Embracing and Teaching Non-Majors, as well as Majors, in an Animal Science Course, Biology of Reproduction [1,2]

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Abstract

A second and third year Biology of Reproduction course was revised to include majors and non-majors, students with more diverse social and cultural backgrounds than just Animal Science students. The redeveloped course was cross-listed in Biology and was general education certified so that it would fulfill four of the six credit hours required for all students. Elements, among others, added in the revision were the inclusion of species other than farm animals, conceptual and inquiry instruction, relevancy teaching, cooperative learning, and instruction that challenged the students to critically and creatively think, make decisions, and solve problems. After revision, not only did enrollment increase, course and instructor evaluations improved. Eighty-nine percent of students, both animal science majors and non-majors, rated the revision course in the upper 10% of the courses they had completed. Therefore, increasing inclusivity had significance and should be considered by others.

Introduction

Agricultural based courses are often taught only for students intending to work in agricultural related careers or veterinary medicine. Furthermore, non-majors often are not attracted to agriculture courses because they have an image of agriculture as an old-fashioned science and may associate agriculture with pictures of dark-suited, austere, nineteenth-century professors and one-horse plows (Handelsman, 1992). In striking contrast, some of the greatest biological discoveries over the past several years (i.e., the cloning of adult cells [Dolly] and the creation of genetically altered microorganisms to produce pharmaceutical products such as Posilac®) have been made in agricultural sciences. Once exposed to agricultural technology instruction, it has been my experience that non-majors not only enroll in more agricultural courses, but often transfer to agriculture so that they can develop a career working with this technology (Kesler, 1997a).

My first venture of working with a considerable number of students outside the College of Agricultural, Consumer and Environmental Sciences was with the instruction of a Discovery course for non-majors (Kesler, 1997a; Kesler et al., 1997b). Many of these students, upon realizing that agriculture was dominate in the conduct of biotechnology research, enrolled in more Animal Sciences courses. Shortly after a retirement, I was assigned the lead responsibility of a farm animal reproductive physiology course. As with my Discovery course, I decided to actively encourage non-majors to enroll in my redeveloped Biology of Reproduction course. This report is a case study of the redevelopment and instruction of this course for both animal science majors and non-majors. The objective of this manuscript is to provide methods of successfully revising a Biology of Reproduction course to include non-majors without negatively affecting the perception of the course by majors.

Materials and Methods

Animal Sciences/Biology 231-Biology of Reproduction, is a study of the basic principles of reproduction, lactation, growth, and hormone regulation of domestic and non-domestic animals as well as humans, including biotechnological methods of reproductive control, manipulation, performance enhancement of lactation and growth, and disease control. It is a four credit hour course that requires sophomore standing and one introductory level biology course as prerequisites. The course is required for students majoring in animal sciences.

Multiple species, including humans, were utilized. The textbook (Senger, 1997) was well received by students

[1] The Immunodiagnostic Pregnancy Detection laboratory was developed with funds from a Karl E. Gardner Teaching Enhancement Award from the College of Agricultural, Consumer and Environmental Sciences at the University of Illinois. Janel Washington collected the data in Table 2 as an undergraduate student on a Minority Summer Fellowship.

[2] The author thanks all students who provided feedback on this course and manuscript.

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although it was only used for two semesters because of only recent availability. However, it and most other available textbooks and teaching materials (Bearden and Fuquay, 1996; Hafez, 1993) that may be used for this subject, utilize only farm animals as examples. However, the lecture material was supplemented with material from other texts (Hadley, 1996; Medical Economics Company, 1998; Merck Research Laboratories, 1996; Veterinary Medicine Publishing Group, 1997; Volpe, 1993; Yu, 1994).

My method of lecturing generally utilizes the blackboard; however, overhead illustrations, slides, and CD-ROM multimedia (Geisert, 1998) are also used to provide detailed illustrations. Questions are encouraged during lecture and pertinent questions about how specific cases fit into concepts always come forth.

The redeveloped course was designed for second and third year students. From previous experience, first year students, even those with extensive biology preparation and excellent grades, did not perform well in this course and are no longer permitted to enroll in it. The course meets for three 50 minute lectures and one 110 minute laboratory per week. The redeveloped course was increased from a 3 credit hour course to a 4 credit course to accommodate the additional multi-species material. Six exams and eight quizzes were given during the semester.

In addition, students were required to complete one set of research problems and three research reviews as teams in class. Example research problem (questions 2-6) and research review (questions 11 and 12) questions are included in Table 1. One assignment was turned in for each team of four to six students. Team members were encouraged to study together for exams and quizzes as previous students have found this to be an effective method of preparing for the exams. In many of the laboratories, students work in teams as well (i.e., Table 2).

This course was closely monitored by the author over the past five years. Although the redevelopment was not abrupt, the greatest change occurred in years four and five when the course was officially changed from three credit hours to four credit hours and became general education certified. Years one through three were more similar to the original format. Both before and after the redevelopment, students completed University of Illinois Course and Instructor Evaluations. After the redevelopment (years four and five), students answered the questions in Table 3 about the course.

Results and Discussion

Student Responses. Based on the responses by students completing the course (Table 3), students liked the course (89% of the students rated it the top 10% of the courses they had completed: question 1) and 97% of the respondents indicated that they would recommend the course to students in Animal Sciences (question 2). Eighty-six percent of all the respondents indicated that they would recommend the course to students majoring in another area of science; however, 100% of the students with majors other than animal sciences indicated that they would recommend the course to students majoring in another area of science (question 2). Ninety-six percent of the students believed that they had a competent understanding of both human (question 3) and farm (question 4) animal reproduction. Students appeared to believe that the course was appropriate for students majoring in animal science (question 5) or in any biological science (question 6). Non-majors rated the appropriateness of the course for students in biological science higher than the whole sample (question 6). Students enjoyed learning about the different species (question 7), including humans, and many students provided specific feedback to that issue as follows.

- ***I learned many new things about my female body and the animals around me.***
- ***Now that I have completed this course, I believe that I have a greater understanding of reproductive biology over a wide range of species. I specifically enjoyed the coverage of multiple species.***

The course encouraged 81% of the majors to enroll in more reproductive biology courses and 96% of the non-majors to consider enrolling in more animal sciences courses (question 8). Therefore, I do not believe that including material on species other than farm animals decreased the quality of the course for animal science majors. In fact, I believe that the inclusion of other species improved ($P < .01$) the quality of the course as course evaluations were higher than before redevelopment (Table 4). The redevelopment of this course for both animal science majors and non-major involved several elements as follows and although I have no benchmark of proof that these elements improved the perception of the course, students gave the course a high rating and course evaluations improved ($P < .01$) when these elements were included.

Inclusion of Students with More Diverse Social and Cultural Backgrounds. A major element in the redevelopment was to include students with more diverse social and cultural backgrounds. The concept of including more non-majors was two fold. First, more diversity gave students in animal sciences a wider range of opinions. This forced the animal science students to understand why other opinions, opinions that animal science students may consider deviant, exist. Furthermore, it brought more non-agricultural students into an agricultural class. Exposing

Table 1. Selected questions from exams and quizzes in Animal Sciences/Biology 231

	Question
1.	A friend of yours has a male dog that she has owned since birth. He exhibits all typical male behavior and has never been castrated, but has no visible testicles. Explain why your friend's male dog has no visible testicles.
2-6.	Altrenogest, the active progestin in Regu-Mate®, is used to synchronize estrus in horses. Using information provided in *Veterinary Pharmaceuticals and Biologicals*, a) how many mL's, and b) how many mg's of altrenogest should you administer daily to a 450 kg mare c) for how many days for estrus synchronization? Also, d) what precautions should you take in administering Regu-Mate and e) why?
7.	Administration of a biosynthetic inhibitor for prostaglandin $F_{2\alpha}$, such as indomethacin, to a ewe on days 10-24 of the estrous cycle, would have what effect on progesterone synthesis (how would progesterone synthesis in this ewe compare to an untreated and non-bred ewe)?
8.	If a woman developed bilateral ovarian tumors during gestation, could she be ovariectomized and still maintain pregnancy? Identify any significant issues that should be considered in making this decision.
9.	A cow was diagnosed pregnant on day 45 via ultrasound; however, you have not observed her in estrus and she has not calved, although 310 days have elapsed since she was last inseminated (265 days after pregnancy diagnosis). What is your initial diagnosis? What would you do to confirm your initial diagnoses?
10.	In order to shorten the inter-parturition interval for cloning research, what hormone would you administer to terminate embryonic diapause in mice?
11.	Using the provided research article (Machado and Kesler, 1996, Drug Devel. Ind. Pharm. 22:1211-1216), identify how the progestin used to block ovulation in primates differs from the progestin used to block ovulation in cattle.
12.	Answer the following question using the data in the table provided. Was the androstenedione effect statistically equal to the testosterone effect?

Table 2. A portion of a laboratory exercise completed by teams of 4-6 students.

Immunodiagnostic Pregnancy Detection Laboratory

Platefile:	Assay JW-Su98	Correlation Coefficient:	0.996
Fit:	log/logit	Coefficient of Determination:	0.991

Equation: $Y = \sqrt[.6813]{.126}^{.6813}([2.359-.5/X-.5]-1)$ where X=absorbance and Y=concentration

Standard Value[1]	Description	Mean Absorbance	(Predicted) Concentration	Coefficient of Variation
0		2.359	---	.04%
12.5		2.040	12.5	1.73%
75		1.578	78	6.40%
150		1.420	130	4.73%
300		1.105	367	.59%
600		1.000	547	4.98%
Sample #1	(day 15-cow 8764)	1.345	3.30 ng/mL	
Sample #2	(day 18-cow 8764)	1.954	0.39 ng/mL	
Sample #3	(day 21-cow 8764)	1.451	2.35 ng/mL	
Sample #4	(day 21-cow 384)	1.999	not calculated	
Sample #5	(day 21-cow 948)	1.267	not calculated	
Sample #6	(Dutchess)	1.199	5.31 ng/mL	
Sample #7	(unknown)	1.272	4.17 ng/mL	
Sample #8	(unknown)	1.954	0.39 ng/mL	
Sample #9	(unknown)	1.799	0.73 ng/mL	

[1]Standards=pg/well
Samples=50 μL of sample was added to each well (not accounted for in the equation)

Questions

1. Blood samples were collected from Cow 8764 on days 15, 18, and 24 after AI and assayed for progesterone via ELISA. What is your diagnosis of her reproductive status?

2. Two cows (384 & 948) were bled 21 days after AI and blood was assayed for progesterone concentrations via ELISA. Which cows would you consider pregnant?

3. A client has a mare (Dutchess) that was bred 90 days ago. The client is worried that Dutchess has aborted. He presents you with a blood sample that you assay for progesterone concentrations via ELISA. What would you tell this client?

4. Sherbert, fat-free ice cream, and regular ice cream were assayed for progesterone concentrations via ELISA (samples 19, 20, and 21). Which sample is sherbert, etc.?

Table 3. Summary of responses by students[a], both students majoring in animal sciences and students with majors other than animal sciences, completing Animal Sciences/Biology 231

Question		Response
1.	Compared to other courses within my major, this course	
	was (check one): in the top 10%, or	89%
	in the next 20%, or	11%
	in the middle 40%, or	0%
	in the next lower 20%. But higher than	0%
	in the lowest 10%.	0%
2.	Assuming that the course was not required, would you recommend the course to:	
	students majoring in Animal Sciences?	97%[b]
	students majoring in another area of science?	86%[b] (100%)[c]
	students not majoring in any field of science?	35%[b]
3.	Now that I have completed Animal Sciences/Biology 231, I believe I have a competent understanding of human reproduction.	
	Yes	96%
4.	Now that I have completed Animal Sciences/Biology 231, I believe I have a competent understanding of farm animal reproduction.	
	Yes	96%
5.	I believe this course is appropriate for students majoring in Animal Sciences. 5=strongly agree to 1=strongly disagree	4.93
6.	I believe this course is appropriate for students with any biological sciences major. 5=strongly agree to 1=strongly disagree	4.54 (4.78)[d]
7.	I enjoyed learning about the different species including humans as well. 5=strongly agree to 1=strongly disagree	4.73
8.	This course has simulated me to take further courses in reproductive biology (majors)/animal sciences (non-majors). 5 = definitely, 4 = highly likely, 3 = uncertain, 2 = not likely, and 1 = definitely not	

	mean (all students)	4.36	
	% 5 and 4 (majors)	81%	
	% 5 and 4 (non-majors)	96%	
9.	Which of the following courses do you believe were necessary for you to successfully complete Animal Sciences/Biology 231?		
	Introduction to Animal Sciences	28%	(5%)[e]
	Inorganic and/or Organic Chemistry	3%	
	Introduction to Biology/Zoology	37%	
10.	Would you recommend that I continue offering six tests?		
	Yes	98%	
11.	The following questions relate to course objectives. How did this course fulfill the following objectives?		
	a. Challenge students to critically and creatively think. 5=This class was more thought-provoking than other classes in my major to 1=This class was no different from other classes in my major	4.41	
	b. Challenge students to make decisions and solve problems. 5=effectively fulfilled to 1= did not fulfill	4.48	
12.	Do you believe that animal welfare and bioethics issues related to the subject were sufficiently and judiciously covered:		
	Yes	96%	
13.	Do you believe that you are more capable of understanding research studies and results now that you have completed this course?		
	Yes	96%	
14.	Do you believe that women's issues related to the subject were sufficiently and judiciously covered?		
	Yes	96%	
15.	Please provide suggestions for course improvement and comments as to why you liked or disliked the course.	within manuscript	

[a]Completed by 107 students.
[b]Percent responding yes.
[c]One-hundred percent of the non-majors would recommend the course to other students majoring in another area of science (majors [83%] vs. non-majors [100%]).
[d]The average response for non-majors was 4.78 (majors [4.49] vs. non-majors [4.78]).
[e]Only 5% of the non-majors believed that an Introduction to Animal Sciences course was necessary (majors [33%] vs. non-majors [5%]).

non-majors to agricultural science and technology gave them a greater appreciation of agricultural sciences. Educating a larger audience in agricultural courses will generate a society that is more educated in the science and issues of agriculture (Handelsman. 1992).

Cross-Listing in Biology and General Education Certification. Two steps were done in order to recruit non-majors into the course. I requested, and received approval, to have the course cross-listed in Biology as Biology 231. This step was easier than many may imagine. At the University of Illinois, I discovered that no undergraduate reproduction classes are offered outside the College of Agricultural, Consumer and Environmental Sciences, and I believe that this situation exists on many, if not on most, other campuses. Also, upon redevelopment of the course I included elements so that the course could be general education certified. The request was approved so that the course would fulfill four credit hours of the natural science (natural science and technology: life science) general education requirement. A minimum of six hours in the natural sciences is required for graduation in all undergraduate curricula at the University of Illinois at Urbana-Champaign. Interestingly, within the College of Agricultural, Consumer and Environmental sciences, this course satisfies a specific requirement or may satisfy a general education requirement in 21 of the 41 options (51% of the available options). The other 20 require specific natural science-general education courses. The only prerequisite for the course is one introductory level biology course. Although Animal Science majors believed that their Introduction to Animal Sciences course was necessary, non-majors did not believe that it was necessary (Table 3-question 9).

Inclusion of Species Other Than Farm Animals. The second element involved the inclusion of species other than farm animals, including humans. This was one of the easiest elements to add. Reproductive biologist from the agriculture disciplines have long been known for having graduate and research programs integrating faculty and students from multiple disciplines including molecular and systemic biology, animal sciences, psychology, veterinary medicine, chemistry, biochemistry, and others. However, joint or integrative undergraduate programs are an exception. The reason that this element was easy was because the integrative graduate programs in reproductive biology require individuals to not only understand farm animal reproduction, but the reproductive processes of other species as well. Therefore, reproductive biology faculty in animal sciences are well prepared to address multiple species reproductive processes. Additional positive comments about the inclusion of multiple species follow.

- ***As a woman, I was able to relate course information to my daily life.***
- ***All I learn about are primates. This class was very good for understanding, comparison, and general knowledge.***

Conceptual Instruction and Assessment. The third element was to provide conceptual instruction and assessment rather than the traditional memorization and regurgitation of details. During my first 15 years of teaching at the university level, I realized that even the best and smartest of students do not effectively remember details over time. Therefore, my goal was teach concepts with the belief that long-term retention and utilization of information would be enhanced. I have provided example exam and quiz questions in Table 1. Selected comments from the student regarding the conceptual instruction and assessment follow.

- ***I really enjoyed learning how reproductive processes work. Through the lectures I was more able to picture the processes discussed.***
- ***Although my grade may not show it, I really think I will retain a lot of what I learned from this class as compared to memorizing and regurgitating.***
- ***I liked the fact that the tests allowed us to think about concepts and apply them.***
- ***I learned more because things were actually explained in lecture, not just listed. This made this one of my most enjoyable classes I have ever taken.***

Inquiry Instruction. An additional component included was that subject matter was taught as inquiry. When instruction is done properly, students become curious about specific phenomenon and begin to question the relationship of a phenomenon to the concept being taught. This is not to say the content competency is not important. However, even the best of students do not have long-term retention of specifics if they have no idea, or minimal understanding, of how these details relate to a concept. Far too often instructors only teach content competency, and students become spectators that are required to memorize and regurgitate, and they quickly learn to detest the subject matter.

Relevancy Teaching. The redeveloped course also included relevancy to the world (contemporary issues) (Williams, 1992). During the instruction of specific concepts, related contemporary issues were discussed. Selected contemporary issues include the following: pseudohermaphrodites and Propecia® (Hadley, 1996), cloning (Kolata, 1998; Wilmut et al., 1997), human reproductive control (Djerassi, 1992), recombinant DNA-derived growth hormone, wild animal population control (Warren, 1997), and human infertility and multiple births (Tan

et al., 1995). Selected comments from the student regarding the relevancy teaching follow.

- *I liked how the subject was applied to real life situations.*
- *I liked how real issues were brought into class and discussed making the material easier to remember and understand.*

Increased Exam and Quiz Frequency. Because I realized several years ago that the amount of subject matter on examinations way overwhelming, I increased the exam and quiz frequency. I gave six examinations and eight quizzes in the redeveloped course. Although frequent, most students, even those that often objected at the onset, were appreciative and 98% recommend that I continue offering six tests (Table 3-question 10). Further, I believe that comprehension was enhanced because there were fewer concepts to understand for each quiz and exam. Selected student comments about the exam and quiz frequency follow.

- *The frequent exams and quizzes forced me to keep up on the material; I feel this led to a better understand of the material that I will probably retain for a longer period of time.*
- *Although I did not like taking so many quizzes, over time I realized that taking the quizzes kept me focused and prepared. Thank you for making me work harder than I wanted to.*
- *The frequent tests and quizzes encouraged me to keep up with my studies so that I never felt overwhelmed.*

Although not a required portion of the class, I offer review sessions the evening before each examination. These review sessions met at 5:00 PM, the best time for students to meet (too many students have extracurricular meetings in the evening), and involved the instructor answering student questions. Offering the review sessions earlier was unsuccessful as students had not spent enough time reviewing the material. Although only about three-fourths of the students attended, about 80-90% of the examination questions were asked. Answers were provided but students were not told that that question was on the exam. The students and I alike have found these sessions most enjoyable and valuable.

Cooperative Learning. Another component that is used in the redeveloped course is cooperative learning. Cooperative learning techniques have been used in the laboratory section of the course and also within the lecture. The research problems and research reviews are examples. An example used in the laboratory section is summarized in Table 2. Cooperative learning techniques have been demonstrated to stimulate higher-level thought and improve student understanding (Hall, 1989; Howe and Durr, 1982; Kesler, 1998). The following are selected comments from students.

- *The research reviews helped me to see that all of the information in the course was applicable.*
- *I liked doing the research reviews in groups. If one person didn't understand, someone else was usually able to explain it.*

Critical and Creative Thinking and Make Decisions and Solve Problems. Two course objectives were: a) challenge students to critically and creatively think and b) challenge students to make decisions and solve problems. I had hoped to partially satisfy the first of these two objectives within the conceptual-inquiry lectures. However, I had hoped to partially satisfy both of the objectives within the examination and quiz portion of the course. Exams and quizzes were given, in my opinion, to students for two reasons. The first is to provide feedback to the instructor on the student's understanding of the concepts (i.e., give the students a grade). The second is to provide a learning experience. Instructors that only teach content competency often use multiple-choice tests that require minimal true-thinking. Problem solving questions encourage students to formulate ideas and evaluate many solutions to a problem (Young, 1992). Example quiz and exam questions are provided in Table 1. Correct exam and quiz answers are discussed upon being returned. Students indicated that the course did challenge them to critically and creatively think and make decisions and solve problems (Table 3-question 11 and in student comments as follows).

- *I enjoyed the fact that the subject matter was presented in a very thought-provoking, informative, and extremely challenging manner.*
- *Lectures were very stimulating and thought-provoking because of the use of examples to teach the rest of the material. This is a great way to learn things rather than be fed a lot of technical information that has to be memorized and regurgitated for the exam.*
- *I will always remember the information because of how stimulating and thought-provoking the lectures were.*
- *I enjoyed the friendly atmosphere and the challenges. This was a fun class and I feel I learned more from this class than many others.*
- *I appreciated the way the tests were set up. They challenged me in a way different than most tests. It allowed for the application of knowledge.*
- *I enjoyed the way we were encouraged to reason through questions and problems, actually apply what we learned, rather than being forces to memorize dry facts.*

Animal Welfare, Biological Ethics, Research and Scientific Methodology, and Women's Issues. Other important issues included in the redeveloped course include animal welfare, biological ethics, research and scientific methodology, and women's issues. These subjects are

relevant and deserve class time, and 96% of the students believed that they were sufficiently and judiciously covered (Table 3-questions 12-14).

Enrollment and Evaluations. Course enrollment of majors and non-majors has changed over the past five years (Table 4). During years four and five, after the course was redeveloped, course enrollment was greater than the previous three years. Course enrollment doubled from year one to year five. Thirty-five percent of the increase can be accounted for non-major enrollment. Not only has enrollment increased, but course and instructor evaluations have improved (Table 4). One student said the following after completing the course.

- ***I really did not look forward to this course when registering because I did not feel I had an interest in reproduction, but I really enjoyed the course. It was interesting to learn about the different species including humans. I had to work hard and the material was not easy to master, but I felt that I got a lot more out of this course than any other course I have taken here.***

Although it is difficult to identify the specific factors that caused the enhanced perception of the course and instructor, it is clear the majors did not object to the inclusion of non-farm animal species in the instruction. Course evaluations were positively correlated ($r=.92$; $P<.05$) with the percentage of non-majors enrolled in the course. I believe that the inclusion of non-farm animal species instruction has improved the perception of the course; however, various other elements have certainly contributed to the improved perception. Furthermore, I believe that the inclusion of non-majors provided alternative perspectives that improved the learning experience for animal science majors.

Based on analysis of course enrollment over the past five years, the class may have 80 or more non-majors enrolled five years from the last, year 5, offering (Table 4). Based on this increase in non-majors and a constant number of majors, there will be about 200 students enrolled in year 10 which is nearly three times the enrollment in year one. For this prediction to become a reality, administration must financially support the course as more instruction time is required with increased numbers of students. A new section

Table 4. Summary of course and instructor evaluations and total and non-major enrollment in Biology of Reproduction during the past five years

	Year					Mean	
Item	1	2	3	4	5	1-3	4-5
Enrollment [a]	66	85	91	110	135	81	123
Rate the Course in General[c]	4.76	4.79	4.79	4.88	4.89[b]	4.78[y]	4.89[z]
Rate the Instructor[c]	4.76	4.75	4.79	5.00	4.98[b]	4.77[y]	4.98[z]
Non-Majors:[d,e]							
number	0	0	1	10	24	0[x]	17[y]
percent	0	0	1	9	18	0	14

[a]Increased an average of 16 students per year ($r=.98$; $P<.01$; $Y=X(16.3)+48.5$.
[b]Includes two evaluations-each used for the overall mean.
[c]Each evaluation was rated in the upper 10% of the campus-wide evaluations (University of Illinois). Course evaluations were correlated ($r=.92$; $P<.05$) with the percent of non-majors enrolled in the course.
[d]Years 3-5 ($r=.99$; $P<.01$; $Y=X(11.5)-34.3$; Y=actual numbers)
[e]Year 10 projection: 81 non-majors
[x,y]Values with different superscripts differ ($P<.05$).
[y,z]Values with different superscripts differ ($P<.01$).

that will boost non-major enrollment has, however, already been approved with funding to be taught as an honors course next year.

Implications

The primary goal of an undergraduate education is to educate students to function in their future and to adapt to change. This goal challenges the educational system to go beyond sheer memorization and to teach students to become skillful in the thought process (Ferguson and Chapman, 1996; Herrett, 1992). This goal was a basis for the redevelopment of this course and fulfills many of the recommendations provided from the conference on "Investing in the Future: Professional Education for the Undergraduate" held in 1991 (Board on Agriculture-National Research Council, 1992). Within this course, students learn, often for the first time, the ability to integrate and synthesize pieces of knowledge and formulate conclusions with their new knowledge. This ability is necessary for students to be able to function in their future and adapt to change (Arnold, 1992). I recommend that others consider redeveloping courses as described herein. However, as observed by others, there is often more resistance to this type of innovation within departments, or areas, than from outside the department, or areas (Cherry, 1992).

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