Attracting an Eclectic Set of Students into a Science-based Agriculture Course Using Terrorism as the Context

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Abstract

Attracting non-agricultural students into agricultural courses is challenging because many do not think agriculture is relevant to them. A course was developed entitled 'Terror in the Food Supply' to attract a diverse group of students into an agricultural venue to increase dialog between agricultural and non-agricultural majors. The course has been taught on a yearly basis since 2007. Students were surveyed at the beginning of each semester and asked questions about their class status and majors, how they found out about the course, what attracted them to the course, what they expected to gain from the course, number and types of courses they had completed, and their understanding of the 'farm to fork' food supply system in the US. Data were analyzed by analysis of variance and regression to establish yearly trends. The percentage of non-agricultural majors increased from 8 to 52% and the number of students enrolled increased from 12 to 33 over a four-year period. Fewer students had an understanding of agriculture as the class grew in size but students who had three or more college-level science courses increased from 5 to 50% over time. Students were attracted to the course because of the subject matter, and the percentage learning about the course from their advisor or a University webpage increased from 0 to 50% with time. Those who learned about the course from friends decreased from 75 to 30% over time. We were successful at attracting non-agriculture majors by applying science to current events.

Introduction

Agricultural students are required to complete courses from a diverse array of disciplines in order to fulfill the requirements for their degree programs. Few institutions require students from outside agriculture to enroll in agriculturally-related courses despite agriculturally-related controversial subjects such as food safety, centralized production systems, pesticide use, animal welfare, water quality, greenhouse gas emissions, and use of genetically modified organisms (Terry and Lawver, 1995). These socio-scientific issues are typified by conflict within the scientific community as well as society at large (Bingle and Gaskell, 1994) and differences in perceptions of agriculturally-related issues exist among students from various colleges within the University (Terry and Lawver, 1995). Agricultural issues are germane to institutional commitments towards scientific literacy, and agricultural students tend to perform better in science classes than the general student population (Chiasson and Burnett, 2001). But scientists often have narrow understandings of their scientific disciplines and fail to (or are unable to) portray science to the overall social or scientific perspective (Shamos, 1995). Thus, it is not surprising that the term 'science' has different meanings to the diversity of students among the various colleges within the University.

Recognizing that agricultural issues are part of the overall scientific literacy effort at the University, administrators in the College of Agriculture and Environmental Sciences at The University of Georgia (UGA) challenged faculty to develop general interest courses to appeal to students from outside the College, in part, to increase public knowledge of scientific issues related to agriculture. One obstacle to fulfilling the challenge is to identify a theme in which a general interest agriculture course might be taught. In 2004, the outgoing Secretary of Health and Human Services, publicly stated that he was surprised terrorists had not attacked the food supply (Branigin et al., 2004). This was a shocking statement that further delineated our inability to secure remote or rural landscapes, and illustrates that vertical integration of our food production, processing, and distribution systems, make our food supply vulnerable to terror attack using plant and animal disease organisms (Cupp et al., 2004). A successful attack on our food supply will likely undermine confidence in local, state, and federal governments which could result in anarchy or, at least, cause chaos (Chalk, 2001). While the impact of an agricultural attack might be less shocking than the horrific images of September 11, 2001, there is evidence that terrorists considered attacking our food supply because it is a low-risk, cost-effective means to disrupt our lives (Chapman, 1999; Chalk, 2001; Cupp et al., 2004; Segarra, 2004). Superficially, terrorism is related to political, military, or law enforcement disciplines.

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However, the broader issue of how to protect ourselves from an attack to the agricultural sector requires an understanding of the biological and chemical agricultural infrastructure, chemical and biological agents which could be used in an attack, detection of potential agents of attack, and how to mitigate or provide prophylactic protection to such an attack. Developing prophylactic protection against such attacks requires knowledge of physical and chemical properties of chemicals (Michaels, 1999), biological (plant, animal, and human pathology and epidemiology; virology, immunology) sciences (Bonaparte et al., 2005; Fabian, 2006; Mead et al., 1999), and chemical and histochemical technologies (Hill et al., 1998; Wu et al., 1997), and to mitigate attacks requires knowledge of the food production and distribution system (USDA- AFTA-ATA, 2004). Thus, understanding the threat of agricultural terrorism may be an opportunity to disseminate scientific principles in a current events classroom venue.

The objective of this project was to develop a general interest science-based course centered on the threat of terrorism to the food supply and determine whether it appealed to students whose majors were in colleges other than the College of Agricultural and Environmental Sciences.

Methods

Upon hearing concerns about security and terror threats to the U.S. food supply from the Department of Health and Human Services, an electronic literature search was performed to obtain reference materials regarding food safety and the threat of terrorism. A draft syllabus was developed and compared to the agenda for the first International Symposium on Agroterrorism, held in Kansas City, Missouri in May, 2006 (http://www.fbi-isa.org/background.html). Minor modifications were made to the syllabus based upon subject matter of the symposium, the course titled "Terror in the Food Supply" was submitted to, and approved, as an introductory level

Table 1. Subject Matter Presented and/or Discussed in a University of Georgia Course Titled "Terror in the Food Supply."

Introduction: How this course evolved. What I have done to prepare this course?
Terrorism: What is it and what types are there?
- The sociology and psychology of terrorism.
- Who are US and International terrorist groups and how active are they?

US farm production - Animal, Row Crop, and Vegetable
- Efficiency of production and vertical integration of the agricultural sector
  - Feed lots and slaughter facilities and transportation
  - Grain production, handling, storage, and transportation
- Diversity and protection against terrorism in the horizontally integrated agricultural sector
  - Mosaics vs. monocultures of crops and diseases: A better scenario?
  - Pasture-raised vs. feedlot finished beef cattle

Infrastructure protection in the agricultural sector
- Animal and Plant Health Inspection
  - protecting against introduction of unknown diseases
- Food Safety and Inspection Service
  - production, processing, storage, and distr. of foods
- Customs and Border Surveillance
- International shipping protocols

Model agents for terrorists
- **Biological background:**
  - Viral recognition of cell surfaces, attachment, and replication
  - Cell signaling and gene expression
  - Cellular interactions of the immune system
- **Case studies for biologicals:**
  - *Non-zoonotic animal pathogens*: Foot and Mouth Disease, Avian influenza, Exotic New Castle disease
  - *Zoonotic pathogens* – Nipah virus, Rift valley fever
  - Acquisition and culturing biological agents
- **Chemical background:**
  - Chemical and physical characteristics of gases
    - Case study: anhydrous ammonia
  - Chemical and physical characteristics of pesticides
    - Case study: methyl isocyanate and the Bhopol tragedy
  - Chemical properties of heavy metals
    - Case study: chromium toxicity to dairy cows

Methods of detecting unseen biological weapons
- Antibodies (ELISA, immunoblot, dipstick), Real-time PCR

Mitigating the effect of biological weapons
- How do we develop cost-effective testing protocols to provide security assurances?

Group attack and defense practicum

Table 2. Survey Questions to Determine Student Profiles and Knowledge of Subject Matter

1. How did you find out about this course?
2. Describe how your advisor responded when you informed him/her that you had signed up for the "Terror in the Food Supply"?
3. What attracted you to the course?
4. At what level are you familiar with farming?
5. How many high school science courses have you completed (ie. biology, chemistry, physics, etc.)?
6. How many college/university level science courses have you completed?
7. In what College/School is you major?
8. What is your current University academic classification?
9. What do you think you will gain from taking this course?
10. Before you enrolled in this course, how confident were you in the safety of our food supply?
11. Describe at what level you understood the flow of food from the US farm to the dinner plate before you took this course.
12. Describe at what level you understood the flow of food from an international food source to the dinner plate before you took this course.
13. Prior to taking this class, how aware were you of programs and protocols used to test fresh food imports for possible contamination?
14. Prior to taking this class, how aware were you of the methods used to identify food contamination by the Center for Disease Control and Food and Drug Administration?
15. Prior to taking this class, how aware were you of the frequency of food recalls by FDA /USDA?
16. Prior to taking this class, how aware were you of the number of agencies which are responsible for the security of our food?

course by the University of Georgia Curriculum Affairs Committee, and the course was first offered during the spring semester of 2007. Subject matter from the syllabus is presented in Table 1. In addition to being responsible for the subject matter in the syllabus, students are assigned to teams of 5-6 students each and are required to 1) develop an attack against a sector of the U.S. food supply using a means of their own choosing and 2) develop a defense against one of their peer group attacks. Group defenses and attacks are presented to the class and graded by professionals affiliated with the U.S. Department of Homeland Security, The Federal Bureau of Investigation, and/or the Georgia Emergency Management Agency using rubrics developed by the professor. The external evaluators were asked to provide feedback as to whether the attacks and defenses simulated credible threats received by their organizations.

Table 3. Student Expectations of the Outcomes They Will Acquire from the Course when Responding to the Question "What do You Expect to Gain from the Course?" Students were Queried to Respond to all Answers that Applied to Them.

Answer	% of responses
A better understanding food security/vulnerability	96
A better understanding of agents which can be used to attack our food supply	84
A better understanding of political issues affecting food safety	80
A better understanding of terrorism	79
Improved critical thinking skills	53
A better understanding of farming	38
LSD (0.05) †	17

† Least significant difference at the 0.05 level of probability

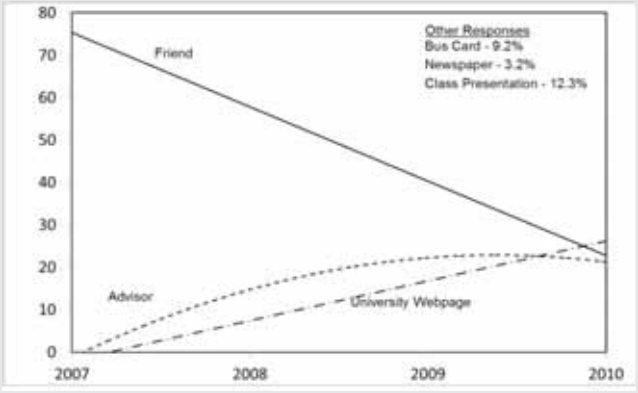

Figure 1. Student responses to the question: "How did you find out about the 'Terror in the Food Supply' course."

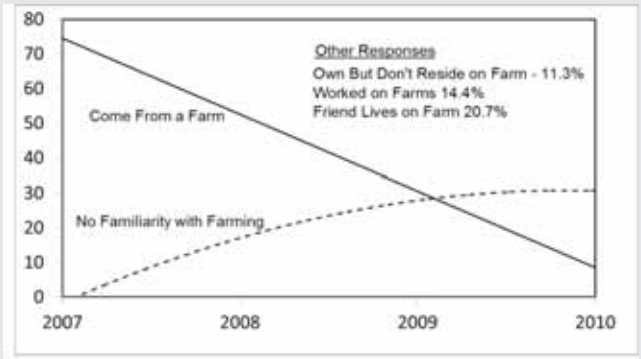

Figure 2. Student responses to the question: "How familiar are you with farming?"

Student recruitment was conducted by placing advertisements on the university transit system, by placing information about the course on the University web page, and seminar presentations in agricultural classes. Students were surveyed at the beginning of the semester to gain information on their academic profiles (academic year, majors, etc), what attracted them to the course, how they found out when and where the course was offered, and what they expected to learn from the course using a multiple choice format (Table 2). Students were also surveyed at the end of the course using the Department of Crop and Soil Sciences course evaluation materials to evaluate the professor, and how the students valued the course (Table 3). All students were surveyed in each of the four years the course has been offered. Data from the surveys were statistically analyzed using the PROC ANOVA procedure of the SAS Institute (Cary, NC) using years as replications. Some data were not consistent among years, so regression analysis was conducted to establish whether trends existed across years using the PROC REG procedure of SAS. The response variables were used as the dependent variables and years in which the survey was conducted as the independent variable.

Results and Discussion

The number of students who enrolled in the class increased linearly from 12 in 2007 to 34 in 2010. Nearly 80% of the students who enrolled in the course in 2007 learned about the course from a friend, but by 2010 recruitment of students were equally distributed among recommendations from friends, suggestions by academic advisors, students surfing the University webpage, and seminar presentations in other classes (Figure 1). Surprisingly, 50% of the students enrolled in the class did so without their advisors' knowledge, a trend which was consistent among years. Therefore, student recruitment was based as much on preferences of the student as it was their advisors. The primary reason for students enrolling in the class was because of their interest in the subject matter (70%), but recommendations from students who had taken the class (15%) and a potential for jobs (13%) were also factors that motivated students to enroll. Seventy-five percent of the students who enrolled in the course in 2007 were from a farm and 92% had majors within the College of Agricultural and Environmental Sciences. However, the percentage of students who resided on a farm decreased linearly with each successive year, and in

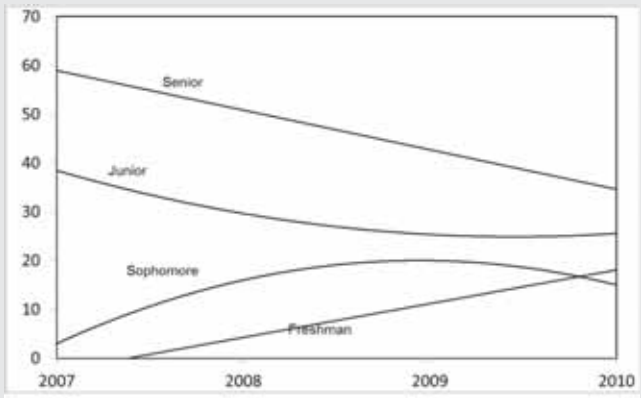

Figure 3. Student responses to the question: "What is your academic standing at the University?"

2010 only 8% of the students who enrolled in the class resided on a farm (Figure 2). There was a concomitant decrease in percentage of students from within the College of Agricultural and Environmental Sciences as the percentage of enrolled students who resided on the farm decreased. In 2010 the students from outside the College represented 42% of those enrolled in the course. Despite the decrease in percentages of students from the College of Agricultural and Environmental Studies, the total number of students from within the College increased from 11 in 2007 to 20 in 2010. The number of students from outside the College increased from 1 in 2007 to 14 in 2010. Students from outside the College had majors in the College of Arts and Sciences (15%), the School of Public and International affairs (15%), and Business (10%). Students from the College of Arts and Sciences had an eclectic collection of majors including math, religion, biology, and psychology. Therefore, the course attracted students from a wide array of majors, including those which are not traditionally steeped in science-based curricula.

There were some interesting trends regarding student academic standing across years. Nearly all students who took the class in 2007 were either juniors or seniors (Figure 3). However, the number of students with an academic rank of freshman or sophomore increased to 33% of the class in 2010. Nearly all students surveyed (96%) completed three or four high school science-based courses, a statistic that was consistent among years. Surprisingly, the proportion of students who have completed three or more university level science courses increased from <10% in 2007 to 55% in 2010 even though a) the proportion of students from non-scientific majors increased over time and b) the students were earlier in their academic careers (Figure 4). This suggests that students who were are not from traditional science-based curriculums tended to have an interest in science and enroll in science courses regardless of their major. It also suggests that the younger students in the class may have been better prepared for college because of advanced placement science courses they completed in high school for which they received University credit. Therefore, it appears that students enrolling in the class were more scientifically literate than the academic profiles would suggest.

Students who enrolled in the class had varied expectations from the course. They were more interested in learning about terrorism and food safety issues than they were learning about farming or acquiring critical thinking skills (Table 3). There was a positive correlation between the percentage of students who resided on a farm and their familiarity with farming (r=0.95), their understanding of the production and distribution system of food in the U.S. (r=0.89), and their confidence in the safety of our food supply (r=0.74). However, most students (>50%) were either unaware that food was tested for contaminants, or the methods used to identify food contaminants (>90%) regardless of whether they were from the farm or not. Eighty percent of the students were confident that our food is safe to eat, despite a record number of food recalls (over 7000 products total) because of *Salmonella spp.* contamination in peanut and vegetable protein products

Table 4. Student Responses to Questions used by the College of Agricultural and Environmental Sciences in Their Course Evaluations. Mean scores are Averages over the Five Years the Course was Taught and the Standard Deviation Represents the Variation among Years.

Evaluation Question	Mean Score	Standard deviation
Did the instructor increase your interest in the subject matter?	1.17†	0.11
Was the instructor knowledgeable of the subject being taught?	1.24	0.06
Was the instructor enthusiastic about the subject?	1.16	0.06
Did the instructor provide individual assistance outside the classroom?	1.44	0.28
Did the instructor encourage you to think for yourself?	1.20	0.03
Did the instructor present the basic principles of the class in a clear and logical manner and take time to explain difficult concepts?	1.49	0.09
Was the instructor receptive to questions and discussion in the classroom?	1.15	0.08
Did the instructor recognize when students had difficulties in understanding new material?	1.56	0.14
Did the instructor keep the course moving at a steady pace?	1.27	0.21
Did the instructor give tests on materials covered?	1.41	0.18
Was the instructor prompt in returning graded materials?	1.22	0.12
Did the instructor clearly describe the grading procedures?	1.74	0.11
Compared to other instructors, how would you rate the teaching ability of this instructor?	1.33	0.12
Compared with other courses you have had at the University, how would you rate this course?	1.35	0.19
How many hours per week did you devote to this course outside of class?	2.05‡	0.05

† 1 = excellent, 5 = poor
‡ 1 = 0-2 hours, 2 = 2-4 hours, 3 = 4-6 hours, 4 = 6-8 hours, 5 = 8-10 hours

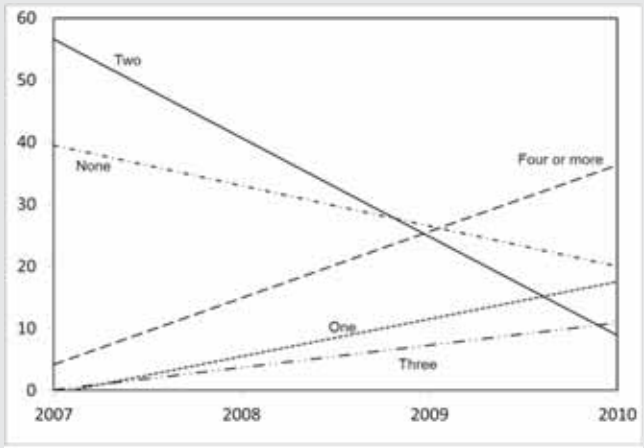

Figure 4. Student responses to the question: "How many University level science courses have you completed?"

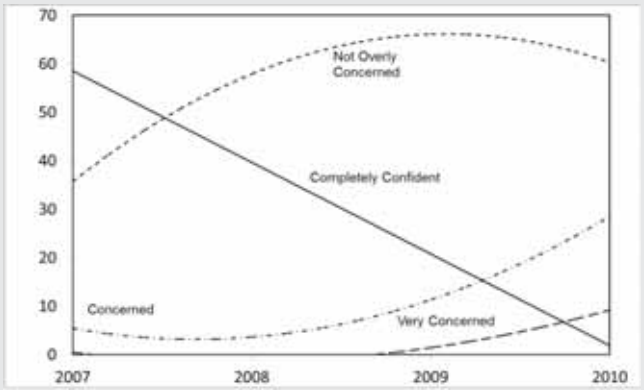

Figure 5. Student responses to the question: "How confident are you in the safety of our food supply?"

(http://www.accessdata.fda.gov/scripts/peanutbutterrecall/index.cfm; http://www.fda.gov/Safety/Recalls/EnforcementReports/ucm208729.htm) in 2009 and 2010, respectively (Figure 5).

The subject matter in the course included specific information regarding cellular receptor sites, cell signaling and gene expression, the immune system, viral replication, the chemical/physical properties or biological properties of potential agents of attack, and molecular and immunological methods of detection (Table 1). While each of these subjects are topics for courses themselves and may appear to be disparate, the students were challenged to understand how biological systems worked and why chemical and physical properties of viruses and toxins might interact at the cellular level to elicit harm to living organisms. Amalgamating that information by students who do not have extensive scientific training can be daunting, and potentially manifest itself with poor evaluations of the course and instructor. However, student evaluations of the course were very good to excellent (Table 4). We interpret this to indicate that, if presented in a format by which they can apply the technology, students willingly respond to the challenge of learning these scientific concepts regardless of their academic background. Student comments such as: "I'm a Management/Insurance major and the professor got me excited about, and interested in, the food supply and that scary subject of ……science!", "As an international affairs major, it brought a new perspective to my education about terrorism and how it can be applicable to agriculture industry," and "The course was interesting, and the professor made the material understandable for students who lacked scientific or agricultural backgrounds" corroborate our finding that students will motivate themselves to learn if they can identify with the subject matter.

As educators we should challenge students to explore subject matter outside of their traditional major-related curricula to fully engage in the "University experience." Students in agriculture are required to take humanities, social science, and (in some cases) business management courses but rarely do they have an opportunity to engage students from outside the college in courses that are more germane to their degree programs. By using terrorism in an agricultural context we were able to recruit students from outside the college to enroll in a science-based course. In addition, the course provided students with an agricultural background a rare opportunity to interface with students from multiple academic disciplines about an agriculturally related subject.

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