offered fifteen times and has served about 200 students. In some semesters there have been international students from as many as 10 different countries.

Third is “Advanced Environmental Policy Analysis,” an upper-level undergraduate seminar designed to serve students who have a particular interest in the application of social theory to environmental problem-solving. Professor Wallace has taught this course six times at two institutions over the past ten years, most recently at Ursinus College. At Ursinus the course serves students interested in spending a semester focused intently on developing critical thinking skills in preparation for graduate study or a policy-oriented professional position. Most of the students enrolled in the class are environmental studies majors. The environmental studies major at Ursinus is explicitly designed to help students develop analytical skills by introducing and applying aspects of interdisciplinarity in varying contexts beginning in the freshman year. By the time they take the advanced seminar, they have had substantive experience with base and scope values and problem orientation and are prepared to spend a semester working with interdisciplinarity’s central theory. In this seminar students engage in a systematic exploration of interdisciplinarity’s main themes and frameworks, using Clark (2002), primary interdisciplinarity literature, and many case studies in the literature, current news, and film. As with the “Foundations” course, above, this advanced seminar is designed to help students gain a stronger grasp of critical thinking skills by explicitly using and reflecting on the use of social theory in

practice. By the end of the semester, if the course goals have been met, the students have a heightened sense of self-awareness that allows them both to identify their standpoint in any social process and to analyze the behavior of other participants using analytic tools of interdisciplinarity. In a sense, the course is run as an exercise in self-reflection as well as a social theory seminar, simultaneously challenging the students to learn about themselves and about the theory and methods of interdisciplinarity.

All three of these courses receive strong, positive evaluations from the students who take them. They typically say the course was demanding and rewarding. Student comments reflect the challenges of the work required of them. One of the positive attributes of these courses is that they are unlike any other courses, or any other approaches to theory and method, offered in students' respective programs. They stand in sharp contrast to other conventional courses. While some student feedback reflects frustration with the approaches and demands of the courses, making it clear that interdisciplinarity is not for everyone, generally the evaluations show that the courses are highly valuable to students. In short, the student demand is for exercises that help them to develop their thinking and problem-solving skills, and students recommend these courses to their peers. It is common to hear from students years after they took one of these courses, reflecting on the value of the experience. Their work, reports, and papers attest to their command of the method and skills.

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Workshops

One way to help people develop problem-solving skills in large scale conservation, for example, with potentially long-lasting benefits is through workshops for working professionals (Hanna 1994, Braus and Monroe 1994, Clark et al. 2002, Mattson et al. 2006). Workshops can meet the growing need for more effective performance, helping professionals move beyond narrow, technical outlooks by articulating and strengthening new ways to synthesize information, think critically and creatively, and solve public policy problems (Sullivan 1995).

Dr. Clark has carried out twenty workshops on natural resource issues in the Greater Yellowstone Ecosystem (in Jackson, Wyoming; Bozeman, Montana; and Denver, Colorado), three in Banff National Park with regional Parks Canada staff, and one in New Haven, Connecticut, on wetlands conservation with officials from town, state, and federal government levels, universities, and advocates. Professor Clark also led workshops with government professionals in Australia over a five-year period in the 1990s, the purpose of which was to introduce agency personnel (in most cases) to interdisciplinarity. Based on the Yale courses described above, the workshops consisted of lectures, readings, case analyses, presentations, and discussions, although, of course, the content was greatly shortened and the focus was on specific issues of concern to the attendees. Typically taught over a few days, the workshops usually

targeted specific audiences and particular problems, or they were designed to teach policy analytic method and skills to professionals or students, usually under the rubric of “interdisciplinary problem-solving” or “better outcomes for conservation problem-solving” (Clark et al. 2002). Among the North American workshops, themes included problem-solving, strategic planning, governance and natural resource management, endangered and special management species (e.g., grizzly bears, wolves, mountain lions), and ecosystem conservation. These workshops were one to two days long and followed a schedule similar to that for the earlier Australian workshops (see Clark et al. 2002).

Workshops require that instructors or leaders undertake considerable preparation in advance—working with participants, developing shared expectations, and discussing content and methods. Typically, for example, Professor Clark met with all the participants in advance to build relationships, preview what would be covered, and familiarize herself with the issues or problems that participants wanted to address in the workshop. Standard adult education techniques were used, such as two-way, communication and asking participants for their advice and clarification on technical and other matters. Attendees were treated as equals, as professionals in different lines of work. Because many of the management issues covered in these workshops were highly contentious, Dr. Clark tried to establish and maintain low conflict and mutual respect within the workshop setting. Conversations were deliberate, organized, and analytic. Discussions were open and free-ranging as experienced participants typically raised many questions and offered rich examples from their work. The policy sciences were used more or less explicitly and offered a perspective on problems and solutions, typically a functional one, to help illustrate the concepts and terms and their utility in understanding and solving actual management problems. These workshops gave attendees a stable frame of reference, a language to use to talk about problems in sophisticated ways, and practice at analysis much like students in the classroom situation receive.

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In our experience, workshops seemed to be more successful when they lasted three to four days, yet most professionals cannot take much time off work, nor are they inclined to read very much in preparation for the workshops. Workshops of at least two days give attendees time to reflect overnight and time to get acquainted in case they choose to work together in the future. The multi-day workshop gives attendees time to assimilate the concepts and discussions much better than a single-day workshop. Workshops can build social capital and have the added advantage of bringing together professionals who might not otherwise interact or whose only contact may have been at volatile public meetings where they were on opposite sides of an issue.

Most of Dr. Clark's workshops begin with an introduction and overview of interdisciplinarity in somewhat conventional terms, keeping remarks brief and mixing conventional concepts and language with the new words and ideas. Students are then divided into teams to give them hands-on experience in analyzing cases and reporting to the group for critique and discussion. Teams pick cases in which they are currently involved. We then revisit the concepts and elaborate on them through analysis and discussion of the case presentations, summarizing as we go along and making comparisons across the cases about problem orientation tasks, social process mapping, decision process appraisal, standpoint clarification, and integration and judgments. The effectiveness of workshops is increased when they are followed up with additional workshops, continuing discussions as informal opportunities arise, and distribution of additional readings. Workshop effectiveness also increases with the experience level and inclination for reflection of participants. The workshop attendees have included county commissioners and planning staff, regional leaders in nongovernmental advocacy groups, and city, county, state, and federal government officials. In the Australian workshops, attendees had all worked from seven to thirty-five years. Most of these people quickly made connections between the interdisciplinary concepts and terms and their own extensive experience. This contrasted dramatically with graduate or undergraduate students, many of whom have limited experience in which to ground their learning of interdisciplinarity.

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The workshops always end with an appraisal from the participants. Feedback is typically positive and substantive. A number of key points have surfaced from workshops on two continents. First, attendees generally want more repetitions of case analyses and applications to give them more exposure to interdisciplinarity's methods and more experience in their use. Second, they recommend more discussion of the concepts and categories of the policy sciences framework. They are often curious about why certain concepts that make up interdisciplinarity are included and others that they consider of importance are not. They are interested in commanding the terms and language to express themselves better in communicating with others who are knowledgeable about interdisciplinarity and to lay people. They express a need for more agency support for improved problem-solving, indicating that there is little support on the job for interdisciplinary-like analysis. About one typical workshop, participants said, "There is a more structured way to think about problems." "I will use [the workshop] to improve my participation and leadership skills as a professional with a federal agency," and "I will certainly share the information with colleagues." "Yes, it was extremely helpful and new." Participants typically want more practical applications, more diverse participation, fewer readings, more discussion of

concepts (such as human dignity and common interest), more cases, and follow-up applied workshops. They want to tackle existing conservation problems as well as those looming on the horizon, and they want to get more of the actual players in real issues in the room and use this approach with them. Overall, there appears to be a huge latent demand among professionals for use of the policy sciences to help solve diverse, real-world problems, particularly those related to large scale conservation.

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Field trips

Field trips are ideal vehicles to help participants develop interdisciplinary problem-solving skills. However, in this format the policy sciences are not presented to attendees in a comprehensive, systematic way. Instead, the field trip is used to “bring out” interdisciplinarity and its utility in actual practice. This is more challenging in some ways, as students are not urged to move beyond conventional thinking in the forceful, guided way that they are in the classroom.

Clark and Ashton (1999) described the benefits of field trips that prepare students to be broad-based, practical problem solvers. When field trips are part of a course, they put students on the front line in contact with diverse professionals and others involved in management or affected by a problem in situations that are often laden with competition and conflict. Students meet the actual people who are affected by a problem, those responsible for creating it, and those who hope to resolve it. In one field trip to Ecuador, for example, students met with an older blind man and his grandson begging on village streets, saw women trying to wash clothes in a muddy, six-inch-wide stream next to a road in the high Andes, and talked with a young man who recently lost both arms in an agricultural accident who was begging for food. These experiences dramatically and practically brought home to the students, in very personal ways, the human dimensions and costs of policy and management decisions. Through field trips students can learn what is involved in on-the-ground management, compare their classroom learning with the workings of real cases, hone their integrative abilities, and develop insight and judgment without the real-life costs of being wrong. They give students the opportunity to exercise their skills in critical thinking, observation, management, and technical matters. Students can apply, discuss, and integrate all their previous education and practice into a concentrated synthesis in the field (Clark and Ashton 2004).

To synthesize both biological and social knowledge into an integrated picture of a conservation challenge, its context, and its resolution requires a genuinely interdisciplinary approach.

Field trips are typically scheduled visits to one or more field sites to examine a specific problem or set of problems. The trips that we have led have lasted one to sixteen days; some included repeated site visits over the course of a semester. For example, as part of a semester-long Yale class on “Rapid Assessments in Forest Conservation for Diversity and Productivity,” colleague Mark Ashton and Susan Clark led several two-week, graduate-level field trips to South and Central America. One trip looked at management of the buffer zone of the La Amistad Biosphere Reserve in Costa Rica (Clark et al. 2003), another examined management policy of the Condor Bioreserve in the high Andes of Ecuador (Clark et al. 2004), and others have examined issues in Panama, Costa Rica, and Ecuador (e.g., Clark et al. 2003, 2006, 2009). This course, which focused on identifying and addressing real management and policy problems in practical and effective ways, centered on the field trip and included pre-trip preparation and post-trip assessment and report writing. All reports and publications were shared with people at the field site and in the region. To synthesize both biological and social knowledge into an integrated picture of a conservation challenge, its context, and its resolution requires a genuinely interdisciplinary approach.

Attendees of the 1998 field trip to the Panama Canal watershed, for example, consisted of seventeen master’s degree candidates who had diverse undergraduate backgrounds and work experiences (see Ashton et al. 1999, Clark and Ashton 1999). Three were from countries in Central America and one was from Indonesia, four American students had Peace Corps experience, and other students also had various field experiences. Half of them spoke Spanish. The goal of the field trips was to help our hosts address their conservation problems. Pre-trip preparation included gathering knowledge and understanding values about the field trip site. During the field trip itself, we visited numerous sites and interviewed key people in the communities, nongovernmental organizations, and government officials. Contacts were made with a broad range of participants, from high-level government officials and various professionals in nongovernmental organizations, to peasants and indigenous people engaged in subsistence living in the canal’s watershed. Some of these people assured us that current policy arrangements for the watershed were just fine, whereas others told us of the severe deprivations they suffered under current policy. Seeing and experiencing for ourselves and contrasting the conflicting stories people told us was a powerful experience at multiple levels, from intellectual to emotional. The policy sciences gave us a way to examine analytically the people and their perspectives (identities, expectations, demands), the values at stake for each of them, their strategies, and the outcomes they each sought, as well as to clarify our own standpoint. We were also able to appraise the ongoing decision process through which these people participated to achieve what was of importance to them (e.g., well-being, power, skills, respect). Round-table meetings were held in the evenings after long days in the field to review and integrate our experiences. After the field trip the students were required to evaluate and discuss their experiences as a team and as a class, to write papers, and to make presentations to the class. Most of their written papers, which demonstrated their level of comprehension and skills, were later published in peer-reviewed journals (e.g., Clark et al. 2009).

In another example, Dr. Wallace spent the spring 2003 semester with the students in his advanced seminar traveling frequently to the site of a nearby riparian restoration project, and interacting with the principal participants, including two local research and conservation organizations, the county planning commission, the county conservation district, and the government of the local municipality. Up to that time, the restoration project had been a purely technical venture, consisting of ecological restoration and monitoring. As a result of the policy science students' involvement, they became the de facto social science experts in the project and were asked to tackle what the municipality considered to be negative public perceptions of the project. The students developed and wrote a "public outreach plan" for the project that they subsequently implemented with the local municipality and other organizations. At the end of the semester the students wrote and discussed an appraisal of the experience, explicitly addressing the role that interdisciplinarity played in their experience. Two of the students then decided to remain involved in the project for an additional year, in which they were given leadership status by all the other participants and orchestrated both the social and technical aspects of the project in an interdisciplinary, problem-oriented fashion.

Field trips typically produce a lot of interaction and feedback during the site visit, analysis, and write-up. Students, instructors, and local participants have judged the concentrated experience of field trips of this design to be extremely valuable. However, students are less able to grasp and use interdisciplinarity in this format than in the classroom experiences or the workshops described above. Many students remain firmly rooted in convention and even those that show the inclination to become immersed in interdisciplinarity are impeded by the workload and time constraints of the field trip format. This was true even for Professor Wallace's advanced interdisciplinary seminar students in 2003, when such substantive involvement in field-based activities detracted from the process of learning the theory.

Applied appraisals

Appraisal has much in common with the workshop approach described above, except that it is typically undertaken as a discussion or collaboration between the person conducting the appraisal and the people who are providing the information that is being appraised. Applied appraisals share the workshop format's focus on issues of concern to the participants, the targeting of specific audiences and problems, and the promotion of better outcomes for conservation problem-solving (Clark et al. 2002). They are also designed to encourage self-reflection, self-awareness, and a greater degree of understanding of the participants' place in an active and ongoing social process. Applied appraisals are not academic exercises; they are designed to provide information on social and decision processes for the purposes of improving or better illuminating those processes. They are conducted in response to conditions that require attention or correction. In practice they combine, like the advanced undergraduate seminar described above, a demand on the participants to undertake applied learning about a policy issue with a challenge to be reflective and introspective in their approach to appraising their professional practice.

Applied appraisals are not academic exercises; they are designed to provide information on social and decision processes for the purposes of improving or better illuminating those processes.

We have conducted many applied appraisals during our careers as analysts of social and decision processes in many large scale conservation arenas (e.g., Wilson and Clark 2007). Dr. Wallace has designed and carried out a number of applied appraisals in recent years that combine a systematic, empirical approach to program evaluation with the reflective approach described above (e.g., Wallace 2003). In these appraisals, Professor Wallace contacts participants in specific programs to seek their participation in the appraisal, describes the appraisal process to them, and then either travels to meet with them at their place of work or holds conversations with them by phone. Most of the appraisals have been in the form of one-on-one conversations. The conversations are based on a directed (but not fixed-response) survey questionnaire that is designed simultaneously to ask the subject to consider specific program or policy issues while also triggering an internal (i.e., psychological) evaluative process. These conversations are designed as supportive engagements, in which the interviewer and the subject interact collegially. As with other approaches to teaching interdisciplinarity, this approach is not for everyone, and a small number of intended participants are put off by the style and design of the appraisal. This is a very small number indeed, however: only two out of ninety participants in one such appraisal (Wallace 2003) were reticent when faced with the applied appraisal experience, and all 100 participants interviewed in a more recent study were open to the experience.

The use of interdisciplinarity in these appraisals is implicit. There is no attempt to teach or promote an explicit understanding of interdisciplinarity as described in the literature or as used in the courses, workshops, or field trips. Rather, the approach is to seek a narrower goal concomitant with the program or policy-related evaluative goals. The interdisciplinary goal is to help the participants in the appraisal become more aware of their observational standpoint in the social or decision process of which they are a part and more aware of their relationship to the processes at hand. If this is accomplished, it results in a greater empowerment for those participants in that process. Follow-up to these appraisals has been only anecdotal but has included responses that highlight the benefits of the method. Comments from program and policy participants in these appraisals included descriptions of the process as “totally cathartic” and “unlike any experience in my professional life.” Other participants have noted that “no one has ever asked me to think about my work in this way” and “no one has ever asked me questions like this before.” Another anecdotal measure of success was that as these and other participants became engaged in the process, conversations that were initially designed, by the length of the questionnaire, to take 60 to 90 minutes, sometimes took several hours or continued on subsequent days. From their initiation as interviewer-driven evaluative conversations, they became experiences driven by their subjects’ buy-in to the applied appraisal process.

Experience and reflections

Our goal has been to create a “transformative” experience for students in learning the basic skills of the policy sciences and applying it to problems of natural resource management. Our thinking on what constitutes such an experience has changed over time. In Poncelet’s (2001) description of theory on personal transformation through interaction, for instance, he noted that problem-solving experiences—such as courses, workshops, and field trips—can and do lead to personal transformation. Transformation might be explained as coming about in predisposed students through a combination of high quality interaction and reflection. It includes an extra-personal level (involving changes in understanding and relating to things beyond the self) and an intra-personal level (involving changes to one’s own conceptualizations). In their discussion of cognitive psychology and epistemology, Maturana and Varela (1987: 231) describe this as a basic change in the “organization and coherence in daily life of this ongoing flow of reflections that we call consciousness and that we associate with our identity.”

Our goal has been to create a “transformative” experience for students in learning the basic skills of the policy sciences and applying it to problems of natural resource management.

Clearly, introduction to interdisciplinarity is transformative for some people. We have observed many examples over the years that demonstrate this. Most recently, one mid-career professional said to us, “The whole policy science ‘renaissance’ (if you will) was a bit like a light going on in my brain. It seems to be a missing piece of what I’ve been trying to do. I’m looking forward to developing a deeper understanding of its frameworks and approaches.”

Clearly, introduction to interdisciplinarity is transformative for some people.

Our students have gone on to publish peer-reviewed book chapters and articles. For example, the students in our rapid assessment course/field trip in 2005 went to Podocarpus National Park in Ecuador. David Cherney and his fellow students co-authored “Understanding Patterns of Human Interactions and Decision Making: An Initial Map of Podocarpus National Park, Ecuador,” recently published in the *Journal of Sustainable Forestry* (Cherney et al. 2009). They noted that successful conservation is as much about people and how they make decisions as it is about flora and fauna. Just as practitioners can understand systematically the biophysical patterns and processes of a natural resource issue, so too are there systematic methods to understand patterns of human interactions and processes of decision making that affect these issues. Understanding these patterns and processes can reveal more effective interventions to improve management and policy. Their paper demonstrates a skillful use of

interdisciplinarity to accomplish that end. The students went on to suggest actions through community-based initiatives to help improve arenas and decision making.

A second example is students in special projects courses. Rebecca Watters and Avery Anderson (In Review) went to western Wyoming (specifically, the Wind River Indian Reservation with the Eastern Shoshone and the Northern Arapaho tribes and the ranching community of the Upper Green River basin) to study the highly contentious issue of wolf management. They wrote “Wolves in Wyoming: The Quest for Common Ground in Native American and Ranching Communities,” a book chapter in a forthcoming book on large carnivore conservation. As the wolf population grows, these human communities face important choices about how to manage the controversial species. The authors offered many practical recommendations to improve matters, all working with local people.

A third example is Doug Clark and his colleagues (2008) in Canada who researched and wrote “Polar Bear Conservation in Canada: Defining the Policy Problems,” a paper in the journal *Arctic*. They concluded that the decision process in polar bear management did not sufficiently foster identification and securing of common interests among participants who express multiple competing perspectives in an arena that has been increasingly fragmented and symbolically charged. The fundamental challenge for polar bear conservation in Canada is to design the decision process so that it can constructively reconcile the various perspectives, demands, and expectations of stakeholders. These authors offered ways to do just that. We have scores of other examples demonstrating students’ command of interdisciplinarity in applications in Africa, Asia, Australia, Europe, and North and South America in diverse cases, on various problems, and in complex settings.

In our experience, about twenty percent of students undergo some kind of transformation once they are exposed to interdisciplinarity, as evidenced in their own evaluations. This occurs in young students at the undergraduate level, those who come directly from undergraduate studies into their graduate work, in more experienced students who have Peace Corps or several years of work behind them, and in returning older students. Comments indicate that some of them underwent significant changes as a result of their investigations using interdisciplinarity in cases of interest to them. We took their comments at face value. Here is a sample of comments made after grades were turned in:

- “For those new to interdisciplinarity, this course will change the way you approach problems.”
- “The framework on which the course is based dramatically changes and improves students’ understanding of the social process.”
- “Interdisciplinarity provide an amazing framework for looking at all kinds of problems and because of this course I am familiar with them and comfortable using the framework.”
- Fantastic course—learned an incredible amount—big influence on my thesis work.”

- “Interdisciplinarity give me a new outlook on problems and conflicts, as well as equip me with the skills and the tools to deal with any type of conflict...not just environmental but in my personal life as well . . . it was invaluable!!!”
- “It has helped me in all my other classes.”
- “The class was one of, if not the, best course I have taken.”
- “Only true interdisciplinary experience in the School—helps to put the other stuff (especially science) into perspective.”

Many similar statements have appeared in our course evaluations over the years that we have taught interdisciplinarity, and from students and others from workshops months or even years after the experience. Transformations were also evident in the changes that some students made in their professional careers once they left school and in the nature of the research and professional work that some undertook after their schooling.

Improving education

To bring about these transformational experiences with a higher frequency and permanence, much more systematic attention must be paid to how the policy sciences are taught, whether in the classroom, workshops, in field trips, and applied appraisals. Three avenues to bring about improvements are new teaching materials, novel educational designs, and continuing opportunities to develop skills and build community. The following recommendations are general, but all three could improve experiences.

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Teaching materials

One of the biggest challenges to teaching and learning interdisciplinarity is a lack of easily accessible readings and teaching materials. Many of us began teaching interdisciplinarity by drawing on the original works of Lasswell and others, but despite his prolific output, students typically find his writing dense, stylistically difficult, and out of date (see Eulau 1958, 1969, Marvick 1977, Muth et al. 1990). Lasswell himself noted that there is a practical problem in explaining and using the policy sciences (Lasswell and McDougal 1992). A number of other authors have written books that are valuable teaching aids, including V. Clyde Arnsperger, *Personality in Social Process: Values and Strategies of Individuals in a Free Society* (1961). *Foundations of Policy Analysis* (1983), by Garry Brewer and Peter deLeon, is invaluable but could be updated. The works of William Ascher and his colleagues, for example, *Natural Resource Policymaking in Developing Countries* (1990), should stimulate similar works that are explicitly in the interdisciplinary tradition. *Finding*

Common Ground: Governance and Natural Resources in the American West (2002), and *Adaptive Governance: Integrating Science, Policy, and Decision Making* (2005), both by Ronald Brunner and colleagues, are also valuable sources.

Much of Professor Clark's time in recent years has been devoted to writing and compiling materials that will be useful for teaching (e.g., Clark 2002, Clark et al. 2005). For example, Professor Wallace is one of many policy scientists who now uses Clark (2002) as a text in interdisciplinary classes at either the undergraduate or graduate level. Dr. Clark is also considering writing a small handbook for citizens and advocates engaged in natural resource and democratic issues. Other policy scientists are no doubt writing or considering writing new teaching materials, which are needed in the natural resource field, as well as international development, biodiversity conservation, health, global change, and other fields. Many more case studies are needed.

Finally, the journal *Policy Sciences*, the Society for the Policy Sciences' new web site (www.policysciences.org), and the recent publication of syllabi and other educational materials are all helpful. The journal contains articles that Professors Clark and Wallace use in their courses. Updated compendia to original materials, like that of Marvick (1977), and compilations of selected readings that are well introduced and explained would be very helpful in adequately introducing Lasswell's writings and keying them to current events. More theory and case books are needed for general and specific audiences. These should integrate readings, current events, and skill building. Interactive experiences, such as workbooks and videos that demonstrate connections between the interdisciplinary concepts and actual cases are also needed.

Educational designs

In addition to well-planned and thoughtfully designed courses, workshops, and field trips, other designs or formats might also be effective in interdisciplinary education. Prototypes—a particularly learning-focused exercise—could be developed by instructors and students for given problems. Small-scale decision seminars might be set up to address specific issues (see Muth and Bolland 1983, Burgess and Slonaker 1978). The “chartroom,” developed as a group project, should be fully explored as a teaching tool (Lasswell 1971). New case materials (short pieces that look at public policy problems in interdisciplinary terms) are needed for general and technical audiences. Interdisciplinarity already provides a wealth of important teaching materials, but a new section explicitly devoted to teaching could be especially useful. Videotapes of the society's meetings, special presentations commissioned from society members, mock decision seminars, and similar documentation of interdisciplinarity at work might also prove to be extraordinarily helpful. Finally, personal testimonials about the value of interdisciplinarity in actual problem-solving might be more persuasive than instructors' promotional efforts in convincing prospective students to study this approach.

We also need more mid- to long-term evaluation of the benefits or drawbacks of existing curricula. Perhaps the Society of Policy Scientists could survey graduates from programs around the country from the last few years with the goal of revealing

patterns in teaching, learning, and applying interdisciplinarity. For example, we know that some interdisciplinary courses attract significant numbers of students who go on to join the society, use interdisciplinarity in their work, continue developing their knowledge and skills, and design, develop, and teach courses of their own. Detailing and profiling these patterns might help us design better educational experiences. We need to compare, upgrade, and diffuse successful designs constantly.

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Continuing opportunities

Participants in college and university classes, workshops, field trips, and applied appraisals in interdisciplinarity need to be supported through continuing contact. The establishment of the Society of Policy Scientists and its web site are important steps in building a community. The society's interest in comparing teaching approaches and results, listing syllabi on the web site, and publishing collections of cases and experiences such as those in this special issue of the journal are additional milestones in advancing teaching of interdisciplinarity.

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Other opportunities might be created for people to increase their interdisciplinary knowledge and skills. The society's summer workshop is one way, as are continuing, short, refresher courses (even self-administered). The society might also want to design teaching modules that would facilitate teaching interdisciplinarity outside the usual settings of the university or professional meetings. Casebooks might be developed as well as workbooks that people could take home as a reference source. Continuing workshop experiences (one or two per year over a two to three year period) for professionals would help to reinforce their initial learning, although more attention to their employing organizations is needed to build lasting institutional support. It is also important to find and recruit new individuals to the society and invite new people to attend appropriate educational experiences.

CONCLUSION

It is clear that interdisciplinarity can facilitate an orderly, problem-oriented inquiry into complex large scale conservation problem settings, and others as well. It is equally clear that it can be taught and used in courses, workshops, field trips, and appraisals to good effect. In a few days to several months, students can gain insight

and skill in critical thinking, observation, management, and technical matters. The interdisciplinary approach, based on our first-hand experience over many years and across diverse settings in several continents, does help professionals, analysts, managers, politicians, decision makers, advocates, the public, and students (as they look ahead to their careers) to take active, informed, and responsible leadership roles in solving policy problems. People in our courses and other educational designs are coming to recognize the severe limitations and practical hazards of being locked into narrow, conventional methodological perspectives, institutional settings, cultural contexts, or professional viewpoints. There is a growing awareness on the part of students that we must understand contexts of time and place and the growing demand from all segments of society for people to be more rational, practical, and humane in their dealings with public policy—characteristics that interdisciplinarity can help them achieve. In short, the skill set that interdisciplinarity encourages is practical.

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