Assessment of Student Learning in *Explorations in Environmental Studies:*
A Short Summary
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In the academic year 2000-2001, the faculty of Huxley College of the Environment moved to revise its core curriculum, placing a new emphasis on problem-solving, interdisciplinary integration of subject matter, and creating a learning community among students and faculty. Explorations in Environmental Studies (Estu/Esci 301) was created to serve as an entry-quarter core experience, to be followed by a choice of other substantive courses to complement the student's major, and finally another integrative, problem-based capstone course. Explorations in Environmental Studies was first offered experimentally as Envr 397 in Autumn 2001 and again in Spring 2002. Three sections were offered in Autumn 2003, and two each in Winter and Spring 2003. This totals 9 sections, each with about 25 students. All sections except the first 397 have been taught using Bellingham Bay as a local place-based focal point.

Evaluation of this course is essential to determine if the faculty's goals for it are being met. An extensive evaluation was done in the first term (397, Aut 2001), focusing on student response to course delivery. Several innovative pedagogies were used, and student impressions and learning were of interest. This feedback supported further course development in Spring 2002. Beginning in Spring 2002, evaluation stressed student learning. Two components have been of interest -- content knowledge, intellectual development; and a third was added in 2003--problem solving. Together these reflect some important goals of the course. A more comprehensive assessment would entail greater demand on students and more resources for analysis. The information we have, however, does provide three angles on student learning. This report, intended for internal use, explains what we have learned.

Methods

Subjects

All subjects were enrolled in Estu /Esci 301. Varying numbers of data forms were administered and returned, or otherwise available for analysis. Thus, number of subjects is mentioned in discussing results from each instrument. Students signed informed consent forms to participate.

Instruments

The evaluation components and the measures used are:

Area of Learning	Measure
Env. science and studies content knowledge	Self-reported learning in subject & skill areas; Knowledge Assessment (KA)
Development of understanding of knowledge and learning (Perry stages)	Measure of Intellectual Development (MID)
Solving real-world environmental problems	"Env. Problem Solving Essay" (EPSE)

Student self-reported learning in content and skill was used as a proxy for content knowledge in one section in Autumn 2002. Students rated each of several areas between 0 and 10 to express how much they subjectively felt their abilities had increased as a result of the class. Comparisons of average gain across individuals for such a measure need to be made cautiously, but are reported because they triangulate the knowledge assessment, as well as touch on other skill areas.

The Knowledge Assessment (KA) instrument rated knowledge gain more objectively by asking students for definitions and examples of 12 concepts such as Conservation vs Preservation; Limiting Factor; Environmental Impact Statement; and Externality. An alternate form used three more open-

ended prompts. For scoring the following procedure was used. Prior to analysis, a list of key points for each concept was constructed from introductory materials in environmental studies. Then points were assigned to each answer to reflect the number of these key points the answer contained (a full list of the items and points is in Appendix A). Answers were then added to create 3 sub-scales: History/ethics; Science; and Policy. These in turn were summed for a total score, and all scales were converted to percentages for comparison across forms and scales.

General intellectual growth during the college years has been widely studied using William Perry's stages of development (described in the discussion section), and can be tapped by the Measure of Intellectual Development (MID) essay. The full set of stages (or positions) reflect the changes over their entire 4 college years and beyond, not over only a single quarter. The MID, however, has proved capable of detecting change within a quarter, especially in courses that are intentionally structured as "learning communities." Although this only partly characterizes 301, it does reflect one of the main intentions behind the course's design, small section size, and discussion-orientation. The data for the MID are essays written by the student in response to a prompt. Multiple essays and scorers, or an interview, would provide a more accurate estimate of student position, but for our evaluation purposes (and budget) a single essay may suffice. Several essay prompts have been used for 301 assessment ("best course"; "self-assessment of learning in 301"; and different problem-solving prompts), but all are score-able. Scoring of MID essays is highly technical and has been done professionally by Bill Moore, Ph.D., of the Center for the Study of Intellectual Development (CSID). Raw scores are reported as a 3-digit code representing the dominant and subdominant position perspectives in the essay, in 1/3 position increments, (or in some cases in one or two figures if less precision is possible due to the brevity or lack or clarity of the essay response). CSID provides a procedure to convert raw scores to a continuous variable for quantitative analysis.

The Env. Problem Solving Essay (EPSE) taps *how* the student thinks about solving complex, multidimensional, "ill-structured" real world problems, such as those many of our graduates will face. An environmental problem-solving prompt was piloted in Autumn 2003, and found to produce information that can be scored for the problem-solving methodology taught in the core, as well as for the MID, thus economizing on students' time spent on course assessment. The essays are scored for whether they showed evidence (criteria were fairly generous) of the 6 problem-solving steps taught in the Case Method Discussion Teaching sessions: 1. Define problem; 2. Set goals & criteria; 3. Identify parties & interests; 4. Generate alternatives; 5. Analyze and compare alternatives according to criteria; 6. Decide & implement. Other interesting possibilities exist for how these essays could be analyzed, such as from the literature on expert and novice environmental problem solving skills.

Results

Self-reported Learning

All Autumn 2002 sections completed the post-course supplemental survey that included self-reported learning in several areas. The results are shown in Figure 1. Group work skills were nearly unanimously the largest area of growth, followed by quantitative reasoning, policy, writing and history/ethics which were clustered at about the same level of gain. Students felt they had learned less, however, in environmental science.

Knowledge Assessment

The KA was administered pre- and post-course in Spring 2002, Autumn 2002, and Winter 2003 quarters. Only the 3 autumn 2002 sections (53 students), however, have been analyzed at this time. Figure 2 shows results from the Autumn 2002 sections on the 3 sub-scores and total, comparing pre- and post-course achievements. The results show a rough doubling or better in the percentage of the total possible for all areas, from about 20% to about 40%.

Measure of Intellectual Development

The MID was administered pre- and post-course in all quarters since Spring 2002, except for Winter 2003. Pre-course data have been analyzed for 101 students, with 99 post-course essays scored as of this time. Due to missing data there are only 78 students for whom we have both pre- and post-scores. Figure 3 shows the frequencies of the raw (categorical) scores for all sections for which we have pre and post data. The lighter (post) bars show an upward shift in the score distribution. For Figure 4, the scores were converted to a continuous variable, and the chart shows pre- and post-course averages broken down by section and total. Variability across sections was moderate. The change in score across students in all Spring and Autumn 2002 and one Spring 2003 sections was significant at the $p<0.0001$ level (pre-mean: 2.95; post-mean 3.25; df=77; t=5.22). The effect size, however, might be considered modest, equivalent to about a 1/3 position change (the level of discrimination to which raters are trained). Nonetheless, the magnitude of change observed resembles the better results among other studies of change in a single course, as does the finding of 53% of students showing positive change. The most recent quarter's data from Brennan's section, with 81% of students showing gains, suggests interesting intersections with problem solving, discussed in the Discussion section.

Environmental Problem Solving Essay

Only the spring 2003 sections completed both pre- and post-course versions of this essay, and only one of these sections' essays were available for analysis (23 students). Results for the problem solving essay are shown in Figure 5. At both times students engaged in problem definition at high levels, and in generating alternatives, comparison/analysis, and evaluate/revise at low levels. Students used the following steps more at the end of the course than at the beginning: 3. Identify parties & interests; 4. Generate alternatives; and 6. Decide & implement. They used these steps less: 1. Define problem; 2. Set goals & criteria; 5. Analyze and compare alternatives according to criteria; 7. Evaluate / revise. The average number of steps of the process used increased from 3.5 to 3.7 steps. The students employed several fallacies at both times, as summarized in the Table 1. It should be noted there is some overlap in these categories, but they highlight a typically incomplete or incorrect use of the logic of problem solving.

Table 1. Percentages of students using errors of problem solving logic

PROBLEM SOLVING FALLACY	PERCENT USING	
	Pre	Post
Lack alternatives & analysis steps	86	78
Assuming the problem or solving wrong one	23	30
Solution unrelated to definition	14	13
Undeveloped sub-problems or sub-solutions	9	43
Jump to solution	9	26
Simple pro-con framing	9	0

Discussion

Self-reported Learning

The students' self-reported learning suggests that the group tasks challenged the students *as* group tasks. In a world of cooperative work teams and collaborations, this is a positive outcome for 301. Group work needs to be supported consistently, with explicit instruction as well as timely and helpful intervention when problems arise. The science learning data suggest a need to re-examine this component of the present course. Only modest weight can be put on these findings, however, due to biases in how students with different actual levels of knowledge and learning may estimate their own gains.

Knowledge Assessment

The consistency in post-course Knowledge Assessment scores across sections suggests consistency in the present case study, and/or in relative emphasis on different broad topics. The level of gains (about 20%) can be looked at as half-full versus half-empty -- or rather as a doubling versus a half-way achievement. The scale of points used to judge answers accounted for all the correct content of the answers, so it does not underestimate performance. However, it also included ideas that, while part of a "basic but complete" understanding of the content, may not have been adequately addressed in any given section of the core. Indeed, there may be little relation between 100% answer and what was intended to be taught in 301. Arguably, students taking the corresponding old core course would have easily reached the 100% mark. A better sense can be attained by looking at the actual scoring points in Appendix A. Everything in one's interpretation of these findings depends on whether one agrees with the adequacy of the scoring criteria. A set of criteria that was developed not just by the evaluator (one instructor), but by all Huxley faculty would be far preferable.

Both the ambiguity of the evaluation, and the level of student performance, point to a continuing lack of clarity among the faculty about *precisely what is the core subject-matter content* a Huxley student should receive, and in *precisely which courses* they should receive it.

Measure of Intellectual Development

The Measure of Intellectual Development results require more background to discuss intelligently. In this brief summary I will refer to students as being characterized by their positions, but it should be kept in mind that this is only one dimension of a student, and that in fact we are referring to only one performance (an essay), rather than a fuller sampling of student ability.

William Perry's scheme is concerned with how students think of the nature of knowledge and learning, and of their relationship to it. Typically students enter college as Dualists (Position 2) who believe that knowledge exists absolutely and right answers are known by the authorities. One such student's favorite class had been one about dinosaurs, and he clearly cherished the nuggets of fact he had retained over 3 years; he liked another class where everything was fully explained. For such students, tasks that require thinking about options or many points of view are confusing, and the legitimacy of alternate perspectives is not yet acknowledged. Judgments are stated as though they are self-evident. Diversity of opinion or uncertainty among Authorities is viewed as inadequacy on their part, or an exercise "so we can learn to find The Answer for ourselves." As can be seen from Figure 2, close to half of our students at pre-core demonstrate a predominantly dualistic perspective with a subset of those reflecting the early transition to position 3, Multiplicity (see below). A typical response of these students to being thrust into the dilemmas of the core class will be confusion and frustration at not being given clearer tasks. During the quarter of the core, however, Figure 3 shows some of these shifting away from dualism. This could be encouraged by the exposure to multiple perspectives in 301.

Students in position 3 of the Perry scale are in a stage of "Multiplicity." As shown in Figure 3, this includes by far the majority of our students. They recognize diversity of opinion and values as legitimate in areas where right answers are not yet known (which may be most areas). But opinions are regarded as without pattern, so no judgments can be made among them. These students are unable to evaluate each perspective on a problem adequately. One student whose essay was scored at position 3 at the end of the course commented, "I learned a lot in the class. I do not feel it is knowledge that is testable, but I learned about the decision making process and all about how healthy or unhealthy our bay is." Another student stressed looking openly at "many different sides in any issue." Students start using supporting evidence to resolve issues rather than relying completely on what authorities say, but they count preconceptions and prejudices as acceptable evidence and once they have reached a solution they have little inclination to examine alternatives. Open-ended questions and cooperative learning are tolerated, but not if they have too much of an effect on grades.

The college years most frequently see the transition from position 3 to 4. Position 4 thinkers are beginning to see the need, especially when challenged by peers, to support their opinions with reasons and data. They may also expect that instructors are not asking them for the Right Answer, but rather "want us to *think* in a certain way, supporting what we say with an argument." They are Relativists. The results in Figure 3 suggest that this position is shown at all by less than a quarter

(10/46) of our students when they started the core. However, by the end, it is in evidence to some degree in close to half (25/55). A student whose essays showed movement from positions 3 to 4 said the course "taught me the importance of examining all aspects and factors of an environmental problem before forming an opinion." Anther spoke of needing to ensure that he "process information and not just regurgitate it."

Although only four of our students in the data show any sign of it, position 5 shows what college-age development may attain. They are "Contextual Relativists." These students see knowledge as relative to particular frames of reference. They show a capacity for detachment; they look for the "big picture," think about their own thinking, and evaluate their own ideas as well as those of others. They differentiate between an unconsidered belief and a considered judgement. Authorities are seen as people who can and should be questioned. One student who showed a "glimpse" of position 5 discussed how it is important for him to be "challenged to think and discuss," to form his own interpretation, and how he seeks to "add new insights and critique the basic assumptions." He was proud that his group's Policy Memo did those things, he felt. Three students in the Spring 2003 Brennan session made large gains and entered stage 5; this will be discussed below.

It is important to recognize that position 5 is not the end of the Perry scheme. Position 5 thinkers, by seeing alternative perspectives, frequently have difficulty making a decision. The next developmental step, however, is not cynicism, but Commitment (positions 6 through 9). As with the other positions, this growth does not always occur, but it involves degrees of ownership of one's own decisions with awareness of relativity; balancing commitments; acceptance of paradox; and being "wholehearted while tentative" or holding deep values while also being ready to learn.

The core class potentially does many things right developmentally. For learners moving from position 2, with a focus on (in the words of Bill Moore) *what to learn,* to position 3 with a focus on *how to learn*, Estu/Esci 301 challenges them by offering conflicting but legitimate perspectives, and not accepting pat solutions or generalizations. For students moving from position 3 to the focus on *how to think* of position 4, 301 supports them by relating course material to their lives (i.e., place-based), and using a wide variety of assignment types and active learning modes. It challenges this majority of students by encouraging them to speculate about open-ended issues with no single solution and requiring them to analyze and defend points of view (i.e., policy memos). And it challenges even more advanced thinkers by pushing them to learn *how to judge* by asking them to define standards for evaluation (i.e., the CMDT sessions), focusing on "messy problems," and asking them (through the journal) to reflect on their own learning and values.

Environmental Problem Solving Essay

The Environmental Problem Solving Essay results need to be interpreted in light of the actual exposure student received to the problem solving steps being tested. They receive explicit attention mostly in that part of the course (about the 6th week) where Case-Method Discussion Teaching (CMDT) narratives are employed to focus the students on a real person's decisions in the context studied (Bay cleanup). These figures are an environmental activist, and, in a second case, by an Ecology official. These sessions account for only a few sessions of the whole quarter. The basic process, however, also underlies the Policy Memo assignment.

Another qualification in interpreting the results is that the pre- and post- essays were responses to two different problems: the bay cleanup, and Lake Whatcom management, respectively. This may in part account for higher levels of undeveloped sub-problems in the post-test, because the watershed management problem entails a variety of identified causes. Nonetheless, few students provided full sequence of steps for the solutions they offered. Students were also inclined to presume rather than explicate the goals and criteria in the watershed issue.

Except for the "feedback" final step, the weakest step across the problem solving essays was the fifth, that of analysis and comparison according to criteria. Next most frequently omitted was the step of formulating alternatives. About 4/5 of the students at both times were missing one or both of these steps. This is interesting in light of the information about intellectual development above, because the process of stating an alternative (i.e., a position), and weighing it against other alternatives

and against criteria (i.e., providing a contextually-reasoned argument for it) is at the core of position 5 reasoning.

This convergence of problem solving steps 4 and 5 with Perry position 5 may underlie the dramatic gains seen in Brennan's section in Spring 2003. It is important to recognize that this was the first quarter in which both pre- and post-course MID prompts were the problem-solving essays. Thus they directly elicited, for some students, the 7 steps. For those students who had absorbed the steps well, they used steps 4 and 5 in their essays, and this in part increased their MID score into the stage 5 range. Thus one could argue that instrument effects created a confound here. On the other hand, one can argue that the problem-solving process "scaffolds" or supports learners in reaching higher level reasoning abilities, at least in the domain of environmental problems. Both may be true. Administration of a traditional MID prompt in addition would reveal if these students' learning had generalized. In either case, it seems likely that 301 could encourage higher level development more if the problem solving process were more integrated and predominant in the class. Brennan explained that he had "starved" the students to know how to solve problems, and then had reinforced the use of the steps in the Policy Memos. Although the use of the same CMDT cases has ensured some similarity across sections, we have not sought to control or quantify the delivery of problem-solving focus across sections. If we did, we could determine more about its effects on students' learning and development.

A non-quantified reading of the essays suggests that students (not surprisingly) are not using approaches that distinguish experts from novices in the field of environmental problem solving. For example, they often pose the problem in only scientific or technical terms; they do categorize or break-down problems conceptually, instead proceeding concretely or according to concepts familiar from other aspects of their lives; they do not identify and pursue multiple goals, consider complexity and uncertainty; and they do not seek to identify practical constraints. Such skills depend upon much longer study and practice in the field. An expert would not be vulnerable to recent arguments, for example, to privatize public land because "look how well people take care of their own yards." Such appeals to familiar social experience instead of more appropriate conceptually organized and empirically winnowed knowledge exploits the weaknesses of novice thinking. Expertise in any problem area requires more than a general problem-solving model, and especially more subject-matter content than students can get in one course. A deeper assessment of problem solving expertise at the end of Huxley students' time here would be quite interesting.

Conclusion & Suggestions

Explorations in Environmental Studies was instituted in the spirit of Huxley's mission as an experimental college. The information summarized here, while by no means complete, does provide some sense of the results of this stage of the new Core experiment. There are weaknesses in both the basic content and problem solving learning of the students in the present formulation. What should our response be? Does our own problem solving include step number 7?

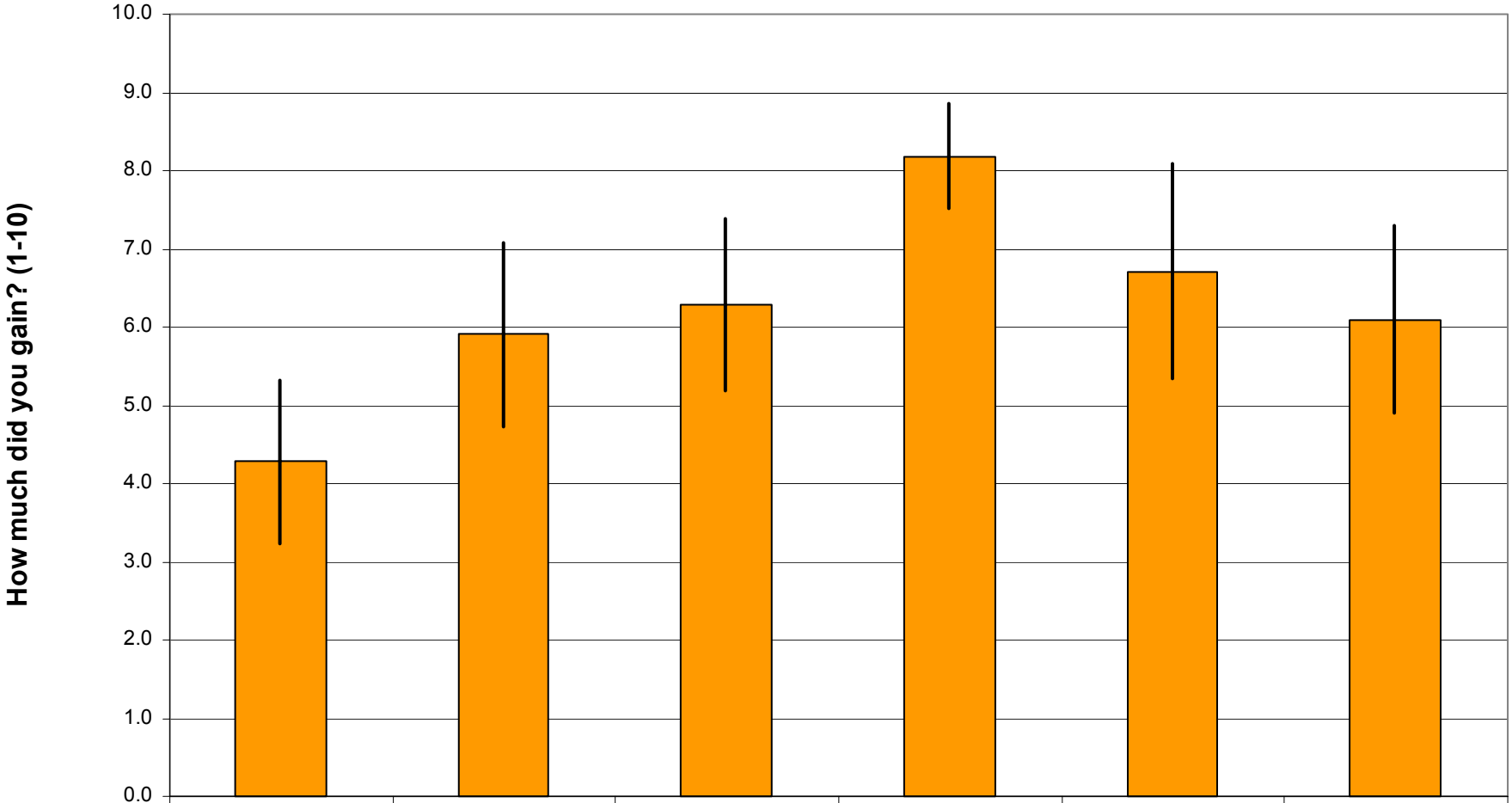
In conclusion, a word about further evaluation of the core. Evaluation should be *useful*, and to be useful there need to be specific people who want the information and intend to use it. Deciding what to evaluate about the Core is as important as deciding what to put in the core, because they are part of the same process. Neither can be done well (i.e., usefully) without participation.

At the present stage, three further steps in evaluation / course development might be:

1. Continue evaluating core sections using the Environmental Problem Solving Essay. Have it scored for MID if we feel that is useful. But more importantly, discuss as a faculty *precisely what do we mean by interdisciplinary environmental problem solving*, *and how can we tell when our students 'have' it?* Then, develop ways to assess it. Use and quantify different methods of teaching problem-solving. Possible intended use: improve the ability of 301 to make our students better problem solvers.
2. Clarify the subject-matter content knowledge expected of the Core (as a whole, including 301), and evaluate it. Possible intended use: ensure that students receive this content and change core system if necessary.

3. Administer an Environmental Problem Solving Essay, and/or Knowledge Assessment, and/or the MID to students who have completed their Capstone. Graduating students should also be asked about their experience of 301, *in retrospect*, because often important educational gains are only evident in hindsight. If we want to do any of the steps in this item, it would make sense to do it with some of the students in the quarters reported on here, because we do have entry data on them. Possible intended uses: assess the effects of a full Huxley education; determine gaps; learn what value the Core has long after it was taken.

Figure 1. 301 Student self-rated understanding/Skill gained (points w/ s.d.) (Aut 02, all sections)



	ENV SCI	ETHICS	POLICY/ECON	GROUP SKILL	QUANTITATIVE	WRITING
tot avg	4.3	5.9	6.3	8.2	6.7	6.1

Figure 2. 301 Pre/Post Knowledge Assessment (Aut 2002, all sections)

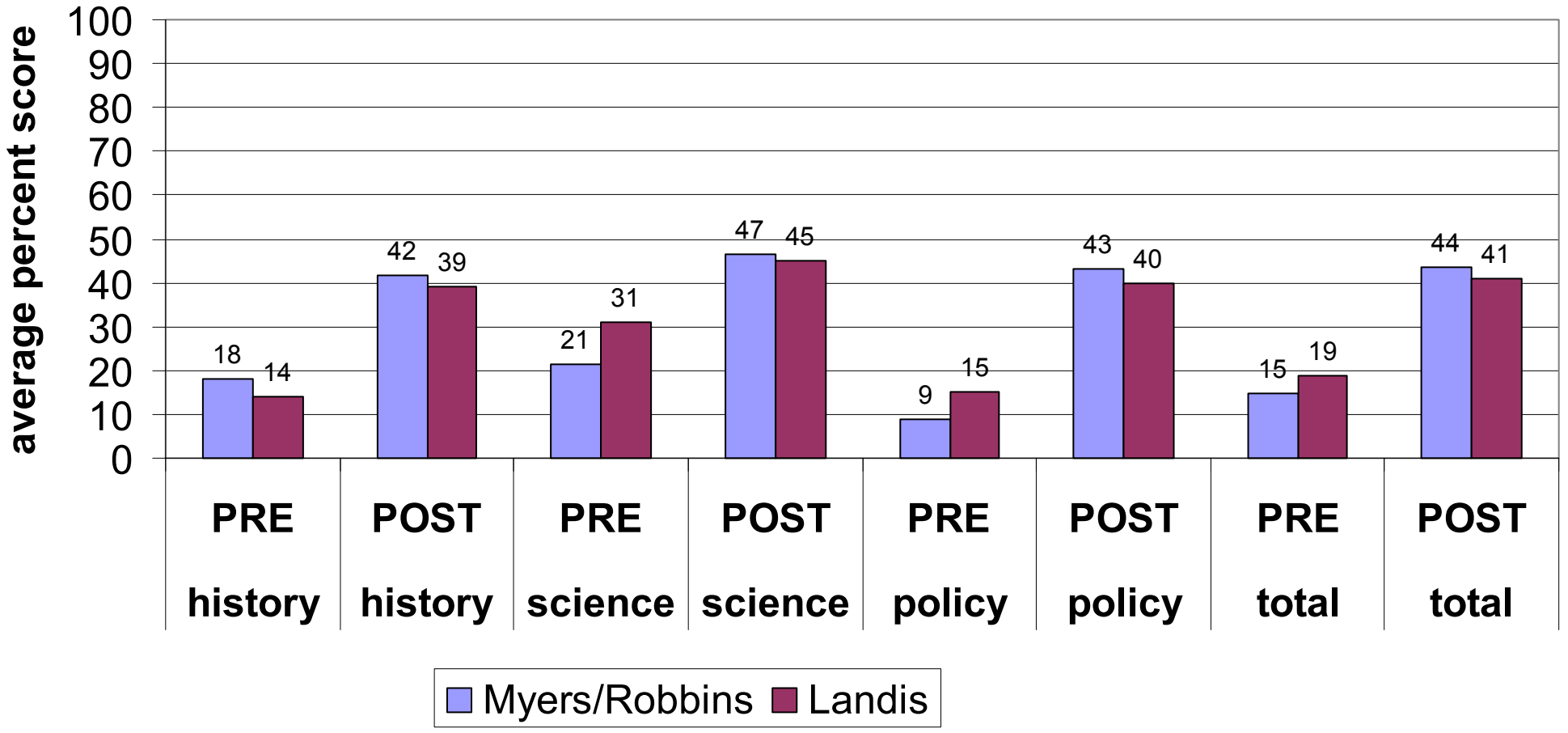


Figure 3. 301 MID raw score frequencies, pre- and post-course
(Spr. & Aut. 2002 & Spr. 2003; pre n=98; post n=96)

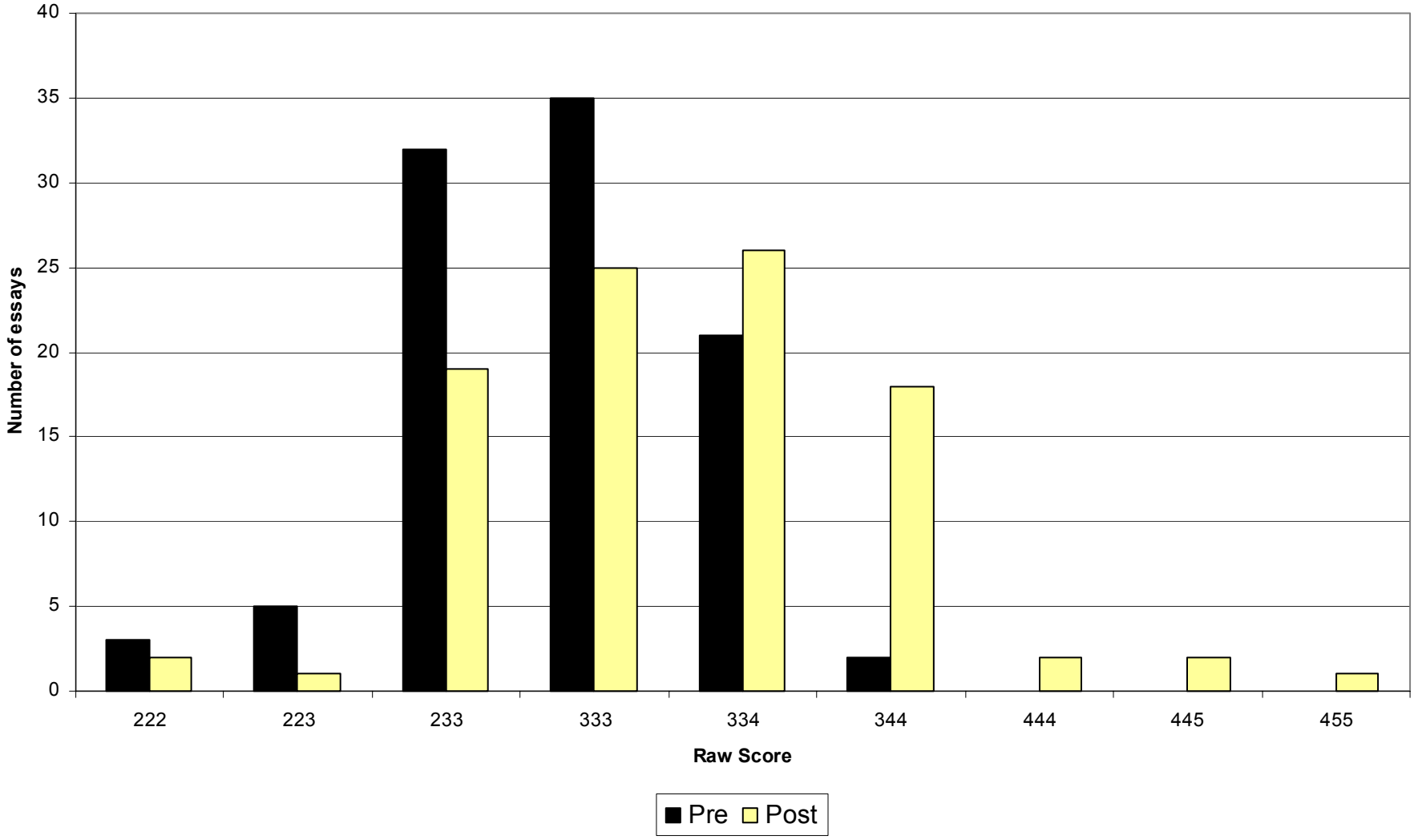


Figure 4. 301 Average course MID score pre- and post-course (Spring & Autumn 2002, & Spring 2003)

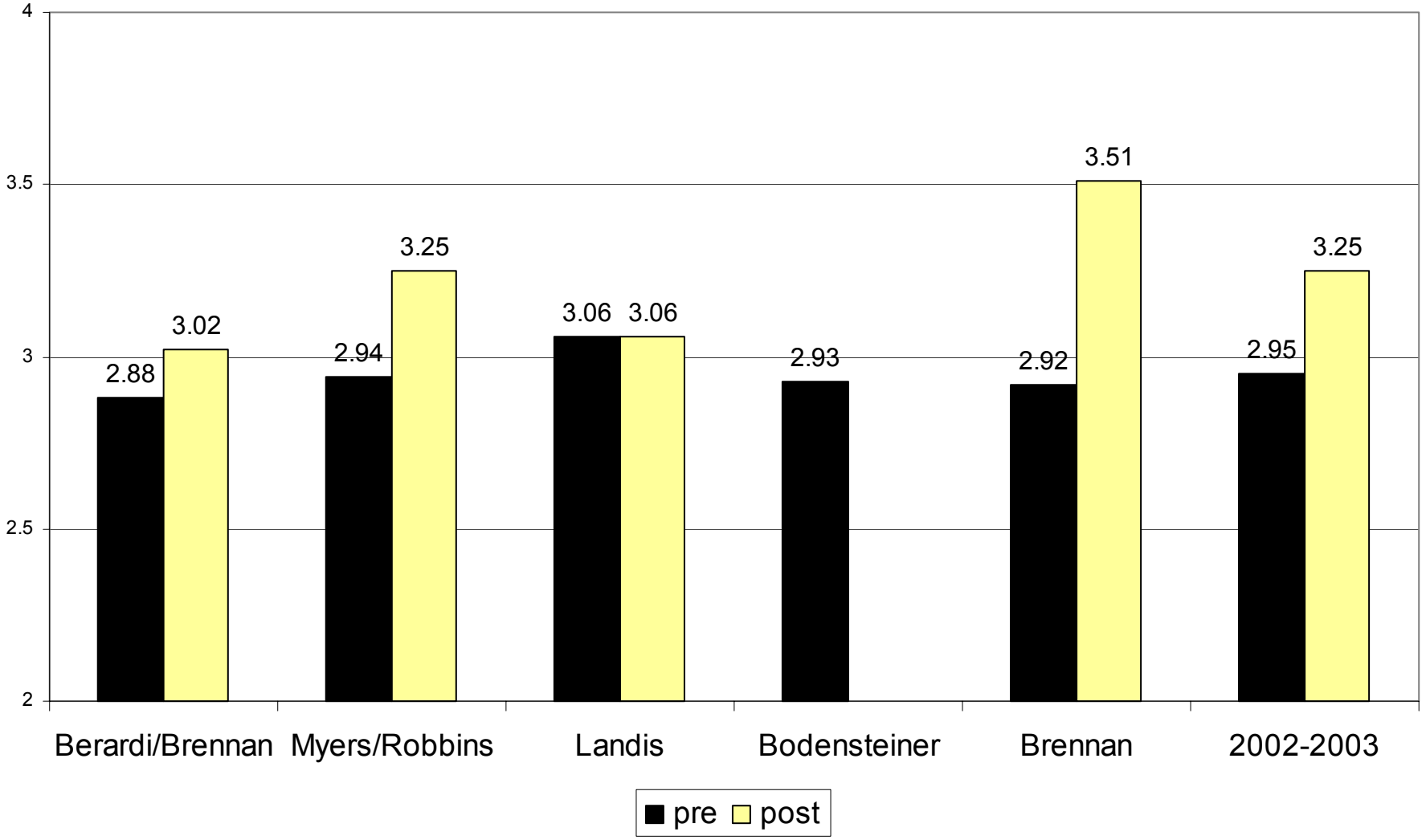
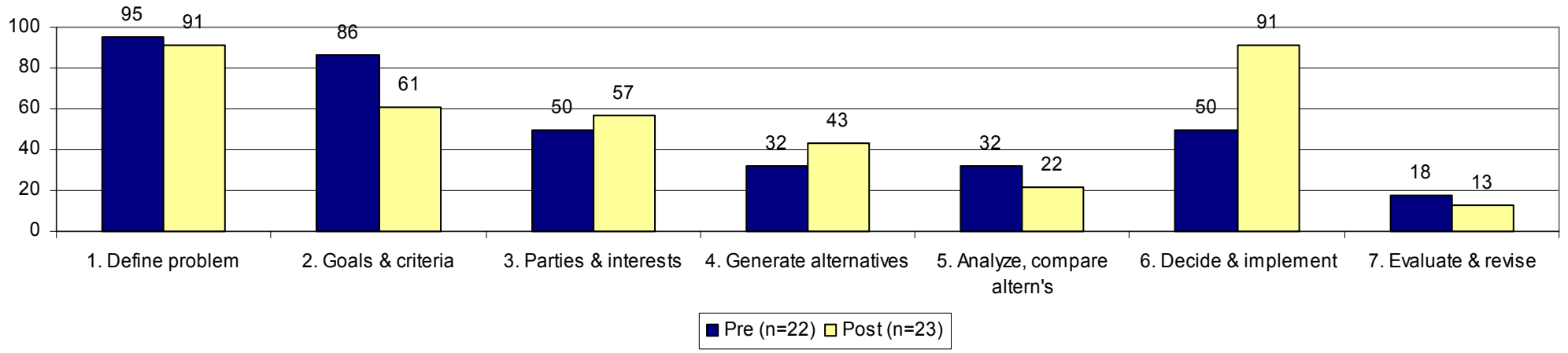


Figure 5. Percentage of 301 students using problem-solving steps (Spr. 2003, Brennan)



APPENDIX A. QUESTIONS AND SCORING POINTS FOR KNOWLEDGE ASSESSMENT

Estu/Esci Final exam / knowledge assessment v. 1 - short answer questions

Please **(1) define** and **2) give an example**, perhaps **explaining the significance** of each of the following concepts. In the case of individuals, please describe the nature and relevance of their work to environmental studies. Be as specific and concrete as possible.

4. Conservation vs preservation -- 10 possible (arbitrary upper limit)
   The terms designate contrasting historical philosophies of our relation to nature, and associated practices & institutions.
   Conservation:
   1 use resources at sustainable (replenishment) rate
   1 compatible with development
   1 efficiency - avoidance of waste or wise use
   1 utilitarian - greatest good for the greatest number over the longest time
   1 professionalism & applied science
   1 institutions: USFS, BLM, DNR
   1 Gifford Pinchot, Teddy Roosevelt, William McGee
   Preservation:
1. non-use, or non-consumptive use, of resources; protection
   1 non compatible with development
   1 nature in its pristine state has aesthetic, scientific, biodiversity, recreation, and/or existence values
   1 institutions: NPS, Wilderness designation
   1 associated with John Muir, Sierra Club, Wilderness Society

5. Aldo Leopold - 8 possible
   1 naturalist / ecologist / writer / wildlife ecologist
   1 author of A Sand County Almanac, 1948
   1 originator of the idea of a "land ethic"
   2 Land ethic says we should extend respect to biotic community
   1 Humans are plain members of that community, not superior to it
   1 looked at conservation through an ecological lens
   1 worked in USFS, helped originate wilderness system

6. Ecosystem - 7 possible
   1 A concept or model designating a system (somewhat arbitrary)
   1 Interactions and/or relationships…
   1 between organisms & each other - (ie, biotic community…
   1 and between the living and non-living elements (biogeochemical cycles, etc)…
   1 exhibiting a flow-through of energy and cycling of nutrients…
   1 in a specific area & time; boundaries are a contentious issue
   1 Examples include a forested area; a lake; a river; an estuary, etc. Smaller than landscape level, larger than a stand or patch

7. Limiting factor - 6 possible
   1 chemistry concept: component of a chemical reaction whose quantity is such that it is in shortest supply relative to required amount, and it thus limits the volume and time of the reaction

1 ecology concept: whatever condition or factor limits the growth of an individual, population, or the productivity or extension of a system

4 limiting factors for primary productivity (1 each):
Phosphorus in aquatic systems
Nitrogen in terrestrial & marine system
Individual organisms: nutrients, water, light, temperature, space, available energy

8. GIS - 6 possible
   1 Geographic Information System
   1 a computerized…
   1 map
   1 utilizing an associated digital spatial database
   1 queried in various ways, allowing analysis and export of spatial data in numerous ways
   1 examples of applications - from ecology to planning, etc.

9. Model Toxics Control Act (MTCA) - 6 possible
   1 Washington State law, modeled (and improving) upon CERCLA (Superfund clean up), 1989, passed by citizen initiative, revised 2001
   1 governs clean up of contaminated sites
   1 governs assignment of liability & collection of fines / costs
   1 requires reporting of spills & creation & review of cleanup plans
   1 Administered by State Dept. of Ecology
   1 generates some funds to pay for cleanups from tax on toxic materials

10. Environmental Impact Statement - 8 possible
   1 a published statement of the expected environmental impacts of a proposed action that is determined to have a significant env. impact
   1 describes the expected impacts of several alternatives
   1 includes "preferred" and often also "no action" alternatives, and mitigation measures
   1 required for federal agency actions expected to have significant environmental impact
   1 federally required by NEPA; Washington State actions covered by SEPA
   1 Agency not bound to choose minimum impact alternative; a procedural law not a substantive one
   1 public hearing, review and comment processes required
   1 Bellingham Bay cleanup requires EIS because permitting and cleanup are under jurisdiction of state Ecology dept. (and US EPA).

11. National Pollution Discharge Elimination System - 6 possible
   1 Clean Water Act system for reducing and eliminating point sources of pollution
   1 requires corporate or municipal entities to get permit for any out-fall or discharge containing pollutants, into a water-body
   1 Permit may allow various mitigating steps, such as diffusers / diffusion zones, the ASB, etc. in GP's permits
   1 permits must be renewed, and public may have input into the review process
   1 fines may be imposed for exceeding permitted amounts; some firms self-monitor
   1 public may also bring action if permit conditions are violated

12. Ecosystem services - 7 possible
   1 services provided by ecosystems; natural capital

1 may be provided directly or indirectly to people and their economic systems
1 includes many things that presently are not priced, or not included in pricing, in economic system
.5 (each) examples: atmospheric gas balances, soil formation, biodiversity, freshwater (surface or aquifer) quantity and quality, nutrient cycling, pollination, the ability of forests, fisheries & wildlife to renew themselves
1 generally non-owned, and may not be amenable to market valuation
1 setting monetary values by other means is difficult and contentious
1 a sound policy would be to set absolute limits on the degradation of ecosystem services

13. Externalities (combine w/ "market failure" in Landis post-test) - 6 possible
1 A cost (or benefit, in the case of the 'free rider' problem) of an activity that is not included when accounting for the costs (or benefits) of that activity.
1 negative externalities are costs that fall outside the transaction between market traders (producer or consumer), and thus on some other party
1 recognized by economists as sign of inefficiency
1 lead to less than optimum allocation of resources (they artificially inflate demand for the under-priced product)
1 examples include pollution that is done without any payment (in form of new machinery, permits, fines, taxes, etc.) and the harm it causes is not reflected in the final price of the good involved.
1 related policy principles: "Internalization"; "Polluter pays"

Additional items used by Landis:
14. Ethnohistory - 3 possible
1 history plus anthropology
1 a culture's own view of, and form of telling, its history
1 the use of both ethnographic and critical historical methods to determine the past of a particular cultural group

15. Species - 5 possible
1 taxonomic convention for grouping organisms that share biological (esp. genetic) traits
1 more specific than genera
1 able to interbreed only w/n group, reproductively isolated from other groups
1 produce reproductively viable offspring
1 grouping based on phylogenetic lineage

Name: _____ Instructor:_____ Date: _____

Estu/Esci Final exam / knowledge assessment v. 2 - short answer questions

Please write responses to each of the following questions. You need not use complete sentences, but rather should aim to get right to the heart of each question and be as thorough and accurate as you can, using all relevant material you have learned in class. Be as specific and concrete as possible. Use the back if necessary.

1. How are ecological benefits and damage evaluated (assigned a value) by our economic system? How might the relationship between ecology and economics be improved?

- 8 points possible
- in present economy, they are not systematically included as separate items in monetary evaluation
- their value is expressed indirectly in the trade of goods originating in nature, and in wages from jobs
- costs and benefits from nature may be internalized in market prices by approaches including 'green' marketing and consumerism, taxation or emission allowances, and costs regulation, fines & new capital investments, or contingent valuation (survey) methods. These techniques are not geared to reflect actual ecosystem service values
- methods for estimating ecological values include: estimating replacement cost of a function using technology and human capital; estimating future values of lost service; dollar estimates of effects of damage on economy.

2. What historical figures and events led to the emergence of the American environmental movement? Provide dates, names, and significance of the events you discuss.

- 10 points possible
- a wide range possible contents
- .5 points for naming/ identifying each
- .5 for giving its/his/her contribution or significance

3. What are the three branches of the federal government, and why is it important for env. scholars/students to understand how they work? Be sure to include a definition of policy in your answer.

- 6 possible
- 1 each for legislative, judicial, executive, but only .5 if proper function not named
- important to solve problems, influence choices, succeed in careers, know where to change things, anticipate & respond to political influences
- policy: guidelines, plan, or principle that directs decision making

4. Name and explain the kinds of interactions that define or characterize ecosystems.

- 10 possible
- concept requires specification of space/time & boundary conditions
- energy flows betw. abiotic and biotic
- matter & nutrient cycles betw. abiotic and biotic
- trophic relations, food webs, trophic roles & functions
- interspecies composition, biodiversity, kinds of things
- niches, tolerance limits, adaptation, evolution, natural selection
- interspecies interaction, symbiosis, population interactions, pop. regulation
- intraspecies interaction, competition, pop. regulation
- human influence