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Cover Illustration: Cover artwork provided by Thomas A. Davis, Loras College. From left to right: Aldo Leopold, January 11, 1887 - April 21, 1948; *Silphium laciniatum* or compass plant, one of his favorite plants; drawing by Aldo Leopold. The artwork is used with permission from the Leopold Education Project and Pheasants Forever

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Freshmen In Science Program

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Abstract: Much has been written about the lack of student interest and abilities in the area of mathematics and science. Too often students rule out careers in these areas before they ever reach college. A variety of programs have been established to encourage pre-college students to become more involved and interested in science and mathematics. Of equal concern are those students who come to college eager and ready to concentrate on their studies in science and mathematics only to drop out by the end of the first year In 1990 the science and mathematics faculty at Rockhurst College entered into a planning process to address attrition problems. A year of bi-weekly meetings resulted in a November, 1991 proposal for a Freshmen In Science, (FIS) program. The goal of the project was to build a support system for the curriculum that would encourage students to put forth their best effort. This paper will describe the planning process, program and results from a six year effort to keep students interested in science-related careers.

Keywords: recruitment, retention, support system, freshmen in science, seminars, evaluation

Introduction

It is a well established fact that colleges are faced with many challenges when presenting their mathematics and science programs. Of specific concern is student recruitment and retention. Recruitment is a problem because many students rule out careers in science and mathematics before they ever reach college. Retaining students has historically also been a problem. Many students who begin their studies in science and mathematics drop out of these programs by the end of their first academic year. The retention of first-year college students has always been of concern in higher education, but a dramatic shift has occurred in the response of educators to this concern in the last 15-20 years. The change has come about primarily because the faculty itself has become concerned with the issue. The challenge is not merely one of retention, but also of the kind and quality of the student involved. Faculty must be concerned with the students and their success in courses and in college in general. Responses must focus on the students' sense of satisfaction with their entire educational experience. It would seem that the more interest paid to increasing student satisfaction with the educational process, the better the retention, and the more successful the student. The primary response to this issue has been the development a first-year experience in the form of a seminar for freshmen. A review of the past history of these seminars can be found in a survey published by Barefoot (1994). Generally the seminar topics cover basic study skills and what the educational process involves (Cohen, 1979), thus familiarizing the student with what is to occur during their education. Most of the references available from ERIC on the topic of the Freshman Experience Seminar (over 4000), are basically directed at the entire freshmen class and cover the same skills and study levels. Occasionally a seminar may emphasize a novel approach such as the "Deliberate Psychological Education (DPE)" method (Young, 1986) used in one variation of the standard seminar. This semester long seminar surveyed topics in psychology and education using modules focusing on specific skills. In another seminar (Kresky, 1982), a course in Introductory Greek was added to the semester The instructor learned Greek along with the students, and the goal was to learn something about Greek in general and native languages in particular, as well as "learning about learning". Different times and lengths of seminars (Rice, 1989) have been attempted. Reading as a basic theme (Brown, 1994) and writing across the curriculum (Papier, 1990) have been used in several different seminars. One seminar was based on "Outdoor Adventures" (Stremba, 1988) as a means of introducing students to college work.

All of these seminars seem to have in common the attempt at highlighting fundamental skills and abilities needed by the "generic" incoming freshmen. No seminar or first-year experience of any sort was discovered which dealt with an academically specific group of students. Hence, we present our program and seminar which is designed specifically with the "science" student in mind, and is focused on any incoming student who indicates even the slightest interest in science.

Addressing Problems

Recruitment and Retention

In 1985, Rockhurst College became aware of its own recruitment and retention problems concerning science students. Eight faculty from the Science Division participated in bi-weekly meetings to address this situation. Careful discussion notes were taken and distributed to members of the group, as well as department chairs. Occasionally, our discussion group made interim reports to the entire division. Some selected topics included: advising, heavy course loads for students, diversity issues (race, gender, vocational), lab experiences, and faculty cooperation. As a result, we developed a program called Freshmen in Science (FIS). The integrated products of this effort include: the Freshmen In Science *Program* (a collection of academic and social activities to address recruitment, retention, and a successful experience throughout a student's course of study), and the Freshmen In Science *Seminar* (a one credit hour class for freshmen students who have identified mathematics and/or science as their primary area of study.)

Planning Phase
Members of the FIS faculty researched the literature on attrition rates in science and mathematics, and led discussions based on their findings. It is worth noting that many of the articles that we reviewed came from discipline specific professional publications. It was clear that attracting and retaining students was a problem shared by all the disciplines in science and mathematics. Following a year of discussion, two faculty members spent the summer of 1991 completing a draft of a Freshmen in Science Program proposal. The purpose of this document was to provide a focus for discussion by the entire Science Division. The proposal included the following program components.

FIS Program Components

⇒**Support System.** It was generally agreed that support activities could be easily developed and implemented. Our initial list of proposed activities included:

- ♦Conducting an orientation session to introduce students to science and math faculty and welcome them into our program.
- ♦Publishing a calendar of science and mathematics exam dates and special events.
- ♦Providing all FIS students with a specially designed t-shirt, thus helping them identify one another as part of a special cohort group.
- ♦Offering Sunday Night Study Sessions held by our upper division majors and supported by faculty teaching freshmen science and math classes.
- ♦Developing special advising information sessions to let the students learn about the wide range of programs within the division

⇒**Curriculum Reform.** In 1990 there was a national reexamination of the manner in which science and mathematics was being presented. After some review of what was being discussed and implemented at other institutions, we decided to focus on cultivating student-centered, research-rich environments.

For us, this meant that we needed to:

- ♦explore alternatives to the standard "lecture" format;
- ♦re-examine the nature of our laboratory experiences;
- ♦increase the use of technology in course delivery; and,
- ♦require students to apply their knowledge to "real problems" in science and mathematics.

⇒**Scientific Collaboration.** One of the most significant results of the first year discussion sessions was the forging of new faculty relationships across different scientific disciplines. As a result of constant communication, students began to view us as a team striving to help them succeed, interested in work outside our disciplines and knowledgeable about the work they were doing in other courses. Our discussion group determined that there was value in looking for opportunities to collaborate and, when possible, to integrate course material.

⇒**Faculty-Student Interaction.** Frequently science and mathematics is thought of as all work and no play. To assist the students in understanding that both work and play are an integral part of the life of a scientist or mathematician, we proposed the creation of social events and seminar experiences that would encourage interaction among faculty, upper division majors and our freshmen.

⇒**Freshmen in Science Seminar.** In the spring of 1991-92, following the first implementation of the FIS support system, our FIS faculty discussion group proposed the development of a Freshmen in Science seminar. To create the seminar, eleven science and mathematics faculty met during the summer of 1992 to discuss topical issues for inclusion in the course, and to consider implementation strategies and supporting activities.

Funding Resources
During the 1991-92 school year, some preliminary efforts to implement the FIS *Program* took place. A science specific orientation session was held, Sunday night study sessions were organized, and exam dates were coordinated, published and distributed to all freshmen on a calendar that also contained other important campus events. The biology, chemistry, mathematics, computer science and physics clubs also sponsored a fall picnic for the freshmen science and math students. In addition to these activities, special advising sessions were held near the middle of the first semester to help students begin to consider a broad range of science related career paths.

Our extensive planning process, detailed program description and the small scale fall implementation helped us attract three separate donors to our project. To support curriculum reform efforts, two NSF Improvement in Laboratory Instrumentation grants were written and funded to provide the technology that would be required to implement curricular changes in introductory biology and calculus. In addition to the matching funds raised for these grants, additional funding was sought for summer curriculum development efforts in other introductory science courses. The funds in this category were distributed to eight faculty across all the disciplines. Table 1 shows income sources that supported our efforts to revitalize our introductory science and mathematics courses.

Curriculum Reform	NSF funds	Corporate funds
Biology	$25,000	$25,000
Mathematics	$70,000	$77,000
Other		$50,000
Totals	$95,000	$152,000

Table 1. Curriculum Reform Funding Sources

In addition to the funding for curriculum reform, the college and a local foundation provided the necessary resources to maintain the support system costs. This money has been used to pay for t-shirts, interest inventory examinations, social events and the development of the Freshmen in Science seminar. Table 2 shows the income sources for support system funding.

Support System	College funds	Corporate funds
1991-92	$2,500	
1992-93	$2,500	
1993-94	$2,500	$10,000
1994-95	$2,500	$10,000
1995-96	$3,500	$10,000
1996-97	$4,000	$10,000
Totals	$17,500	$40,000

Table 2. Support System Funding Sources.

Freshmen In Science Seminar

The major component of the FIS *Program* was the one-hour FIS *Seminar*. When this Seminar was initially developed during the summer of 1992, a panel of faculty met to discuss various topical inclusions considered to be essential for freshmen students. From these discussions, major themes emerged: the role of ethics in science, utilization of time management skills and strategies to improve those skills; the partnership between students and faculty; the manner in which laboratory classes are different from and essential to their complementary lecture courses; and the way in which a student's values, skills and interests can direct choices for a major and a career. Throughout the development of this course, these topics were interwoven in various ways.

Once these topical areas were identified, structural issues were addressed. Key issues included the design of some topics for small discussion groups rather than in a large lecture hall; development of a panel of teachers for the course, rather than a single instructor (this would allow each small group to be lead by a member of the science division faculty); and recruitment of sophomore students to be paired with each faculty member. To help tie the themes together, the film "And the Band Played On" was shown to the students at the beginning of the semester during a special session. This film about the A.I.D.S. epidemic was used to illustrate real-life examples of many of the course topics: the impact of personal ethics on scientific outcomes; the necessity of partnerships in research; the potential conflict between personal values and interests with objective assessment; and the ways in which past experiences may bias future trials. Throughout the semester, this film was used as a reference point. To provide more specific information about how the various topics were presented and structured for this course, each week's topic is listed below followed by a brief explanation of its intended value and means of implementation.

FIS Seminar Topics

- Course Introduction: Presentation of goals and objectives of the course are explained to the students along with an outline of formal and informal course activities. Faculty and student facilitators are introduced and expectations regarding professional behavior for this and for all college classes are explained.

- Student-Teacher Partnerships: Students and facilitators explore the manner in which teachers seek to unite with students as partners to uncover rather than withhold information.

- Ethics: Through film presentation and discussion, ethical behavior's impact on scientific outcomes and its role in collaborative study are explored.

- Time Management: Students and facilitators are asked to document the use of all waking hours, in an attempt to help students contemplate alternatives to both study and non-study time.

- Learning Through Labs: The importance of pairing applied study (laboratory) with theoretical investigation (lecture) is presented, along with an exercise which addresses *how* data are explored.

◊ Valuing Diversity: The importance of including all possibilities when examining a scientific questions is presented. Social implications of maintaining a broad perspective are also examined.

◊ Core Curriculum: In keeping with the discussion on diversity, the necessity of a well-rounded education, and its effect on scientific inquiry are presented by a panel discussion.

◊ Advising: Students are presented with the semester-to-semester structure of chosen majors as well as the possibilities for alternative majors and/or minors and graduate studies.

◊ Presentation by Professionals: Spanning two class periods, students are required to explore four different career options by interacting with professionals from outside the college who hold science degrees and work in science related fields.

◊ Seeking Balance: The value of stress reduction techniques and use of leisure time are explored with reference to their effect on professional performance.

◊ Reading Science and Mathematics: Strategies for improved comprehension of scientific writing are discussed.

Course Presentation

As previously noted, we realized during the development of this course that some topics could be more fully examined within small group discussions, rather than through a large lecture presentation. Additionally we believed that interactive small groups might create an atmosphere for developing friendships (and thus fortifying bonds to enhance retention.) Groups were kept small enough (10-12) to allow each student to participate in discussions. With enrollment in the seminar ranging between 150 and 200, fifteen to twenty faculty members served as faculty facilitators each year As the course developed, sophomore students who had previously taken the course and who demonstrated leadership ability, were recruited and paired with faculty leaders. This provided the freshmen with both faculty and student insights and experiences.

When freshmen were assigned to small groups, an attempt was made to diversify the membership by paying attention to gender, major and intended careers. To accomplish this, demographic information was collected during the first class and was used for assigning students to small groups.

Assessment of the Seminar

Beginning in 1993, students were required to complete an evaluation of the seminar. We asked some fairly straightforward questions. Student responses to most of these questions have remained fairly constant over time, so what will be reported here is data collected from the 1995-96 freshmen class of 152 science students [see chart below]. (The college freshmen class size for that year was 288.)

Did you find this course useful?
85%- YES 13% - NO 2%-SOMEWHAT

Would you recommend this course to another freshmen science student?
85%- YES 8% - NO

Which TOPICS interested you the MOST and LEAST? (in rank order)
MOST: Presentations by Career Professionals; Work/Professional Ethics; Basic Advising; and Time and Stress Management.
LEAST: Skills, Values and Interests; How to Read Science and Math; and Collaboration, Cooperation and Coping

Which course ACTIVITIES interested you the MOST and LEAST?
MOST: Service Project; Strong Interest Inventory LEAST: Weekly Journal Writing; Strong Interest Inventory.

It is interesting to note that the Interest Inventory was rated most liked and least liked by equally high percentage points. Our interpretation of this is that students who arrive on our doorstep confident in their choice of fields of study see little value in exploring their skills and interests. On the other hand, students who are less sure of what they want to study, find this activity both revealing and helpful. The generally overwhelming positive response from students helped us gain needed support from faculty and administrators. Student reactions, both positive and negative, to specific topics and activities provided us with clear indicators of things we were doing well and things we needed to improve upon. For example, we struggled with helping our students understand the importance of appreciating diversity We attempted to introduce this topic in a variety of ways and were unsuccessful in the first few years. This past year, we added a session on Scientific Bias tying the discussion back into our over-arching theme of treatment of the A.I.D.S.crisis and the film "And the Band Played On." The students were more willing to enter into a discussion of diversity when the topic was tied directly to their interest in science. This appears to have been a reasonable compromise between what the students are capable of handling and willing to consider, and faculty expectations of what should be addressed when we talk about issues of diversity

Tracking Student Attitudes about Science and Mathematics

In addition to studying student responses to the seminar, we have been asking them to tell us about their experiences as students of science and mathematics. Information is gathered through a student survey administered at the end of the first semester The survey instrument has evolved over a four year period, so what will be reported here are the results from the 1995-96 survey.

Demographic Information

Of 152 respondents, 69% were women and 31% were men, 77% were residential students and 23% were commuters. Distribution of students by intended majors can be found in table 3.

MAJOR	NUMBER	PERCENT
Biology	60	39%
Chemistry	13	9%
Computer Science	5	3%
Mathematics	2	1%
Nursing	22	14%
Physics	1	1%
Psychology	22	14%
Sociology	6	4%
Business or Education	12	8%
Other	7	5%

Table 3. Distribution of Students by Major

Self-Reported Study Habits

When asked how many hours per week were spent studying science or mathematics, 144 students responded with an average of 11 hours per week. In addition to study time, 73students reported that they were tutored for an average of 1.8 hours per week in science or mathematics. 132 students said they had sought help from their instructor

Responses to FIS support activities.

- 132 (87%) attended the brief one hour orientation session prior to the start of school. Of those in attendance 98 (74%) found the session useful.
- 125 (82%) attended the half-day Saturday orientation session. Of those, 90 (72%) found it useful.
- 41 (27%) attended the spaghetti supper held at an off-campus location and 34 (84%) of those attending found it useful.
- 141 (93%) found the FIS calendar and coordinated exam dates useful.

Overall Impression of Science & Mathematics

The students were asked about their impression of science and mathematics courses and programs at the end of their first semester of classes. A graduate student, not associated with the FIS program, was asked to interpret the narrative responses of the students on a scale of 1 to 5 with 1 being very dissatisfied and 5 being very satisfied. 143 students responded to this question with a mean of 3.8. Of concern to us was the possibility that we might be serving the needs of one group of students better than another. With this in mind, we looked at the mean response to the "Overall Impression" question with a variety of populations. The results are listed in Table 4 below.

An analysis of variance on the following seven groups (Biology, Chemistry, Math/CS/Physics, Nursing, Psy/Soc, Bus/Ed, Undecided) indicated no statistical difference in the means. In addition, a two-sample T-Test was performed on the following: male vs female, residential vs commuter, health science vs non-health science, nursing vs non-nursing and all possible pairs among the individual majors and careers. In all but a handful of instances, there was no evidence of a statistical difference in the means. The exceptions were nursing vs non-nursing, nursing vs biology, nursing vs pre-medicine and nursing vs Occupational Therapy & Physical Therapy. In each of these instances, the nurses had a significantly lower impression of their science and math experiences. We are currently in the process of examining their narrative comments in an attempt to better understand why they appear less pleased than other constituents.

Group	N	Mean	St Dev
male	45	3.95	0.73
female	97	3.76	1.01
commuter	33	3.72	0.87
residential	110	3.85	0.94
Health Science	100	3.84	0.94
Non-Health Science	37	3.83	0.95
Nursing	21	3.42	0.74
NonNursing	121	3.89	0.94
Biology	56	4.07	0.71
Chemistry	12	3.83	1.19
Math, CS, Physics	8	3.62	0.74
Psy, Soc	27	3.81	1.04
Undecided	7	3.71	1.38
OT/PT	56	3.92	0.97
Pre-Med	21	4.09	0.88
Bus, Ed	11	3.55	1.29

Table 4. Overall Impression of Science & Math

Retention Data

We tracked students who had taken the FIS seminar course. Retention information can be found in Tables 5 through 7.

Year	# in Seminar	# in College, Fall. 95	# in Science, Fall, 95
92-93	114(58%)	74(65%)	68(60%)
93-94	190(55%	137(72%)	127(67%)
94-95	205(55%)	184(90%)	169(82%)

Table 5. Retention Data from Fall, 92 to Fall, 95

Year	after sem 1	after sem 2	after sem3	after sem 4	after sem 5	after sem 6
92-93	9%	15%	4%	4%	2%	1%
93-94	7%	14%	5%	3%		
94-95	4%	6^				

Table 6. Percent withdrawal Each Semester

Year	By Year 1	By Year 2	By Year 3
92-93	24%(vs 30%)	32%(vs 36%)	35%(vs 36%)
93-94	21%(vs 23%)	29%(vs 32%)	
94-95	10%(vs 17%)		

Table 7. cumulative % science withdrawal (vs% cumulative college withdrawal)

Conclusion

Overall, the Freshmen In Science *Program* and *Seminar* have been successful. The marked improvement in the retention rate of students continuing their studies in science and mathematics (from 79% to 90% after the first year of studies is complete) is one piece of evidence. Additionally, the self-reported student satisfaction index of 3.8 on a scale of 1 to 5 with 5 being the most satisfied, points to a high degree of comfort with the program. What does not show up in the statistical analysis is the increased sense of community that is evidenced by an increase in participation by our students and faculty in outreach science and mathematics programs for area pre-college students. There has also been a noticeable increase in participation in the social events that are held for science and mathematics faculty and students. Of equal interest to us is the increase in collaborative efforts across the scientific disciplines that are occurring. Currently, there are joint research efforts taking place between biology and chemistry, mathematics and physical therapy, and computer science, physics and mathematics. There is also an NSF funded collaborative effort taking place between all the disciplines in science and mathematics. While not necessarily a direct result of the FIS program, there is anecdotal evidence to indicate that these new collaborations are an indirect result of the program. Future plans include minor modifications to the seminar and more detailed statistical analysis of the effects of the program geared toward determining if the program has an effect on the academic success of our students.

Literature Cited

Barefoot, Betsy O. 1994. The 1994 National Survey of Freshman Seminar Programs. Continuing Innovation in the Collegiate Curriculum. *The Freshman Year Experience Monograph Series #20.*

Brown, Byron. 1994. The Rigor and Exorbitance of Reading: Teaching Critical Thinking in the Freshman Honors Seminar. *Proc. Nat. Conf. of Succ. College Teaching.*

Cohen, Robert D. 1979. *Freshman Seminar: A New Orientation.* Westview Press, Inc., Boulder, CO, 142 pp.

Kresky, Jerome. 1982. *Ancient Language as an Educational Tool: Report on an Experiment.* (ERIC, http://www.clarion.edu/resource/ERIC.html)

Rice, Robert. 1989. "The Effects of Various Types of Orientation Programming upon Freshman Academic Performance and Reaction to College." Paper presented to Western Regional conference of the Freshman Year Experience (Irvine, CA, January 29-31).

Papier, Sarah N. 1990. "Joining Freshman Orientation Concepts with Writing-Across-the-Curriculum." EDRS; (paper/microfiche) RIEFEB94.

Stremba, Bob. 1988. "Passages: Helping College Students Matriculate through Outdoor Adventure." *In* Life Beyond Walls: Proceedings of the 1988 National Conference on Outdoor Recreation (Ft. Collins, CO, November 10-13.)

Young, Eric D. 1986. *Psychoeducation Studies: A Freshman Guided Studies Seminar.* (ERIC, http://www.clarion.edu/resource/ERIC.html)

Problems and Issues for the Classroom: What works in generating class discussions using the method of Shared Inquiry

A friendly chat about smallpox, or should we reduce species diversity by one with the elimination of Variola?

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Abstract: The potential extinction of the human smallpox virus lies in the hands of a few scientists and policy makers. Whether this decision should be made can serve as an excellent issue for extended, focused classroom discussion.

Keywords: smallpox, Variola, shared inquiry, class discussions

INTRODUCTION

For about two decades a mass murderer has waited on death row. As with other scheduled executions, this one is not without controversy, but the final decision to execute will not be made in the courts, nor will it be made by popular vote. Further, this murderer is not a person. It is the smallpox virus, and the last portions of this killer known to science are held in special vials within the cold storage chambers of two high-tech microbiology laboratories. One set of samples, numbering some 450 units, is held in Atlanta at the Centers for Disease Control and Prevention, commonly known as the CDC. The other samples (about 150 units) are in Moscow at the Institute for Viral Preparations.

The human battle with smallpox (a.k.a., variola or varida) is an ancient one, dating back at least 2,000 years. However, with mortality rates ranging from a low of 1% to a depressing 50% depending on the strain, the effect of this scourge on humanity has never been the same in all societies. Nevertheless, if not a killer, smallpox usually left evidence of its presence in the form of deep scars or pock marks on the survivors.

Unfortunately, throughout much of history our arsenal against smallpox was limited. Progress, therefore, in overcoming this disease was very slow. The earliest records of combating smallpox come from the 10th century. These accounts chronicle early attempts to control epidemics by a practice called variolation. In China variolation was done by having people inhale dust that had been produced by crushing the dried scabs collected from the pock scars of people with variola. In the Middle East a variation of this practice was done. Here scab material or fresh fluid was ingested by, or inoculated into, a disease-free person.

To some, variolation seems to be a silly idea, but the concept was sound. Rather than waiting for an epidemic to come along, entering a population where few people were immune, a small epidemic was started. In this way the terrible scourge of a smallpox epidemic was controlled as a negligible outbreak. Negligible, of course, to those who did not become seriously ill. In immunological terms, variolation relies on a phenomenon known as herd immunity; the more people in a community (the herd) who are immune to an infectious disease, the less chance there is for the disease agent to establish an full-blown epidemic.

Variolation was introduced into England in 1718 by Lady Mary Wortley Montague, spouse of the British Ambassador to Turkey. The practice was used in England until the end of that century. Even Washington had his troops protected in this way Variolation worked best when the milder strain of smallpox, variola minor, was used. Unfortunately, when a more virulent strain of the disease was used, variola major, the case-fatality rate could exceed 50%.

Modern treatment for smallpox stems from the work of Edward Jenner in the late 18th Century Jenner noted that dairy maids in rural England usually did not carry the characteristic smallpox scars seen on those who had survived their bout with smallpox. Jenner formulated a hypothesis that the dairy maids had contracted cowpox and that this conferred an immunity to variola. Cowpox generally causes little problems to humans or even to cattle for that matter. Working on this insight Jenner inoculated a boy, James Phipps, with the pus from cowpox scabs and then a scant three weeks later injected the boy with material from smallpox victims. Common knowledge at the time held that the boy would come down with at least the mild case of smallpox, but he did not. Thus was born the practice of vaccination, the procedure of conferring immunity against a certain disease through inoculation with a specific substance. The word vaccination is derived from the term used for the cowpox virus, vaccinia (Latin, vaccin-, of a cow) (Borror, 1960).

Jenner's prophylactic for smallpox was hardly without controversy. Political cartoons at the time predicted that those inoculated with cowpox scabs would grow the heads of cows from their arms or other parts of their bodies. As vaccination proved effective, its practice became widespread, but not universally. In the U.S., vaccination was rigorously applied so that smallpox epidemics have been rare in this century. Eventually, the need for immunization in the U.S. declined and, except for the armed forces, it has not been possible to get a vaccination of smallpox for many years. So in the U.S., smallpox vaccination became a memory before epidemic smallpox was eliminated from the world. The elimination of routine vaccination explains the rarity of vaccination scars on the arms of people younger than about 25-30 years of age (i.e., most, if not all, of the students in your classes). Presently it is estimated that <50% of the world's population is currently immune to smallpox, either through a natural active immunity (i.e., surviving the disease) or artificial active immunity (i.e., vaccination).

As humans are the only natural host of the virus, the World Health Organization (W.H.O.) saw the possibility of a worldwide immunization campaign against smallpox with the goal of its eradication. The W.H.O. program was not without its political and religious problems, but the goal of universal immunization against smallpox was achieved late in the 1970s. Smallpox was declared eradicated in 1979 by W.H.O. (the publication date was actually 1980) and smallpox is now considered to be a disease of the past.

To close this part of history, we should note that the last case of epidemic smallpox was diagnosed in a Somalian, Ali Maolin, in October of 1977. The only other case developed as a result of a laboratory accident the following year. That infection resulted in two deaths, but only one from smallpox itself. Janet Parker, a medical photographer from Binningham University Medical School in England, died of the disease; the other death was a suicide by the head of the smallpox laboratory.

THE DEBATE

So what do we do with the vials of the variola virus that await their fate in those deep freezers? And why is there any debate at all over their fate?

DESTROY:

Those who favor the destruction of the smallpox virus maintain that there is no need to keep the virus for five reasons. (1) We already have sequenced the genetic code of the major variants and the virus has been divided into several short fragments which have been inserted into separate plasmids. Thus, there are adequate ways of studying the virus without the possibility of causing an epidemic. (2) The virus produces a slow moving epidemic with easily recognizable symptoms. Therefore, any new epidemic supplied from unknown sources may be contained by quarantine. (3) It is not necessary to keep stocks of smallpox virus on hand from which we could make vaccine; new epidemics would provide sufficient stock and of the proper variant(s) to produce new vaccines. (4) Destruction of the viral stocks would remove forever the possibility of accidental or deliberate release. The latter could occur from hostile nations engaged in biological warfare or from terrorists. (5) Destruction of this virus will be an important symbol of hope in these days of a different plague, AIDS.

SAVE:

Those in favor of saving the samples argue that destruction of the samples does not eliminate the threat of additional outbreaks of smallpox. First, new epidemics could come from some unknown active pocket in a remote corner of the world, from a victim buried in the permafrost of Siberia, or from mislabeled samples that may remain in laboratories around the world. Second, outbreaks also could come from an evolutionary change in another existing virus such as monkeypox, thereby permitting an emergence of a new pox virus into the human population. Therefore, smallpox reserves should be retained to permit controlled studies allowing full understanding of the biology of a deadly virus we have yet to completely comprehend. Opponents of the destruction also argue that the study of this virus might provide insights into other important diseases. Finally, they argue that we should not get into the habit of eliminating any life form--even the etiological agents of disease--as we exterminate far too many species already.

Shall science execute this plague virus or not? A morning's work with an autoclave or even a large pressure cooker in two different sites is all that is needed to send this killer to oblivion. A report from W.H.O. scientists was prepared for the General Assembly of the United Nations and the recommendation was made to destroy the smallpox virus. After one stay of execution a second date was set for June 30, 1995, but another reprieve was granted. A new date for the destruction of smallpox is approaching, and the question remains: what should we do with the virus?

ASSIGNMENT

Students in two of my courses have been given this essay as background reading before class discussion. These courses are: (1) Concepts in Biology, a one semester course for majors and non-majors and (2) Microbiology, a one semester, junior–senior level course covering the general issues of microbiology. On occasion I also assign readings from other textbooks or ask students to search for websites addressing certain issues that I expect the class to explore. Assigned readings from textbooks are of the sort that discusses the history of smallpox and explains the course of the disease in its victims (e.g., Atlas, 1997; Black, 1996; Lim, 1998). The use of the Web has not been very productive for my students. As a test of this conclusion I did a simple web search on 22 October 1997. Using the search word smallpox, Yahoo® provided at least 300 hits, most of which were of marginal use; many of these hits were completely useless.

To begin the in-class discussion I first ask if there are any questions regarding the factual material from any of the assigned readings. There usually are a few questions. Then, taking my lead from the student questions I go in one of two directions. Often I go to the heart of the matter, asking shall science destroy the remaining stocks of this virus or not? Other times I back into the issue by asking other questions first. Two examples will suffice. (1) How might smallpox be useful to a military commander or to an invading culture (i.e., society)? (2) Assume that you live in a community that does not understand the development of smallpox. What would happen in that community when the first people come down with smallpox? While not immediately obvious to all students, someone quickly connects these questions to early U.S. history and to a scant 15 years ago.

Most of my students argue for the destruction of the virus, which happens to be my personal opinion, but I do not tell them my views until after class, and then only if they ask. A few times the entire class has agreed that destruction should proceed and that it should be done immediately When the class is that one sided, I either take the opposite view or I divide the class into small working groups of 3-4 students and ask them to come up with at least two new reasons to retain stocks of smallpox.

COMPARISONS ACROSS SCHOOLS

I am interested in your comments on this topic. Should you use this approach, I'd like to hear about the general knowledge of your students and about the kinds of discussions that it generates in class. How many students know about smallpox, its history, and biology? Do first-year majors and non-majors understand the difference between diseases having fungal, bacterial, and viral etiologies? In general, do students know about the pending decision to destroy the smallpox virus? Do majors and non-majors differ in their understanding of the issues? Do their opinions differ as to what the world health community should do?

Also I would like to hear of any other issues to be considered that weigh-in on the pro-destruction or anti-destruction side.

Literature Cited

Atlas, R.M. 1997. *Principles of microbiology*, 2 nd ed. Wm C. Brown: Dubuque, Iowa.

Black, J.G. 1996. *Microbiology, Principles and Applications*, 3 rd ed. Prentice Hall: Englewood Cliffs, New Jersey.

Borror, D.J. 1960. *Dictionary of word roots and combining forms.* Mayfield: Palo Alto, California.

Lim, D. 1998. *Microbiology*, 2 nd ed. Wm C. Brown / McGraw-Hall: Dubuque, Iowa.

Additional Readings

Brock, T.D. (ed.) 1990. *Microorganisms: from smallpox to Lyme disease.* Freeman: New York, New York.

Ogden, H.G. 1987. *CDC and the smallpox crusade.* U.S. Department of Health and Human Services. Public Health Service, Centers for Disease Control and Prevention, Washington, DC. HHS publication no. (CDC) 87-8400.

Saunders, Paul. 1982. Edward Jenner: The Cheltenham Years, 1795-1823 Being a Chronicle of the Vaccination Campaign. University Press of New England: Hanover, New Hampshire.

Winslow, O.E. 1974. *A destroying angel; the conquest of smallpox in colonial Boston.* Houghton-Mifflin: Boston, Massachusetts.

Developing A Personal Land Ethic: An Interdisciplinary Course on Aldo Leopold

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Abstract: Herein I describe a multidisciplinary course which I have developed and taught that has successfully enhanced awareness, appreciation and stewardship of the land, a land ethic, in college students.

Keywords: Land ethic, environmental ethics, Aldo Leopold, interdisciplinary courses, outside speakers, field experiences, prairie restoration, oak savannah restoration

Introduction

The fire engine-red cardinal whistled his morning reveille only fifteen feet above the stream of students heading to class on this bright, crisp, January morning. As I tramped along with the crowd I noticed I was the only one with my head up enjoying the "with you, with you, with you, you, you, you." I wondered if the students were not awake yet, or if they had their next exam on their minds, or maybe they had never heard or learned about a cardinal exclaiming the rights to his domain. I thought of Aldo Leopold and his concern for people who had little if any awareness of natural events or of their connection to the natural world around them. He wrote in the 1940's, "the problem is how to bring about a striving for harmony with land among people many of whom have forgotten there is any such thing as land, among whom education and culture have become almost synonymous with landlessness. This is the problem of 'conservation education' " (Leopold, 1949). I wondered how I could help students become more aware, more appreciative and better connected to the environment. I needed a plan to battle landlessness. I needed a way to develop a personal land ethic in some of these students. I knew Leopold was part of that plan

> *"All ethics so far evolved rest upon a single premise: that an individual is a member of a community of interdependent parts.*
>
> *His instincts prompt him to compete for his place in the community, but his ethics prompt him also to co-operate. The land ethic simply enlarges the boundaries of the community to include soils, waters, plants and animals, or collectively, the land... In short, a land ethic changes the role of Homo sapiens from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also a respect for the community as such."*
>
> (Leopold, 1949)

Herein I describe a multidisciplinary course which I have developed and taught that has successfully enhanced awareness, appreciation and stewardship of the land, a land ethic, in college students.

Course Objectives

The student objectives of this course are

a) to develop and describe orally and in writing their personal land ethic and describe how they view the present and future status of the natural environment;
b) to criticize and/or empathize with the writings and principles of Aldo Leopold as they apply to past, present and future ecological issues;
c) to understand and give examples of the basic principles of the science of ecology; and
d) to be aware of the simple beauty and mental refreshment of the natural environment in its pure, "unhumanized" form.

General Course Description
This course is a 3 credit, sophomore level, Honors course that meets for 80 minutes twice per week. The course has had an average of 20 students, 90% of whom have not been biology majors. There are no formal exams. Points are given a) for 7-10, two-page reaction papers to class activities; b) for 3 oral reports from student teams on various topics; c) for 2 written lab reports in which they collect and interpret data, support their conclusions through references and present the report in front of the class; d) for class participation in discussion; and e) for a final paper. Much of the student work is done in cooperative teams. Through these evaluation techniques, this course enhances the ability of each student to write and speak effectively, interpret data, listen well, argue constructively, work cooperatively with a team, and evaluate several points of view on an issue.

Figure 1. Questions to include in an introductory class period to create a starting point for personal land ethic development and a set of statements to return to at the end of the course to analyze changes.

Please briefly answer the questions below as a basis for the following discussion:

1. What is an ethic?

2. What is a land ethic?

3. If you have one, can you explain YOUR personal land ethic, how it got started and how you have strengthened it in the past 5 years.

4. In your own words, what is a wilderness area? Do you think we need more or less wilderness areas?

5. From your experiences regarding the environment, are you an optimist or a pessimist concerning its future and why?

Course Content
The course and this article are divided into six sections which are explored in the order presented here. The six sections include:

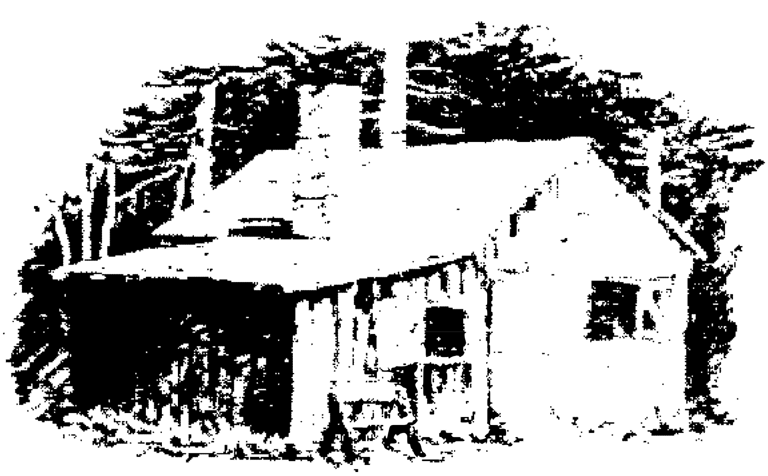
a) learning about Aldo Leopold, his life, his writings and his impact;
b) learning about the science of ecology and how we fit into the big environmental picture;
c) briefly learning about the history of land use in America and some important people in environmental thought;
d) having guest speakers from other college departments and from occupations who work with the land every day tell about their land ethics;
e) several field trips, including one to Leopold's Shack, two to local natural areas, and one to a local site where humans have destroyed the landscape; and
f) a final report which includes determining how to use what was learned in the course in the future.

Learning About Leopold
A good way to introduce Leopold to a class is to show the first half of a video titled: "Aldo Leopold, A Prophet for All Seasons" (Northword Press: Minocqua, WI). This video describes the life and experiences of Leopold and how he developed his land ethic that is so powerfully described in his epic, *A Sand County Almanac* (1949). It works well to have the students read some of the monthly essays in the first part of the *Almanac* that correspond to the time of year in which the course is taught. It is even better to take the class to a nature center, a wetland, or a pine grove to let them experience the sounds, the names, and the activities of the natural inhabitants of these areas. An excellent set of outdoor and indoor activities that have been specifically designed for use with the *Almanac* are found in *Lessons in a Land Ethic*, a teacher's guide (Pheasants Forever, 1995). This guide is one of the materials available to educators as part of a curriculum called the "Leopold Education Project" (see LEP Update in this issue of *Bioscene*). Through reading parts of the *Almanac*, using exercises described in the teacher's guide, and getting students outside to experience current natural events, the awareness and appreciation of Leopold grows, the eagerness to learn more and make more connections increases, and the students begin to ask their own questions. The last 25 pages of *A Sand County Almanac* bring together Leopold's land ethic. I have students read this section early in the course, write about their reactions and ask questions about the content so they are exposed to his conclusions and his style of writing. But I always return to this section near the end of the course to have students read it again, reread their initial responses, and then write more about how the experiences in the course have helped or changed their initial thoughts.

Learning About the Science of Ecology
Teams of students get parts of ecology textbook chapters chosen by the instructor to summarize and present orally the major concepts of ecology (Ricklefs, 1997; Smith, 1996). Some of these concepts include levels of ecological organization, habitat, niche, adaptations, energy exchange, nutrient cycling, succession, biodiversity, and succession. Specific visual examples of each are required in each report. Students try to understand how ecologists think and do research by summarizing several papers in the journal *Ecological Monographs*. Research topics that cover current issues

like spotted owl habitat or wolf reintroduction reports and simultaneously illustrate several ecological concepts have been especially enlightening to students. Ecologists who have done research on PCBs or neotropical migrant bird populations have come into the classroom to describe their research experiences but also to describe their land ethics and how they developed. Many of these people mention the role that *A Sand County Almanac* has played in the development of their environmental ethic.

Learning About the History of Land Use in America
I have used part of Hargrove's (1989) *Foundations of Environmental Ethics* to help students understand the progression of land use attitudes and influences that have formed the current landscape of our country Through these readings in several class periods, the students get a good picture of how German and Saxon Freemen, Thomas Jefferson, John Locke and others formed and reformed the fundamental right of property ownership. Discussions follow about the use and ownership of government public lands and about the role government plays in the regulation of activities on private lands. This brings the realization that now, since our land is limited, we must begin to evaluate how we use the land sustainably and keep it viable for future generations. Each student team chooses an important person in American environmental history - like Muir, Pinchot, Marshall or Zahniser - and summarizes their contribution to the development of our current environmental situation. We also spend a class period discussing Native American land ethics. We read aloud Chief Seattle's message and mythical stories from Ojibway, Iriquois and Lakota Sioux.



Learning From Other Disciplines and Occupations
In an effort to have students hear and question different points of view on various environmental issues, I have brought into the classroom speakers who are asked to share a description of their jobs, their personal land ethics, and their opinions of the present and future of the environment in which they work every day Iowa farmers who have feedlots and row crops have talked about the challenges, problems, and rewards of working the land on a daily basis. Students ask questions directly and better understand the economics and implications of current technology after farmers visit the classroom. Leopold's article, "The Farmer As a Conservationist" (1939), has been used as a prelude or postscript to this class session. A director of the local County Conservation Board, a regional state forester, a local rep from the Natural Resources Conservation Service (formerly the US Soil Conservation Service), a hydrologist for the Army Corps of Engineers, a state wildlife biologist, and representatives from the Iowa Natural Heritage Foundation, the Nature Conservancy and the local Bluffland Alliance have come to discuss their jobs and how their personal land ethics have developed over time. I have also asked two of my colleagues from the Philosophy and Economics departments to spend some time in class discussing the interface of ecology, economics and environmental ethics. These two class periods are spent discussing topics like whether future generations have rights, business ethics and environmental ethics, quality of life versus standard of living, and the effect of constant economic growth and "progress" on the environment.

Learning Outside the Classroom
One of the highlights of the course is a visit to Leopold's Shack north of Baraboo, Wisconsin on the Wisconsin River. The land around Leopold's worn-out farm that he purchased in 1935 is now owned and managed by the Aldo Leopold Foundation. The Shack and the Leopold Memorial Reserve are available for tours and work projects by college and other educational groups. Working groups are especially encouraged to spend several hours during their visit helping in prairie restoration, oak savanna restoration, collecting prairie seeds or other habitat management. Students have enjoyed this active involvement in land stewardship.

Sharing the pictures and descriptions of the Shack in Leopold's time with my students before they arrive helps them appreciate how time has changed the vegetation (Bradley, 1987). During our Shack visit, I have the students do a species diversity analysis of a 4 ft square woodland plot, an edge plot, and a prairie plot. Students count the number of individuals of each plant species in the plot and use these numbers to generate a Shannon species diversity index number (Smith, 1996). Similar species diversity measurements, comparisons, and ensuing discussions on habitat stability or longevity can be made from aquatic samples of macroinvertebrates and phytoplankton from different lakes or streams.

Final Paper

The students in this course build a final paper that is due one week before the last class period. The first two thirds of the paper are on an environmental topic of personal interest that they have researched during the semester. Actual past titles of these sections have been "Edward Abbey: Rebel with a Cause," "Hydroponics: Food for the Future," "The Environment and Economic Growth: Can They Coexist?", "Barefoot Foresters Without Diplomas", "Piggies Stink - What Do We Do About It", and "Buffalo Commons: A Challenging Proposition." The last third of the paper is a written expression of their personal land ethic. This section brings together their thoughts from the course and their past experiences, and it tries to address three questions: "What should be DONE next?" How can this developing land ethic be put into action? What do they see as their next step? We spend the last two class periods listening to individual students read their personal land ethic statements and discussing their implications. During this last class period, I leave them with several reminders. One is to read Leopold again. Each time Leopold is read, more of his insights and connections come out. A second reminder is to get out on the land more often. Find a natural place or two to enjoy and return to those places over and over to watch them change with the seasons. Get to know the inhabitants. Try to understand their needs and challenges. Doing this will connect the students with that place and will make them fight for it if it becomes threatened. A third reminder is to become teachers of environmental awareness themselves. Teaching others about what each of us enjoys and why we enjoy it is the essence of environmental education. One of the cornerstone Leopold quotes of the Leopold Education Project says it best:

> *"The objective is to teach the student to see the land, to understand what he sees, and enjoy what he understands."*

Hopefully, this course description will spark more ideas about how to better connect our young people with our natural environment. Now, whenever I hear a whistling cardinal, I wonder if anyone else may be hearing him and whether they are sharing his meaning and beauty with those around them.

Literature Cited

Bradley, Charles C. 1987. Doctor of the Land, A Matter of Degree. Wisconsin Academy Review 34: 7 - 26.

Hargrove, Eugene C. 1989. Foundations of Environmental Ethics, Prentice Hall: Englewood Cliffs, New Jersey.

Leopold, Aldo 1939. The River of the Mother of God and other essays, Susan L. Flader and J. Baird Callicott, eds. Univ. of Wisconsin Press: Madison, Wisconsin.

Leopold, Aldo 1949. A Sand County Almanac. Oxford University Press: New York, New York.

Pheasants Forever 1995. Lessons in a Land Ethic. Leopold Education Project, Pheasants Forever, Inc.: St. Paul, Minnesota.

Ricklefs, Robert. E. 1997. The Economy of Nature. 4th Ed., WH. Freeman: New York, New York.

Smith, Robert. L. 1996. Ecology and Field Biology, 5th Ed., Harper Collins: New York, New York.

Other Leopold Resources and Information

Leopold Education Project, Pheasants Forever, Inc. P.O. Box 75473, 1783 Buerkle Cir., St. Paul, MN. 55175, 612-773-2000, email: lep@pheasantsforever.org website: http://www.lep.org

The Aldo Leopold Foundation, E12919 Levee Rd., Baraboo, WI. 53913-9737; phone: 608-355-0279

Northword Press, Inc. Box 1360, Minocqua, WI 54548 1800-336-5666

Essay exams in introductory courses: Peer graders as assistant evaluators

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Abstract: The use of peer graders can help instructors to use essay exams in large classes without being overwhelmed and still treating students fairly

Key Words: essay exams, peer graders, teaching careere, teacher-student cooperation

"Should I use a multiple choice, matching or true/false exam, or subjective short answer and essay exam?" The answer to this question is too often dependent upon the number of students in a class. In a large class, the idea of grading 30, or 40, or 50... essay exams is daunting! It is enough to make most of us think twice about the value of subjective assessment tools. The prospect of sorting through all those different handwriting samples alone is enough to make one quake at the thought of an all essay exam. Yet, I usually find that I am frustrated with the level of assessment of knowledge I attain with objective exams, and I find that it is more difficult for me to get a handle on what students are not picking up from lecture with an objective evaluation format.

Major's introductory biology courses are a challenge in any university setting. In schools with a medium to large biology program these courses are often quite large, where all the students meet for a common lecture and are then distributed into smaller laboratory sections (or in some cases there is no longer a laboratory component for the freshman year!). Another option is to have several faculty teach different sections in order to bring the class size to more reasonable levels. At Truman State University we have six to eight different faculty members teaching the Introductory Biology for Majors (a two semester sequence) class each semester. The lecture class size generally ranges from 24 (one laboratory section) to 72 (three laboratory sections). Even in a smaller class of 24, it is difficult for most faculty to envision giving essay exams to their introductory students, particularly in light of the fact that they are also teaching several other demanding, and generally upper level, courses.

During my third year at TSU, I began experimenting with the use of peer graders in the essay exam format. I started with one trusted junior level student who met me in my office after the exam, prepared a well written answer to one of the exam questions that I then critiqued, and then began reading student exams (again, a freshman level course with about 50 students). I directed the student to find three exams that answered the question well, and three that were poor. We then critiqued these together and the student then felt prepared and competent to work through the others. We used a "code" of + and - signs for strong and weak parts of the answers, and question marks for confusing passages. Occasional comments were written to indicate an omission of grave consequence. Unreadable exams due to atrocious handwriting were given a note of caution by the grader We graded together for three to four hours - I could generally work through most of two questions in the time my student could finish one. Once a student had read about 10 exams, it became clear to her what constituted a "good" answer (concise but complete, thoughtful, creative, etc.) and what was a less than complete answer I was always present to answer questions, or to read through a particularly difficult exam and offer direction.

The faculty perspective...

Did this original student, and subsequent peer evaluators benefit from this task? Yes! There is nothing like reading through many poor and mediocre exams to make one realize how important it is to have a clear understanding of the problem at hand. The past two years I expanded my student graders to two to four students per exam, depending upon their and my time, the number of questions per exam, and the difficulty or potential variability of the answers. I now invite the students to come to my home for an evening of grading and eating, and we work through the majority of an essay exam in one evening. This does not necessarily save me a great deal of time, but it is time that I feel is more usefully spent. Instead of examining every question on every exam for each of my introductory students, I have input into parts of each exam, and more input into the future teaching careers of my student workers. We are all more excited about essay exams!