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the professional journal advancing the scholarship of teaching and learning in agricultural, environmental, natural and life sciences

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# Factors Influencing Choice of Food Safety Related Career Path: An Online Focus Group Study

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## Abstract

The increased demand for trained professionals with a science, technology, engineering, and math background to monitor and maintain the safety of the food supply has been identified by related industries and government agencies. Information regarding the influential factors identified by students to major in a food safety (FS) related career path is lacking. Online focus group sessions with 20 students in a FS related major provided insight to factors influencing career decisions as well as the relationships between FS and chosen career paths. Sixty percent of the students majored in an agricultural related field. The remaining students were dietetics, hospitality, microbiology and biotechnology majors. Social Cognitive Career Theory served as the guiding force to develop the survey questions. The information shared by students was analyzed using focused coding methods to extract common descriptive terms. The descriptive terms led to themes of influential factors related to the students' chosen career paths. For example, students identified a desire for a career where they could help others (n=10) and work with people (n=13). These two common descriptors generated a theme of job satisfaction (influential factor). Market forces related to employment demands and financial gain were less of a factor. Agriculture classes, FFA, job shadowing, and work experience were described as influential factors in exposing students to career paths and confirming their decisions. When seeking professional employment, the students identified passion for their career while financial stability was referred to in a subtle manner.

## Introduction

Fewer students are enrolling in agricultural related sciences in higher education than is required to meet the need (Association of Public Land-grant Universities [APLU], 2009). The United Sates Bureau of Labor Statistics (USBLS, 2012) projected a 10% increased need for Agricultural and Food Scientists from 2010 to 2020. Animal scientists were forecasted for a 13% increase by 2020 and plant scientists 12%. Additionally, the United States Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) proposed a goal to increase the supply of trained graduates in the food and agricultural sciences. The plan included strategies to inspire, ensure access, and enhance academic capacity of students from all groups in the United States to excel in the agriculture and natural resources sciences (APLU, 2009).

The National Academy of Sciences (NAS) recognized the potential pool of students for agriculture related disciplines is no longer a group of young people that grew up on farms. Many students were unaware of the multi-dimensional and challenging nature of agriculture related disciplines. Educators have not helped students make the connection between science, technology, engineering and mathematics (STEM) courses and an agriculture related degree (NAS, 2009). Additionally, Gilmore et al. (2006) found that 41% of students in high school have a misconception with agriculture sciences, 33% lack knowledge about employment opportunities and 22% are unaware of related fields of study. According to Collins (2008), traditional agriculture production science programs, such as soil science, have become much greater in scope and need to be packaged differently within university systems.

Choosing a career is a lifelong process (Ferry, 2006). Ferry's focus group research identified emerging themes of family, school and community influencing career choices. Behrman et al. (1997) identified the market place as key impact on a student's career choice.

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Information related specifically to food safety (FS) related career paths was lacking. Therefore, this study focused on influential factors related to the decision of undergraduate students at South Dakota State University (SDSU) choosing a major closely connected to FS.

To obtain more quantitative and qualitative insight specific to students majoring in food safety, surveys in cooperation with focus group research methods are useful. The focus group process provides more insightful information than can be obtained through a standard survey (Krueger and Casey, 2000). Focus group discussions provide insight and clarification to the attitudes and values contributing to the decision making process when career choices are made.

## Purpose

Through focus group research, insight was gained regarding influential factors guiding students to specifically choose agriculture and food science majors. The primary purpose of the research was two-fold. First, students shared how they perceive their major area of study as they complete their coursework; and secondly, how their chosen major contributes to a vision regarding a future career.

A primary objective of the investigation was to identify if market forces, related to the growing need for agricultural and food science professionals, influenced students' decisions regarding a major related to FS. The opportunity for students to address the market forces in their career decision were incorporated into the focus group process.

## Methods

### Online Focus Group Process

Four online focus group sessions were conducted simultaneously with students at SDSU obtaining a FS related bachelor's degree. The focus groups were conducted using an asynchronous Internet-based discussion board.

The primary purpose of the focus group investigation was to identify themes of student's perceptions regarding the relationship of their values, attitudes and experiences with their chosen major (Grudens-Schuck et al. 2004). Additionally, students were asked to share how they vision their career impacting the safety of the food supply. As recommended the Krueger and Casey (2009), the opportunity for students to share the influence of market forces in their career decision were also incorporated into the focus group process. To avoid suggestive answers, the question format did not include terms related to market forces such as job opportunity, salary, job security, potential salary, or other similar terms.

### Sample Population

Students recruited for the focus groups were required to have a FS related major including agriculture and food sciences, dietetics, nutrition, agriculture journalism, family consumer sciences education and hospitality management. Participants were recruited by faculty teaching FS related courses. Previous work by Hegerfeld-Baker et al. (2014) surveyed over 400 undergraduate students at SDSU. A recruitment email was sent to 76 of the 400 participating students who identified their willingness to participate in the upcoming focus group research.

The recruitment email was linked to an online survey generated through QuestionPro©. The survey described the research protocol, obtained demographic information and consent to participate. Twenty students consented to participate by registering for the online focus group discussion through Desire2Learn© (D2L), the SDSU course-management system. Students were familiar with the D2L system as all courses taught at SDSU are required to use D2L.

As students registered, they were blindly assigned to a discussion group. There were five students in each group. Krueger and Casey (2000) suggests six to nine people per group, with three to four groups to reach a saturation point when holding in-person focus group sessions. The groups were comprised of majors related to FS representing all levels of the food delivery system including production, processing, foodservice and supporting sciences (i.e. microbiology). The groups were homogeneous in nature since all represented majors were related to safety of the food supply (Krueger and Casey, 2009; Tillberg and Cahoon, 2005). However, there was variability within each group in regards to their major area of study. All students recruited had no personal stake in the research project (DeLeeuw, 2008).

### Development of Research Questions

The questions were developed with the guiding force of Social Cognitive Career Theory (SCCT) focusing on self-efficacy, expected outcomes, interest of the person and individual goals (Lent and Brown, 2006; Kelly et al., 2009). Several reviews of the questions were carried out with colleagues and students to be certain they were clearly understood and of a difficulty level that participants could answer (Krueger and Casey, 2000 and 2009).

When students began the on-line focus group process, they viewed an introduction addressing technology, purpose of the study and participant expectations. Participants were also instructed to not be concerned with improper grammar and misspelling. These instructions were to encourage spontaneity (Kenny, 2005). The questions addressed the original research question by gaining insight of students' perspectives on career choice in respect to high school science classes and teachers; life experiences; desired employment; and safety of the food supply. The focus group questions, in their proposed final format, were reviewed by project advisors and a social sciences researcher with expertise in focus group research.

### Online Discussion Format

Each student's identity was not anonymous to other participants in their group. If using the anonymity option with a D2L discussion board, the response would also have been anonymous to the investigator, therefore impossible to track statements of each participant. Coding the participant's major to their responses was necessary for the project. The student's identity was confidential following the discussion group. This study was approved as exempt human subjects' research by the SDSU Research Compliance Coordinator.

The questions were posted simultaneously for students to start responding to questions at their convenience. The questions were not of a sequential nature (Table 1). Participants were to respond to others' posts as well (a minimum of one time required for each question). Similar research projects posting a new question at regular intervals, over several weeks, in a specific sequential order experienced difficulty keeping participants engaged in the study (Krueger and Casey, 2009; Deggs et al., 2010). Of the 20 students in this study, 16 (80%) fully participated, answering all questions and responding to at least one person for each question.

### Analysis of Focus Group Discussion

The data (discussion) was analyzed using the focused coding method (Hesse-Biber and Leavy, 2011). The two types of codes generated from the discussion board conversation were literal and analytical. The literal codes tended to be descriptive and were obtained from the D2L threaded discussion board, which were transferred to a spreadsheet. Specific words and phrases were pulled and color-coded in regard to the level of the food delivery system (production, processing, retail, consumer) generating the response. The literal codes were assessed for internal consistency, frequency and extensiveness of comments within the context of the question. These assessments contributed to the analytical codes. The analytical codes were more closely tied to the researcher's insight into the subject and more interpretive in nature than the literal codes. The analytical codes served as a tool to generate a summary or final theme that "tells the story" related to the discussion (Hesse-Biber and Leavy, 2011; Krueger and Casey, 2009).

**Table 1. Focus Group Questions used to generate data (discussion) among undergraduate students (n=20) in a food safety related major.**

| Questions | Descriptive Analysis of Data – Emerging Themes |
|---|---|
| 1) When considering a career related to food and agriculture, what first comes to your mind, and what do you think most people would think is a food or agriculture related career? | • Student view – farming and ranching<br>- positive view of feeding the world and nutritious choices<br>• Perception of general public view – farming and ranching; foodservice/grocery stores<br>- negative view of agriculture – GMO, animal welfare |
| 2) Think of your high school science class and/or teachers. How critical was this experience in directing you to the career path you have chosen? | • Six students identified agriculture classes and FFA, ignoring the reference to science class.<br>• Eight students majoring in courses related to biotechnology and microbiology recognized science as preparing them for college, and less critical in directing their career path. |
| 3) Consider the various life experiences you had while in high school and during your first year of college. How do you think these experiences influenced your choice for a major in college? | • Growing up on a farm or ranch (most predominant answer) and a passionate response<br>• Extracurricular activities of 4-H and FFA<br>• Opportunities to experience career of interest (i.e. job shadowing) |
| 4) Looking ahead to the day you receive your bachelor's degree, what type of job do you hope to get, and why do you want that type of a job? | • Job satisfaction – rewarded by work outcomes<br>• Market forces – secondary<br>• Types of employment varied by major |
| 5) You have been asked to participate in this group because you have chosen a major area of study that is related to the safety of the food supply. On a scale of 1 to 10 (one being low and 10 exceptionally high), at what level do you think your major is related to the safety of the food that Americans eat every day? | • Perceived value of majors in contributing to a safe food supply (highest to lowest):<br>1. Production Ag and regulatory inspections – dairy, animal and veterinary science<br>2. Preparation – primarily foodservice<br>3. Education – dieticians, agriculture education followed by journalism.<br>• Dairy ranked the highest (10)<br>• Agriculture journalism was the lowest (3) |

## Results and Discussion

### Participant Demographics

The majority (85%) of the 20 participants were from STEM related backgrounds. The gender of the group was predominantly female (n=18). Females are more likely to respond to surveys and qualitative research than males (Dillman et al., 2009). A $15 gift card served as an incentive for recruitment and full participation. Similar qualitative investigations (online and face-to-face) varied in overall number of participants with as little as six to 182 (Hong and Schull, 2010; Tillberg and Cohoon, 2005). Of the 20 students, seven major area of study were represented (Table 2).

The first question was related to food and agriculture careers. Students were asked: "When considering a career related to food or agriculture, what first comes to your mind and what do you think most people would think is a food or agriculture related career?" The students were asked to justify why they chose those answers. A word summary (literal code) and emerging theme were generated from the responses (Table 1).

From the recruiting process, students were aware that FS careers were a focus of the investigation. Therefore, they may have emphasized FS in their answer. Their responses provided insight as to what first comes to their mind, along with an explanation of their response. Overwhelmingly, the most common career identified was farming and ranching (n=13). The students listed additional

**Table 2. Number of Students in Focus Group Study by Major in College**

| Major | Number of Students |
|---|---|
| Dairy Production | 2 |
| Agriculture Education | 3 |
| Dietetics | 5 |
| Microbiology & Biotechnology | 5 |
| Animal Science | 5 |
| Hospitality Management | 2 |
| Range Science | 1 |

Note: three students had two majors, therefore the sum of all majors (n=23) is greater than the number of participants (n=20).

careers and shared their opinion regarding the impact a specific career has on food, agriculture and FS. The participants shared that a career in agriculture is beyond farming and ranching, such as feeding the world (n=3) and providing nutritious food choices (n=4).

When discussing what the general public thinks is a food and agriculture careers, the most common response was also farming and ranching (n=16). The second most common career response was directly related to the handling of food at the retail level with references made to foodservice or grocery stores (n=9). The students shared 9 different terms (36 postings) when identifying how the general public perceives food and agriculture careers. In contrast, they shared 17 different terms (57 postings) when describing how they perceive food safety careers. Their explanations often described the general public as unaware or misinformed of careers related to food and agriculture. Seven participants provided personal experiences of the general public being uninformed or misinformed.

Several students (n=9) speculated the general public as having a negative perception of food and agriculture related careers. The students volunteered no perceived favorable or positive views of food and agriculture careers by the general public. In contrast, they shared several positive statements (n=7) such as feeding the world or more nutritious foods for their perspective regarding food and agriculture careers. These descriptors were not identified as the general public perception. The students (n=5) shared careers with a strong science and technology foundation such as chemical research, genetically modified organisms (GMO) and biotechnology (n=5). Students did not speculate on the general public's perceiving these types of careers related to food and agriculture.

Two students served as advocates for agriculture while in high school and college. They identified this type of job as a food and agricultural career. A non-agriculture food related major shared concerns regarding large for-profit farms, mistreatment of animals, and the need for labels describing how the animal was raised. There were no responses from the group to the posting provided by this student.

A disconnect was indicated between what students think about food or agriculture careers and how they perceive what the general public thinks. This indication was based on the difference in number and diversity of responses as previously described. A disconnect between the agriculture industry and the general public has been clearly identified by professionals in agriculture and food system. The United States Department of Agriculture (USDA) is addressing this issue through the program Know Your Farmer, Know Your Food. This program is described on the USDA website as a "national conversation about food and agriculture to strengthen the connection between consumers and farmers" (USDA, 2012).

The second focus group question asked the students to think of their high school science class and/or teachers. How critical was this experience in directing your chosen career path and to explain your answer. The emerging themes from this discussion are provided in Table 1.

The majority of students (57%, n=12) were from a major related to agriculture. Several students (n=5) did not address the question; instead they responded that their high school agriculture class was critical in directing their career path, ignoring the reference to science classes in the question. The responses by these students (n=6) also stressed how important the agriculture teacher was in their career choice. The most common descriptor used for describing their agriculture teacher was "caring".

The students shared the impact of high school science classes on a STEM related career choice were based on the teacher's ability to engage students and the diversity of courses offered. High school science classes (n=8) were identified particularly by students that were majoring in a field of study immersed in science such as biotechnology or microbiology. When referring to science classes, students (n=4) most often identified their science classes preparing them for college. Hegerfeld-Baker, et al. (2014) identified high school classes as influencing students when choosing a STEM major instead of a non-STEM in college. However, the odds ratio reflecting the level of predictability was only slightly positive (1.14, $P<0.001$).

Four students identified college courses as more influential in directing them to a specific career path in comparison to high school classes. In three instances, animal science was identified. One student decided to not pursue a veterinarian degree after learning in animal science class about the role veterinarians fulfill in animal slaughter. The opportunity to learn more about a career in an introductory college course was valuable to those confirming or changing their major.

Students (n=6) identified FFA as an organization directing their chosen career path by describing FFA as exposing them to a career they desired to pursue. These same students shared definitive statements regarding the role FFA played in their career decision. Agriculture industries have recognized FFA as a key student organization to partner with for students to experience agriculture related careers (AVMA, 2007). A national study comparing FFA to non-FFA high school students identified that FFA members more than non-members plan to attend a four-year college. The same study identified that six of the top ten career choices for FFA members were related to agriculture. In comparison, non-FFA members chose one career related to agriculture (Balschweid and Talbert, 2004).

The third question asked students to consider various life experiences (i.e. jobs, volunteer work, farm life, family, friends, extracurricular activities, etc.) they had while in high school and during their first year of college. They were to describe how they thought these experiences influenced their choice for a major in college.

Three main themes emerged relating to the influence of life's experiences on their chosen career path (Table 1): 1) opportunities to experience a career; 2) extracurricular activities; and 3) growing up on a farm or ranch. Students (n=4) very explicitly described the impact of job shadowing on their career decision. This was similar to research by Hodges and Barbuto (2002) identifying the importance of school counselors creating opportunities for students to experience various careers.

The extracurricular programs identified most often were 4-H and FFA (n=8). Those in non-agriculture majors did not identify FFA (they could have been a member but it was not identified). One student (3-B, Online Focus Group Session [OFGS], February 2013) stated: "*I believe that extracurricular activities and work experiences are what led me to choose the majors I did. While in high school I was very involved in 4-H and FFA, these organizations inspired my interest … and my job educating people from urban areas about agriculture.*" FFA organizations hold career development events for students to explore career opportunities in today's agriculture industry through an inquiry-based problem solving approach.

Nine of the participants explicitly identified growing up on a farm as influential in their career choice, this included students seeking non-agriculture degrees. The experience of growing up on a farm may not be unique in the rural Midwest. Since only 2% of the U.S. Population lives on farms, the experience of growing up on a farm is less common nationally (EPA, 2012a). One student (3-C, OFGS, February 2013) stated the following regarding farm life: "*When you live on a farm, you have many opportunities to experience things that people in the big cities rarely do or maybe even heard of. Life experiences make you who you are today without them you would probably have turned out in a different field or lifestyle than you are right now.*"

A report by Goecker, et al. (2010) identified that five percent more college students with expertise in food and agriculture will be needed from 2010 to 2015. Their expertise to agriculture and food systems will be needed at a greater level than in the past. The concern regarding the shrinking pool of young people entering college who grew up on farms and were exposed to agricultural careers is a concern for the agricultural industry (NAS, 2009).

A passion for what they hoped for after completing their degree was evident from the five students identifying a passion or love for an aspect specific to their career choice. These passions were cultivated through experiences primarily achieved in a rural agricultural environment. This is a concern for the agriculture industry since fewer students have the experience of growing up in a production agricultural environment (APLU, 2009; Collins, 2008; Goecker et al., 2010).

The fourth question focused on employment opportunities in their career path. Students were asked to look ahead to the day they receive your bachelor's degree, what type of job did they hope to get and why did they want that type of job. The overall response was favorable to job satisfaction (Table 1). Indicators related to market forces were shared secondary to job satisfaction.

A primary objective of the investigation was to identify if market forces favorable to agriculture and food science influence the student's career path. Question #4 was developed in a manner to not be suggestive in nature toward market forces. Responses such as job security, long-tern ambitions and goals served as indicators that market forces did play a role in decision making. However, the leading responses were connected to the theme of job satisfaction. The results contrasted with a previous investigation by Hegerfeld-Baker, et al (2014) in regard to the level of influence of market forces in choosing a STEM related major. The market forces predictor variable odds ratio (1.976, $P < 0.001$) was higher than passion for career (1.494, $P < 0.01$).

Students expressed how their career choice provided an opportunity to positively impact the lives of the people they would work with. Ten students identified helping others as a reason for their chosen career path. A focus group study by Tillberg and Cohoon (2005) reported a similar conclusion in regard to women identifying that a computer programming degree interested them because they could help people, while men were more interested in computer hardware. The results relating to the desire to help people in their chosen career path may be related to the predominant number (90%) of females in this focus group study.

Terms or phrases (n=13) related to helping and working with people were common. Students entering the agriculture industry specifically shared that they wanted to work with producers. For example, a student (1-B, OFGS, February 2013) with plans to be a dairy farm inspector "liked the idea of being able to interact with farmers and getting to know different operations."

Passion and love were two words that were shared by those expressing a connection to animals. The students planning to work in dairy production always connected their career with passion and love for animals.

A pattern of opportunity was identified with terms and phrases that related to the types of jobs students were quite certain was waiting for them after finishing their degree (n=4). In all of these situations, the student was going back home. These students did not express any negativity in their responses.

Nineteen of the 20 students described the type of employment they hoped to find after graduation and shared how this first job would evolve toward their career goals. Those striving for internships or veterinary school identified options if they do not get accepted into a program. A career goal for several students (n=6) was to own their business, primarily farming operations. These students described their plan to work hard to eventually reach their career goals. These descriptions were interpreted as an indication of market forces and financial stability by the researcher.

Not one student explicitly identified financial reasons for their career path. The terms money and financial were not mentioned. However, they shared terms or phrases connected to financial stability as indicated by the following statements: "*ag economy is vital to the growth of America; … industry does well; … opportunity to return to dairy I worked at in high school; … take over dairy operation; … food products become more valuable due to increased safety; … job openings in two years when I graduate; and, high demand for agriculture educators*" (Students 1-D, 1-A, 1-F, 3-D, 3-B, OFGS, February 2013). These comments were not the leading response when answering this question.

Information from the USBLS reported a 10% increase from 2010 – 2020 along with competitive entry-level salaries (median salary $58,450). Based on this information, it was expected that students would volunteer comments related to market forces (Gilmore et al., 2006; Goecker et al., 2010; USBLS, 2012). However, terms related to job satisfaction (n=34) were expressed in a more obvious nature and more often.

The students identified content and performance goals while pursuing their respective bachelor degrees (Lent and Brown, 2006). Market forces such as enticing salary packages were not identified. However, as addressed previously, several of the students had speculated on the type of job they hoped to have and where it will eventually lead them. One-third of those responding had plans to own a farming operation or business. Since these businesses were all related to production agriculture, a multi-million dollar investment would be required, particularly related to land values and input costs (SDSU-AES, 2012; EPA, 2012b).

The final question addressed the relationship between their chosen career and the safety of the food supply. The students were first informed that they were asked to participate in this focus group discussion because they have chosen a major area of study related to safety of the food supply. Students were then asked to express on a scale of 1 to 10 (one being low and 10 exceptionally high), at what level did they think their major was related to the safety of the food Americans eat every day and to explain their answer. The students identified a clear distinction to various areas of agriculture; agriculture education versus regulatory, consumer perspective and educating consumers (Table 1).

Those (n=11) involved in livestock related majors (dairy, veterinarian and animal science) gave high values (eight or greater) to their chosen profession regarding the direct impact on the safety of the product they are producing. Non-livestock production majors responded in agreement regarding the responsibility of livestock production in providing a safe food supply.

Dietetics and Ag Education students viewed their majors as contributing to food safety education, and impacting the safety of food secondary to livestock production. Those working with consumers regarding consumer safe food handling practices were higher (seven and eight) and Ag Education ranged from five to eight. The Ag Educators planned to implement lab exercises connected to FS at the production level of agriculture.

The overall findings for this question were very similar to a survey conducted with 38 economics students from North Dakota State University (NDSU). Their perception of careers related to FS were people directly handling food and food inspectors (Wachenheim and Beauchamp, 2013). The students in the focus group repeatedly recognized policies and regulations that must be met. On a scale of one to ten, they continually rated careers related to food policy and regulations very high, most often a ten, particularly related to the production and inspection of dairy and meat products.

## Conclusions, Implications, Future Research, Limitations

### Conclusions

The results of the focus group process provided additional insight into the predictability of influential factors to choosing a food safety (FS) related major. The focus group was considered homogenous since it consisted of students with FS related majors. The focus groups were discussion based therefore information was descriptive and included insight regarding how the participants were influenced by their life experiences.

Several themes were identified from the responses students shared in their discussion (Table 1). The most pronounced theme was the strong passion participants have for their career path. They were very explicit, particularly the students that had majors related to agriculture. These students did not address the amount of money they hope to make.

The focus group process provided additional insight from previous research by Hegerfeld-Baker et al. (2014) regarding the impact of high school courses. The students were asked to reflect on their high school science class regarding the influence in choosing their career path. The most predominant answer identified their agriculture class in combination with the FFA program as influencing their career path. One student described FFA as an experience that exposed them to a career path bringing them to SDSU for a major they would not have known existed without FFA. They identified their high school science class as preparing and inspiring them to attend college. Additional life experiences students described as influential were growing up on a farm and work experience including job shadowing.

### Implications

According to the survey results from Hegerfeld-Baker et al. (2014) high school classes were slightly positive (1.14, $P<0.001$) in predicting that a student would choose a food and agriculture STEM major in college. The focus group process provided additional insight regarding the engagement of high school courses. According to student responses, science classes were viewed as preparing and inspiring them for college. The students identified agriculture classes as teaching them about careers. Bringing agriculture and food STEM concepts and laboratory techniques into high school science classes using an inquiry-based approach exposes more students to food and agriculture careers.

The responses of students support the agriculture and FFA programs in their schools as critical influential factors in their career decisions. As budgets at schools and universities struggle with shortfalls in revenue and rising expenses, non-mandatory programs such as FFA and agriculture education can be targeted for cutbacks. The agriculture industry needs to continually evaluate their involvement with schools, universities, organizations and policy makers to provide the needed support of these programs that are critical to the vitality of their industry and to the safety of the food supply.

The students overwhelmingly shared descriptors related to job satisfaction. This was evident in descriptors such as enjoy, passion, love, privilege, diversity, not boring, helping others, excited, enthusiastic, no regrets and giving back. Students explicitly shared descriptions related to job reward and satisfaction when describing why they chose their specific career path. Understanding how they want to help others or the qualities they enjoy in a career can be useful when developing marketing materials for recruitment of students into programs at universities. The aspect of job demand and potential earnings may be a consideration in the marketing strategy, however job reward and satisfaction may be more important to a student choosing this type of a career path. The SDSU Dairy Science Department captured the various components for marketing a career path through a video on their website, “SDSU Dairy Science – The Cream. And the Crop” (South Dakota State University – Dairy Sciences [SDSU-DS], 2012). The market forces were addressed in the video as well as job rewards and satisfaction.

The need to utilize more than one type of investigation to gather data to set policies, develop curriculums and recruiting materials, was exemplified in the research results. If the survey results from previous work by the researcher (Hegerfeld-Baker et al., 2014) was used to set a policy related to the impact of extra and co-curricular school activities, the decision would not have been favorable to support these types of programs. However, when including the focus group results, the impact of FFA in guiding students to needed careers was very favorable. As described by Krueger and Casey (2009), the focus group process fulfilled added detail to the information generated by a quantitative survey, provided information on participants’ attitudes and values, and gained clarity on the impact of personal experiences.

Needs assessments provide qualitative and quantitative data to assist in the decision making process. Focus group studies of this nature should be solely to gather the data needed. The investigative design should not make the decision. The stakeholders will make decisions based on the results of the investigation.

### Future Investigation

The differing perspective of agricultural and food careers provided by the students in regard to how they view these careers compared to the general public revealed a need to expand on question #1. Research bringing together students with agriculture and non-agriculture majors addressing differing perceptions may provide insight on how to best address views and values regarding FS, food production and processing.

### Study Limitations

The majority of the students in this program were from the production aspect of the food delivery system (57%) and 45% stated growing up on a farm. This was not representative of the general population since 2% of the U.S. population lives on farms (EPA, 2012a). A homogenous focus group study is limiting in scope regarding the population that was studied. Therefore, the results may not be comparable to a university located in a metropolitan environment.

The study consisted of 20 students and 90% were females. The students were from one university and the number of participants was low. However, the most important aspect was reaching saturation (repeated views and values). The results may have been impacted by the high percentage of females.

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# The Rural Brain Drain and Choice of Major: Evidence from One Land Grant University

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## Abstract

Rural areas in the U.S. face the challenge of academically talented high school graduates who leave to pursue postsecondary education and often never return. This study assessed migration of 2007 and 2008 bachelor's degree graduates (N = 6,165) from a mid-south land grant university by college. Rural students enrolled in agricultural, food and life sciences (AFLS) (32.3%) at a significantly ($p < 0.05$) higher percentage than the university overall (26.9%). AFLS (21.1%) and engineering (19.4%) had significantly ($p < 0.05$) higher percentages of graduates currently living in rural areas than the university overall (15.3%). Rural AFLS graduates returned to rural communities at a significantly ($p < 0.05$) higher percentage (56.7%) than did rural graduates overall (45.1%). Overall, only 4.3% of graduates originally from non-rural areas were living in rural areas six or seven years after graduation; there were no significant ($p > 0.05$) differences by college. Rural communities experienced a net loss of 716 college-educated individuals over two academic years.

## Introduction

Rural communities in the U.S. must deal with the effects of out-migration of young people to urban and suburban areas (USDA-ERS, 2014; Whitener and McGranahan, 2003). This exodus of youth from rural communities has been dubbed the rural brain drain as the most academically-able rural youth leave for college and often never return to rural communities (Carr and Kefalas, 2009; von Reichert et al., 2011). According to Lichter and Brown (2014), land grant universities should play a key role in enhancing economic, social and educational opportunities in rural communities. Yet, by their very natures, land grant universities are part of the mechanism whereby the most academically capable rural youth are enabled to leave rural communities, with potentially negative consequences for these communities (Artz and Yu, 2009).

Rural can be defined in a number of ways; a common USDA Economic Research Service (ERS) definition for rural is any county that is not considered metropolitan, meaning these counties contain no urban areas with populations greater than 49,999 (USDA, 2012). From virtually any perspective, Arkansas is a rural state, with 62 of the 75 counties classified as non-metropolitan in the 2010 census (University of Arkansas, 2013). From 1900 to 2010, Arkansas has consistently been home to a higher percentage of rural people than the nation as a whole, with 44% of Arkansas residents classified as rural in the 2010 census compared to 19% of the U.S. population (University of Arkansas, 2013). Arkansas, like many other rural states, deals with the effects of rural out-migration. In the 2010 census, 35 of the 36 counties in Arkansas that experienced population losses were rural counties (University of Arkansas, 2013).

Population changes occur through two mechanisms – natural increases/decreases or migration. In the case of rural communities in Arkansas, population decreases can be largely attributed to out-migration (University of Arkansas, 2013). Much of this out-migration occurs as high school graduates leave rural communities to attend college and, upon degree completion, settle in metropolitan areas where the economic returns to investments in education are greater (Marré, 2014).

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Marré (2014) used data from the U.S. Census Bureau's 2012 Current Population Survey to estimate the percentage of college graduates (Bachelor's degree or higher) in rural areas working in each of 13 industry sectors. Marré estimated more than four in 10 (41.5%) college graduates working in rural areas were employed in the education and health services sector; the next largest sector, manufacturing, employed less than one in 10 (8.9%) college graduates. The agriculture and forestry sector tied (with construction) for seventh, employed 3.4% of college graduates in rural areas; however, this very likely underestimates the percentage of rural college graduates working in what are traditionally considered agricultural occupations. For example, food and feed processing are classified as manufacturing occupations, while farm machinery dealerships and farm supply stores are classified as retail trade occupations (USDOL-BLS, 2014).

Artz and Yu (2009) studied Iowa State University graduates and found that alumni majoring in agriculture and life sciences were both more likely to have been raised in rural areas (44.8%) and to live in rural areas after graduation (26.2%) than were graduates of ISU's other five undergraduate colleges. Graduates in design (18.2%) and engineering (21.2%) were least likely to have been raised in rural areas or to live in rural areas after graduation (5.2% for each). The rural retention rate (percentage living in rural areas / percentage from rural areas) ranged from 24.3% for engineering to 58.5% for agriculture and life sciences.

The University of Arkansas consists of six undergraduate colleges; agriculture, food and life sciences (AFLS), which includes human environmental sciences; architecture; arts and sciences; business; engineering; and education and health professions. The purpose of this study was to examine the migration patterns of 2007 and 2008 bachelor's degree graduates (N = 6,165) from the University of Arkansas, overall and by college. Specific objectives were to determine: (1) the overall percentage of graduates from rural areas and if percentages for the six undergraduate colleges differed significantly from the university as a whole; (2) the overall percentage of graduates currently living in rural areas and if percentages for the six undergraduate colleges differed significantly from the university as a whole; (3) the overall percentage of rural graduates returning to rural areas and if percentages for the six undergraduate colleges differed significantly from the university as a whole; (4) the overall percentage of non-rural graduates living in rural areas and if percentages for the six undergraduate colleges differed significantly from the university as a whole; (5) the overall percentage of rural graduates returning to their home communities and if percentages for the six undergraduate colleges differed significantly from the university as a whole; and (6) the overall percentage of rural graduates returning to nearby (within 50 miles) rural communities and if percentages for the six undergraduate colleges differed significantly from the university as a whole.

## Methods

The data set for this study was provided by the University of Arkansas Alumni Association in March 2014 and included parents' (or guardians') zip code at the time the student first enrolled in the university, graduates' current zip code and the undergraduate college for all 2007 and 2008 bachelor's degree graduates (*N* = 6,211). According to the University of Arkansas Alumni Association, alumni mailing addresses (and thus zip codes) are updated every 90 days to ensure that all alumni mailings reach the intended recipient at their current address (T. Dover, personal communication). No names or other personal identifiers were provided so as to maintain the anonymity of graduates. Graduates from 2007 and 2008 were selected for study because, at seven or six years, respectively, after graduation, these alumni were likely to have completed any post-graduate education and early career transfers and be settled into fairly stable residential environments. Parental or current zip codes were not available for 46 (0.74%) alumni; these observations were deleted from the data set, leaving 6,165 valid observations for further analyses.

Parents' zip code (at the time the student entered the university) and graduate's current zip code were used to classify each graduate's pre-college residence and current residence as either rural/small town (hereinafter referred to as rural) or non-rural based on the Rural-Urban Commuting Area (RUCA) zip code approximation database (Rural Health Research Center [RHRC], n.d.). The RUCA zip code approximation database is based on USDA RUCA codes and was last updated in 2005 (Hart et al., 2005). Primary RUCA codes range from one to 10, with codes one through three being "metropolitan" (classified as non-rural for the purpose of this research) and codes four through 10 considered "rural" (USDA, 2012). Under this classification, a zip code was considered rural if it did not contain or partially contain a city of 50,000 or more in population (USDA, 2012). Data were analyzed using descriptive and non-parametric statistics; the 0.05 *alpha* level was set a *priori* for all tests of statistical significance.

## Results and Discussion

The 6,165 bachelor's degree graduates from 2007 and 2008 were evenly distributed between years at 50.1% and 49.9%, respectively. Slightly over one-half (52.4%) of all graduates were female. The college of arts and sciences had the most graduates (34.5%) followed by business (24.1%), education and health professions (14.0%), AFLS (10.5%), engineering (9.8%) and architecture (3.1%). Chi square analyses revealed no significant ($p < 0.05$) differences by year for number of graduates, gender, or college attended; thus, graduates from the two years were combined for all subsequent analyses.

Overall, 26.9% of 2007 and 2008 graduates were from rural areas as indicated by parents' (or guardians') zip code. At 32.3%, AFLS had a significantly higher percentage [$\chi^2$ (1) = 9.63, p = 0.0019] of graduates from rural areas than did the university as a whole (26.9%). None of the other five undergraduate colleges differed significantly from the overall university in the percentage of graduates from rural areas.

Only 15.3% of 2007 and 2008 graduates lived in rural areas six or seven years after graduation (Table 1). Graduates from AFLS [21.1%; $\chi^2$ (1) = 17.01, p < 0.0001] and engineering [19.4%; $\chi^2$ (1) = 8.20, p = 0.0042] lived in rural communities in significantly higher percentages compared to all university graduates (15.3%). At 13.4%, the college of arts and sciences [$\chi^2$ (1) = 6.30, p = 0.0121] had a significantly lower percentage of graduates currently living in rural areas. The colleges of architecture (16.8%), education and health professions (15.5%), and business (13.5%) did not differ significantly from the university as a whole in the percentage of graduates currently living in rural areas.

**Table 1. Percentages of Graduates from Rural Areas and Currently Living in Rural Areas by College and Overall for 2007 and 2008 Graduates (N = 6,165), as Classified by ZIP Codes**

| College | *n* | Percent from rural areas | Percent currently living in rural areas |
|---|---|---|---|
| AFLS | 650 | 32.3** | 21.1** |
| Architecture | 190 | 32.1$^{NS}$ | 16.8$^{NS}$ |
| Arts & Sciences | 2372 | 26.1$^{NS}$ | 13.4* |
| Business | 1485 | 24.8$^{NS}$ | 15.4$^{NS}$ |
| Education & Health Professions | 861 | 26.7$^{NS}$ | 13.5$^{NS}$ |
| Engineering | 607 | 28.5$^{NS}$ | 19.4** |
| University | 6165 | 26.9 | 15.3 |

*Note.* Within each column one-way chi square tests were used to test for significant (p < .05) differences between the university and each college in the percentage of graduates currently living in rural areas.

$^{NS}$, *, **; ***, Nonsignificant or significant at *p* = 0.05, 0.01, or 0.001.

**Table 2. Percentages of Rural and Non-rural Graduates' Currently Living in Rural Areas by College and Overall (N = 6,165)**

| | Graduates originally from: | | | |
|---|---|---|---|---|
| | Rural areas | | Non-rural areas | |
| College | *n* | Percent currently living in rural area | *n* | Percent currently living in rural area |
| AFLS | 210 | 56.7*** | 440 | 4.1$^{NS}$ |
| Architecture | 61 | 36.1$^{NS}$ | 129 | 7.8$^{NS}$ |
| Arts & Sciences | 617 | 41.5$^{NS}$ | 1755 | 3.6$^{NS}$ |
| Business | 368 | 41.0$^{NS}$ | 1117 | 4.5$^{NS}$ |
| Education & Health Professions | 230 | 48.3$^{NS}$ | 631 | 3.8$^{NS}$ |
| Engineering | 173 | 51.4$^{NS}$ | 434 | 6.7* |
| University | 1659 | 45.1 | 4506 | 4.3 |

Note. Within each column one-way chi square tests were used to test for significant (*p* < .05) differences between the university and each college in the percentage of graduates currently living in rural areas.

$^{NS}$, *, **; ***, Nonsignificant or significant at p = 0.05, 0.01, or 0.001.

**Table 3. Percentages of Rural Graduates (n = 1,659) Currently Living in Home Community or Rural Area within 50 Miles of Home by College and Overall**

| College | *n* | Percent of rural graduates currently living in rural home community | Percent of rural graduates living in rural home community or in rural area near (≤ 50 miles) home community |
|---|---|---|---|
| AFLS | 210 | 41.0$^{NS}$ | 46.2* |
| Architecture | 61 | 31.2$^{NS}$ | 32.8$^{NS}$ |
| Arts & Sciences | 617 | 33.6$^{NS}$ | 37.6$^{NS}$ |
| Business | 368 | 33.2$^{NS}$ | 35.6$^{NS}$ |
| Education & Health Professions | 230 | 34.4$^{NS}$ | 41.3$^{NS}$ |
| Engineering | 173 | 37.6$^{NS}$ | 44.5$^{NS}$ |
| University | 1659 | 34.8 | 39.3 |

Note. Within each column one-way chi square tests were used to test for significant (p < .05) differences between the university and each college in the percentage of graduates currently living in rural areas.

$^{NS}$, *, **; ***, Nonsignificant or significant at p = 0.05, 0.01, or 0.001.

Of the 1,659 graduates originally from rural areas, less than half (45.1%) were living in rural areas six or seven years after graduation (Table 2). At 56.7%, rural AFLS graduates were significantly more likely to currently live in a rural area than were university graduates as a whole, $\chi^2$ (1) = 11.37, p = 0.0007. No other college differed significantly (p > 0.05) from the university in the percentage of rural graduates living in rural areas.

Of the 4,506 graduates originally from non-rural areas, only 194 (4.3%) currently lived in rural areas (Table 2). Only the college of engineering differed significantly from the university in the percentage of graduates (6.7%) from non-rural areas currently living in rural areas, $\chi^2$ (1) = 6.11, p = 0.0134.

Overall, 577 of the 1,659 (34.8%) graduates originally from rural areas were living in the same zip code area as their parents six to seven years after graduation and were considered to have returned to their own rural home communities (Table 3). By college, the percentages of rural graduates returning to their home communities ranged from 31.2% for architecture to 41.0% for AFLS, with no significant (p > 0.05) differences between any college and the university as a whole.

Overall, 39.3% of graduates from rural areas (n = 1,659) were currently living either in their home community or in a rural community within 50 miles of their home community, as measured from center to center of zip code areas (Table 3). AFLS (46.2%) had a significantly higher percentage of graduates living in their own or nearby rural communities compared to the university as a whole, $\chi^2$ (1) = 4.18, p = 0.0409. There were no other significant (p > 0.05) differences between any college and the university overall.

To determine the relative "stickiness" of rural and non-rural areas, the percentages of graduates returning to their home and nearby (within 50 miles) areas were also compared for rural and non-rural graduates. At 34.8% and 36.1%, graduates from rural and non-rural areas, respectively, did not differ significantly in the percentages currently living in the same zip code area as their parents, $\chi^2$ (1) = 0.90, p = 0.3429. However, a significantly lower percentage of rural graduates (39.3%) than non-rural graduates (59.3%) lived in areas within 50 miles of their parents, $\chi^2$ (1) = 135.88, p < 0.0001.

## Discussion

These results document the reality of the brain drain for rural communities sending students to one land grant university (Carr and Kefalas, 2009; Howley, 1996). For the 2007 and 2008 graduating classes, rural communities sent 1,659 students to the university and, in return, received 748 rural and 194 non-rural graduates for a net loss of 717 (43.2%) graduates. While this may not constitute the "hemorrhage" claimed by

Carr and Kefalas (2009, p. 1), it does represent a significant decline in both the population and intellectual capital of these rural communities.

Although Arkansas is considered a rural state with nearly one-half (40.7%) of all public school students classified as rural (Provasnik et al., 2007), only 26.9% of 2007 and 2008 graduates of the University of Arkansas were from rural areas. Thus, rural students are underrepresented among graduates of their state land grant university. This finding is consistent with previous research reporting a positive association between hometown population and the probability of students applying for admission to the University of Minnesota, a land grant university (DesJardins et al., 1999).

The overwhelming majority (84.7%) of graduates from the University of Arkansas lived in non-rural areas six or seven years after graduation. Graduates from AFLS (21.1%) and engineering (19.4%) resided in rural communities at significantly higher rates compared to all university graduates (15.3%). Yet, according to Marré (2014), agriculture and manufacturing together accounted for only l2.3% of rural jobs requiring a bachelor's degree or higher. Either AFLS and engineering graduates are working in areas not related to their majors or the percentages cited by Marré (2014) underestimate the rural career opportunities available AFLS and engineering graduates.

As might be expected, AFLS attracted a larger percentage of rural students (32.3%) compared the university as a whole (26.9%). AFLS also had more rural graduates living in rural areas (56.7%) and returned significantly more rural graduates to communities within 50 miles of their home community (46.2%). Thus, AFLS majors may be especially suitable for preparing rural students to return to rural communities, helping to ameliorate the rural brain drain. Rural AFLS majors likely include many of the students "with the firm intent of coming back despite the limitations in rural labor markets" (von Reichert et al., 2011, p. 42).

Conversely, AFLS graduates originally from non-rural areas (4.1%) were no more likely than other non-rural graduates (4.3%) to currently live in a rural area. Thus, graduation from AFLS is not associated with rural residence for graduates originally from non-rural areas. Instead, it appears that graduating with an AFLS major is associated only with rural graduates returning to rural areas. Again, this is consistent with the work of von Reichert et al. (2011).

Non-rural graduates (59.3%) were significantly more likely to live within 50 miles of their home community than were rural graduates (33.9%). This is likely due to the greater demand for educated workers in more metropolitan areas (Marré, 2014).

## Recommendations

The results of this study should be shared with rural educators, policy makers, parents and others. Rural educators and parents should be aware of and discuss with rural youth the fact that selection of a college major influences more than what students will study; it may also influence where the graduate will later live. Rural students in this state with a desire to return to rural communities should be informed of the rural employment opportunities available to graduates.

AFLS should highlight these results in efforts to recruit students. Rural students and parents should be informed that AFLS graduates are more likely to return to rural communities, especially rural communities within 50 miles of home. This would likely be a potent recruiting message in rural communities, given the importance rural residents place on family and community (Meece et al., 2013). Conversely, since AFLS graduates originally from non-rural areas were no more likely than other university graduates to currently live in a rural area, AFLS may also be able to better recruit non-rural students by emphasizing the availability of employment opportunities in metropolitan areas.

Research should be conducted to determine the specific types of jobs secured by AFLS and engineering graduates living in rural areas. Are these graduates working in careers that make use of the specific skill sets developed in their degree programs or are students accepting out-of-field employment as the cost of living in a rural area (Reichert et al., 2011)?

Land grant universities, with their historical commitment to rural areas, must play a key role in enhancing rural economic opportunities (Lichter and Brown, 2014). If rural communities are to survive, this role must include economic development activities that will increase the demand for college educated workers in rural communities. Without availability of sufficient high-skill jobs, rural communities will most likely continue to export their most academically talented students to metropolitan areas.

This study used a limited data set, applicable only to the graduates from the University of Arkansas, and left a need to gain more detailed data about rural graduates. Research should be conducted to better understand the educational, occupational, and residential aspirations of rural youth in Arkansas. While these results for University of Arkansas AFLS graduates were consistent with those for Iowa State University agriculture graduates (Artz and Yu, 2009), this study should be replicated in other, less rural states to determine if these migration patterns are present in other land grant universities serving more urbanized states. Additionally, further research is needed to determine the status and satisfaction of rural college graduates, both those returning to rural areas and those living in non-rural areas.

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# A Comparison of Higher Order Thinking Skills Demonstrated in Synchronous and Asynchronous Online College Discussion Posts


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## Abstract

Developing higher order thinking skills in students is an important task for higher education. Students who are competent analyzers, synthesizers, and evaluators become workers who are better prepared for the work challenges they will face. Class discussion, a long-standing and well-regarded instructional method, in online classes is either synchronous or asynchronous. Synchronous discussion is in real-time, often using chat or messaging applications. Asynchronous discussion typically uses online discussion boards where students respond to comments and questions from class-members. The intention of this study was to explore what higher order thinking skills develop naturally via student social constructivism. This exploratory study measured instances of higher order thinking skills in synchronous and asynchronous online discussion using the Florida Taxonomy of Cognitive Behavior. In this study, overall synchronous discussion was found to be at the knowledge level and overall asynchronous discussion was at the comprehension level. An experiment was conducted comparing overall cognitive levels of synchronous and asynchronous online discussion and a statistically significant difference in the overall cognitive level of comments between the two groups was found.


## Introduction/Theoretical Framework

A primary goal for education is to develop students who are prepared for the work and life challenges they may face (Association of American Colleges and Universities, 2010). Formal elementary through post-graduate education seeks to produce analytical, problem-solving, critical thinking students. It seeks to cultivate students who are not only able to acquire knowledge and comprehend ideas, but also to synthesize thoughts and evaluate concepts. These skills, which include the higher order thinking skills of analysis, synthesis and evaluation, are paramount to preparing students to become learners, workers, and contributors to society.

The National Research Agenda for the American Association of Agricultural Educators has outlined key areas for research focus; a "*Sufficient Scientific and Professional Workforce that Addresses the Challenges of the 21st Century*" is among those goals that address this issue (Priority #3, Doerfert, 2011). Many suggest that the ability to think critically and perform higher level thinking skills is better preparation against change than any specific knowledge or skill set. "*The need to provide a highly educated, skilled workforce capable of providing solutions to 21st century challenges and issues has never been greater*" (Doerfert, 2011, p. 19). In this new century and its information era higher order thinking is a necessary competency for processing through the abundance of new and often contradictory information. It is especially important in adult education which seeks to develop independence of thought, sound judgment, and autonomy of action for people as they navigate an increasingly complex social environment (Fellenz and Conti, 1989).

Jones and Safrit suggested that distance education may be uniquely able to develop student's higher order thinking skills because of the interactive and collaborative nature of distance education (Jones and Safrit, 1994). Well-designed distance education creates opportunities for students to process course content in a variety of ways; asynchronous activities also allow students to access course content when they are most ready. Often the pacing of distance education discussions (asynchronous, at least) allows time for reflection which may lead to deeper understanding (Ellis and Goodyear, 2010). Online distance education (through both synchronous and asynchronous discussions) could be poised as a useful tool in building critical thinking abilities (Ellis and Goodyear, 2010). These thinking abilities are identified as no less than a requirement for survival in the complex technology age.


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Discussion is one of the best ways of demonstrating and sharing one's thoughts; Arends calls it the "externalization of thinking" (Arends, 2004, p. 428). Discussions involve students in their own learning (Davis, 1993) and serves as a way to practice thinking through problems, sorting concepts, and creating arguments and rebuttals. It also tends to reach higher levels of thinking as students respond to each other's questions more completely, and in more complex ways, than they respond to instructor questions (Hunkins, 1995). When students work together to decipher meaning or construct ideas through communication it is called social constructivism (Scardamalia and Bereiter, 1996; Vrasidas, 2000). Arends (2004) noted that many instructors found online discussions work the same as face to face and sometimes even better. Purposeful dialogue about course content allows students to delve deeper, and to wrestle with the ideas and meanings presented in class (Wilen, 2004). If discussion in brick and mortar classrooms is the vehicle through which these skills are exercised and taught, it should also serve that purpose in distance education courses.

Synchronous online discussion provides an opportunity for students to interact with one another. Since participants are discussing topics and content in real time, each student is able to respond immediately which creates opportunities for comments that might change the direction or thoughts of another student (Arends, 2004). Synchronous discussions are dynamic and multi-faceted; their direction may vary with each new comment.

In asynchronous online discussions students are free to discuss topics in greater detail (Wilen, 2004), allowing for more social constructivism. Students do not feel pressured to respond as soon as a question is posed, allowing time to think about how they wish to respond. Asynchronous online discussions may provide a greater opportunity, for students to develop together a more complete answer, specifically one that exhibits higher order thinking skills.

The theoretical framework for this study was built upon Piaget's concept of constructivism, the basis for social constructivism as described by Vygotsky and Bruner (Bruner, 1996) and Scardamalia and Bereiter (1996). "*Constructivists, such as Dewey (1916), Vygotsky (1978), and Bruner (1996), view knowledge as constructed by learners through social interaction with others*" (Huang, 2002, p. 28). The constructivist idea is that learning is not listening and then repeating the stated view of the situation, but instead joining in and interfacing with the surrounding environmental components including other learners. For distance education Vrasidas (2000) used both constructivist and social constructivist lenses arguing knowledge has both individual and shared components.

Constructivist thinking is "constructing knowledge from personal experiences" (Bender, 2003, p.17). Using personal experiences as a link for learning is a hallmark of Andragogy (Knowles et al., 2005). Knowles, et al. (2005) identified the life experiences of adult learners as a touchstone that must be included and used as a reference for all subsequent adult learning. Good discussion provides opportunities for learners to share their experiences and connect them to their current learning. This concept of cognitive scaffolding supports the development of more complex (higher order) thinking through interaction.

The overarching goal of Social Constructivism is to empower students in the task of "meaning making," in the "co-construction of knowledge" (Palinscar, 1998). Meaning making requires communication and contemplation of what we know and to what we are being exposed. Communication and contemplation occur in both external (social) and internal (reflective) settings. For Piaget reflection helped create higher order knowledge by allowing the resolution of components of lower level knowledge (Bruner, 1996). Social constructivism paves the way for this resolution to be found in the dialectic of online discussion. Learners must deliberate, ruminate, and consider many possibilities in order to determine what they think is correct. Then learners must perform those same actions and decide together what the meanings are and what the ideas or events represent.

Social learning situations that enable interactions from students on many levels, regarding a variety of topics in multiple points of view should provide the necessary elements for higher order and critical thinking to blossom. If these discussions are synchronous, students are able to interact with one another in real-time, which may heighten the interaction and fortify cooperative meaning making. If these online discussions are asynchronous, a crucial time element is added that provides opportunity to think about, process, and reflect on the discussion. This time for reflection may be crucial in accessing higher order thinking skills.

Curtis sought to explore the benefits of small group asynchronous online discussions in his education graduate class. Using a qualitative approach and a content analysis method with guiding questions for both latent and manifest content, Curtis explored these small group discussions (of 11 graduate students) to seek answers to guiding questions about levels of interaction, and its effect on meaningful learning and group problem solving. For many instructors, and arguably most students, the interaction provided by other class members is a vital element in the learning process. This interaction provides a social element with enjoyment, comfort, solidarity, competition, and (as social constructivism touts) deep learning potential (Curtis, 2004). Many successful online instructors recognize the strong positive influence these social elements provide and specifically incorporate interaction opportunities. Analysis of actual comments made in synchronous chat showed many instances of students relying on each another to understand not only the logistics of the class, but also the content. Chats were intended and demonstrated "opportunities for students to better understand the material by hearing others' interpretations while sharing their own" (Curtis, 2004, p.143).

For many years, researchers of online learning and other educational professionals have supported the value of community in online learning environments. Community includes both student-student and student-instructor interactions. Black et al. (2008) attempted to quantify this sense of community by using Learning Management Software (LMS) activity logs to explore if a student's sense of community was related to the number of posts and other data (time logged on, grades, attempts, elements accessed, etc.) generated by that student. Significant strong positive correlations were found between the concepts of community and connectedness ($r = 0.774$, $p < 0.01$) and community and learning community ($r = 0.597$, $p < 0.01$) (Black et al., 2008, p. 68). Dawson (2006) found similar results in his study of over 400 undergraduate and graduate students. Using activity logs to tally online behaviors and a sense of community assessment survey, Dawson states that, "*the data demonstrates that students with greater frequencies of communication interactions possess stronger levels of sense of community*" (p.153).

The learning that takes place through good discussion is specifically suitable in distance education settings. Online learning is considered very effective in uniting communities of learners (Ellis et al., 2006). Ellis and Goodyear purposefully chose online discussion as a means to provide possibilities for discussion, interaction, and social meaning making to their online class (Ellis and Goodyear, 2010). If, as Palinscar claimed, "Explaining one's thinking to another leads to deeper cognitive processing" (Palinscar, 1998, p. 349), then online discussion should be a successful arena for students to work together and grow their higher order thinking abilities.

## Purpose

This exploratory study compared the higher order thinking skills in synchronous and asynchronous online discussion in a graduate level course by comparing the weighted mean cognitive level scores.

These research questions were used to address the problem and guide the study:

- What is the weighted cognitive level score of student comments made in each synchronous and asynchronous online class discussion?
- What is the overall weighted cognitive level score of discussion demonstrated in synchronous and asynchronous online class discussion?

Stated in the null form for statistical analysis, the following hypothesis was tested at the 0.10 level of significance: HO1: There is no significant difference in the overall mean cognitive level between synchronous and asynchronous online discussion.

The primary limitation of the study is that it is only generalizable to this specific subject and for this population. Technical problems are not uncommon in distance education; some students reported Internet connection difficulties. There were no reports of ongoing or long-term inability to maintain an Internet connection; however, any interruption in service connection may have limited the discussion comments from students.

## Materials and Methods

This study was exempted by the North Carolina State University Institutional Review Board. The questions of this study utilize an experimental research design. The independent variable (synchronous or asynchronous) was manipulated and the dependent variable (overall mean weighted cognitive level score of synchronous and asynchronous online discussion) was observed, the constant is that the same discussion questions were used. This scenario is experimental research as described by Fraenkel and Wallen (2009).

Class participants were randomly assigned to either the synchronous or the asynchronous group. All participating students were from the same class, the same section, and the same enrollment period. All students in the course were provided weekly course content online. Discussion questions related to the weekly content were made available to the asynchronous group on the Moodle server. The discussion questions were not visible to the synchronous group until the time of the chat session. Unless a specific question was posted for the instructor or a specific need for clarification and further instructions were required the instructor did not post to the discussion thread. The intention of the study is to explore what higher order thinking skills and critical thinking are naturally developed by student social constructivism given the situation, population, and questions.

Participants of this study were the entire enrollment of a 2010 University's Agricultural and Extension Education (AEE 505) graduate class utilizing online discussion. The course is a Trends and Issues reading and discussion course with topics from multiple areas of interest within the department and field of agricultural and extension education. The intent of the class is to not only familiarize students with the current topics of importance in the Agricultural and Extension fields, but also to help students develop ways of learning about new topics, analyzing and assessing the research regarding those topics, and to develop treatments (activities, curricula, programs) that could be used to address these and future topics. This particular course was required for each master's degree offered through the Agricultural and Extension Education Department. As this was a required course for the master's degrees, the students enrolled in the course are similar to the general graduate student AEE enrollment. The students represented a variety of ages (20s through 50s), locations (East Coast to Colorado), and a fairly even mix of males and females. This course is offered online and on-campus and is part of the regular course offerings of the department.

Only students participating in the online section of the class were involved in the study (N=24). These students were randomly assigned to either the synchronous or the asynchronous group; there were 12 students in each group. Each group had the same rubric for assessing discussion posts, received the same type of open-ended discussion question prompts, and was required to participate in the same number of discussion events. All other assignments and requirements were the same for the two groups.

This study utilized an evaluation instrument that assessed the level of thinking exhibited in the online discussion. To examine the student's cognitive level score of comments made in both synchronous and asynchronous online discussion, discussion board comments were coded with the Florida Taxonomy of Cognitive Behavior (FTCB). The FTCB was designed by Brown, Ober, Soar, and Webb in 1966 and has been used many times (Miller (1989); Whitington and Newcomb (1993), Cano and Metzger (1995); Miller and Pilcher (2001); and Ewing and Whitington (2009)). The FTCB is based on Bloom's Taxonomy and is used as a tool to ascribe Bloom's Taxonomy levels to statements from the target audience (Brown et al. 1966). Bloom's Taxonomy breaks thinking into six cognitive levels (knowledge, comprehension, application, analysis, synthesis and evaluation), the FTCB uses seven (knowledge, translation, interpretation, application, analysis, synthesis, evaluation).

Whitington and Newcomb (1993), Ewing and Whitington (2009), and Cano and Metzger (1995) each established intra-rater reliability of the FTCB by viewing video tapes of lectures, coding cognitive behaviors with the FTCB and then repeating the process some weeks later. Intra-rater reliability for this study was similarly established, the raters used the FTCB to code discussion transcripts from one of the discussions not used in the main study (first week, different section) and then repeated the process 2-3 weeks later. A Pearson-Product Moment (Fraenkel and Wallen, 2009) coefficient of reliability of 0.93 (rater #1) and 0.94 (rater #2) was calculated. Inter-rater reliability was determined by using the same discussion transcript (first week, different section) from each rater. A Pearson-Product Moment (Fraenkel and Wallen, 2009) coefficient of reliability of 0.88 was calculated.

The course utilized discussion as an integral component of its overall course makeup. In addition to other written assignments unique discussion questions were asked in nine lessons during the semester. Asynchronous students were required to post a specific number of times; synchronous students had to participate in discussion chat sessions. A rubric for assessing all discussion comments was provided to the students at the beginning of the semester. Online class discussion participation was a requirement for successful completion of the class. Students were made aware that their postings were going to be reviewed for data collection; however, they did not have access to the FTCB coding framework. The reviewer did not assess student discussion class grades, and the review was completed after all course grades had been submitted.

All discussion postings were made using the Moodle Learning Management System. All online class participants had access to a Moodle class site specifically for their course section. Information and guidance for using Moodle was made available through verbal instruction, slideshows, written instructions, and the helpdesk information was provided. Moodle maintains a written record of all online discussions (both Chat and Forum). Those written records were the transcripts that were reviewed and classified using the FTCB. Over the course of the semester discussion (either synchronous or asynchronous or both) occurred most weeks. Nine discussion events for each delivery type (synchronous or asynchronous) were reviewed. In addition, no discussions from the first or last week of the semester was utilized. This allowed students time to become familiar with the class, each other, and the (Moodle) Learning Management System software specifically the Forum or Chat function they used.

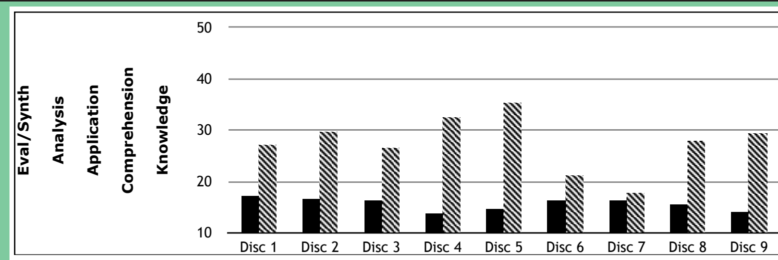
Once all the discussions concluded, two observers were given the discussion transcripts and used the FTCB's 55 descriptor statements to rate each comment. Once coding began the observers did not consult with each other regarding coding. The observers completed all of the synchronous discussion transcripts before they began the asynchronous transcripts. Within each delivery mode the nine discussions were not coded consecutively. This controlled for changes in expectations of the comment level as the semester progressed.

For this study, the FTCB was used to categorize students' cognitive behaviors via a written transcript of the discussion postings. The descriptor statements help the observer match comments to categories. As per the instructions for use of the FTCB (Whittington 1991, 1995; Whittington et al., 1997; Whittington and Newcomb, 1993; and Miller, 1989) for each student's posting any identified level of cognitive behavior was only recorded once per instance regardless of the number of occurrences at that level. If a student's discussion post lists multiple facts in one instance the knowledge cognitive level box was only checked once. If a posting had an additional component at a different cognitive level both levels were recorded.

Once each statement had been coded the scores were processed using a weighting system which assigns a multiplicative value of 0.1 for each comment made at the knowledge level (0.2 at the comprehension level, 0.3 at the application level, 0.4 at the analysis level, and 0.5 at both the synthesis and evaluation level) (Miller, 1989 and Cano and Metzger, 1995). The weighting system accounts for the hierarchical nature of Bloom's Taxonomy. For example, a level four (analysis) comment pre-supposes cognition at levels one through three (Miller, 1989; Brown et al., 1966). So an analysis comment demonstrates that knowledge, comprehension, and application cognitive processes have already occurred in the discussant's mind.

The data were collected from online discussion transcripts; coded using the FTCB, tallied and simple percentages were calculated using Microsoft Excel. The individual weighted cognitive level scores for each discussion and the overall means for each group were also calculated through a weighting system and compared via t-tests. An alpha level for tests of significance was set a priori at $p < 0.10$. According to Agresti and Finlay (1997) an alpha level of 0.10 is acceptable for exploratory studies.

**Figure 1. Weighted cognitive level score for each discussion by delivery mode.**




Note. Total weighted cognitive level scores can range from 10-50; 10-19.9 knowledge, 20-29.9 comprehension, 30-39.9 application, 40-49.9 analysis, 50-synthesis/evaluation.

## Results and Discussion

### Question #1 What is the weighted cognitive level score of student comments made in each synchronous and asynchronous online class discussion?

An overall weighted cognitive level score for each discussion was determined using the FTCB and weighted by multiplying the percentage of comments present at each level, knowledge = 0.10, comprehension = 0.20, application = 0.30, analysis = 0.40, and synthesis /evaluation = 0.50 (Miller, 1989). The sum of each level's scores equals the weighted cognitive level score for that discussion. Weighted cognitive level scores could range from 10 to 50 (the total percent possible is 100 with a minimum weight of 0.10 which equals 10 and a maximum weight of 0.50 which equals 50). A score of 10.0 would correspond to the knowledge level of Bloom's Taxonomy, 20.0 to comprehension, 30.0 to application, 40.0 to analysis, and 50.0 to synthesis/evaluation (Miller, 1989).

For synchronous discussion the weighted cognitive level scores ranged from 13.7 – 17.2. All scores from the synchronous discussion were within the knowledge level; therefore, each discussion was representative of lower order thinking. For asynchronous discussion the scores ranged from 17.7 – 35.4. These numbers indicate that there was an individual discussion at the knowledge level, others at the comprehension level, and still others at the application level. None of these individual weighted cognitive scores, however, is indicative of a higher order thinking score. Overall weighted cognitive scores do not mean every comment was at that level, or that there were no higher order thinking comments. It is important to remember the weighted cognitive scores provide an overall number for each discussion in its entirety, which make comparisons easier.

Weighted cognitive levels scores do not follow any pattern; lowest scores are not the first or last discussion and the highest asynchronous score is not the first or last discussion either. The highest synchronous score was from the first discussion, but subsequent scores are uneven. For either delivery case the scores do not consistently increase or decrease as the semester progresses. The variety of scores across the semester is better seen graphically. Figure 1 is the graphical representation of each discussion's weighted cognitive level score for both synchronous and asynchronous delivery modes along with the level of Bloom's Taxonomy for each (as described by Miller 1989).

### Question #2 What is the overall weighted cognitive level score of discussion demonstrated in synchronous and asynchronous online class discussion?

To examine synchronous and asynchronous discussions as methods for developing higher order and critical thinking skills, it is necessary to compare the weighted cognitive scores of the two delivery methods. To do this, an overall mean was calculated for each delivery mode. This was done by summing the weighted cognitive level scores for each type of discussion and dividing by nine (the number of discussions). Results for the synchronous discussion are grand mean $X = 15.67$, the SD = 1.24, the SE = 0.41, and the range = 10.0 – 50.0. This overall weighted cognitive score for synchronous discussion is representative of discussion primarily at the knowledge level. Weighted cognitive scores between 10 and 19 correspond to the knowledge level of Bloom's Taxonomy (Bloom, 1956). The knowledge level is the first level and is considered a lower order thinking level. Results for the asynchronous discussion are grand mean $X = 27.46$, the SD = 5.38, and the SE = 1.79. A weighted cognitive score of 27.46 is within the range of the comprehension level of Bloom's Taxonomy. This score is on the high end of the comprehension level, but is still demonstrative of lower order thinking skills.

### Research Hypothesis: HO1: There is no significant difference in the overall mean cognitive level between synchronous and asynchronous online discussion.

A t-test was used to determine if the difference in overall mean weighted cognitive level scores of all synchronous and asynchronous discussions was statistically significant. The t-test used was a matched pair, one-tail t-test. Table 1 details the t-test calculation. The p-value reported was 0.0002, which is less than the alpha of 0.10. The hypothesis was rejected; there is a difference in mean overall weighted cognitive level scores for synchronous and asynchronous groups.

**Table 1. Independent Sample t-test on the Overall Weighted Cognitive Level by Delivery Mode**

| Delivery Mode | n | Mean Weighted Cognitive Score | SD | t-value | df | p-value |
|---|---|---|---|---|---|---|
| Synchronous | 9 | 15.67 | 1.24 | 5.811 | 8 | 0.0002 |
| Asynchronous | 9 | 27.46 | 5.38 | | - | - |

Note. Weighted cognitive scores can range from 10-50.
[a] $p < 0.10$

## Summary

**Question 1 - What is the weighted cognitive level score of student comments made in each synchronous and asynchronous online class discussion?**

For the synchronous delivery mode each discussion was within the knowledge range. While there was one asynchronous delivery class with a score within the knowledge level, and a few at the application level, most asynchronous discussions were at the comprehension level. None of the individual discussion weighted cognitive level scores was indicative of a higher order thinking taxonomic level.

**Question 2 - What is the overall weighted cognitive level score of discussion demonstrated in synchronous and asynchronous online class discussion?**

The overall weighted cognitive level score for all synchronous discussions combined was in the knowledge level of Bloom's Taxonomy (Bloom, 1956). The overall asynchronous weighted cognitive level score was in the comprehension level of the taxonomy. Neither the synchronous nor the asynchronous group produced online discussions which registered a weighted cognitive level score within the higher order thinking range (analysis, synthesis, evaluation).

**Research Hypothesis: HO1: There is no significant difference in the overall mean cognitive level between synchronous and asynchronous online discussion.**

The hypothesis was rejected; there is a significant difference in mean overall weighted cognitive level scores for synchronous and asynchronous groups.

If online distance educators must choose between asynchronous and synchronous discussion, then asynchronous should be chosen because it elicited higher weighted cognitive level scores in this study. Asynchronous discussion may also be better because it provides online students with the temporal flexibility they often desire and the time they need for reflection.

Another recommendation may be to utilize both synchronous and asynchronous delivery for the same group of students during the semester. While cognitive scores were higher for the asynchronous group there appeared to be more interaction and a greater social presence in the synchronous group. Using synchronous discussion occasionally throughout the semester may strengthen the social presence quotient and encourage students to challenge, help, and develop together. There is research to indicate that contact and communication between and among students helps foster a sense of community and connection (Bender, 2003; Lang, 2005; Curtis, 2004; Brown, 2001). Students who feel isolated may be at a disadvantage when it comes to learning, processing, and retention.

Although online and distance education is not a brand new field, there are still significant gaps in the literature. Researchers seem to be just beginning to explore specific techniques, methods, and strategies intended to generate deep, analytical thinking. Additionally, the technology changes so quickly and significantly that new options for content and instructional delivery are very dynamic. Changes in logistics may always allow for innovation, however, that should not prevent practitioners from researching current procedures. Finding andragogically sound practice for developing higher order and critical thinking skills in online classes will benefit online education greatly.

Replication is the key to being able to make experimental results, such as these, broadly generalizable. To that end, studies that specifically utilize the FTCB and the weighting system should be conducted to strengthen these results. Other studies regarding teaching methods that elicit higher order thinking skills, especially those conducted in online scenarios should be undertaken. If there is an advantage to one delivery method or the other (synchronous or asynchronous) it would be beneficial for improving the cognitive level (and therefore the quality, depending on objectives) of online discussion. Such an advantage can only be indicated based on empirical evidence. It would benefit the field of distance education to conduct research to try and ascertain this empirical evidence.

This research indicates that these discussions were primarily at lower cognitive levels, which is similar to results regarding cognitive levels of instruction found in the Whittington studies (Whittington, (1991); Whittington, and Newcomb, (1993); Whittington, (1995); Whittington et al.,1997); Ewing, Whittington, (2009). A desired level of higher order thinking skills was not pre-established, but comparisons to other cognitive level studies show these percentages to be below instructor's desired levels of cognition (as were the assessed cognitive levels in the studies). If, in fact, these students are unable or unprepared to utilize analytical thinking skills they may be insufficiently prepared for future jobs or job changes (AMA, 2010). Research indicates (Hansen and Hansen, 2007; SHRM, 2008) that employers are seeking employees proficient in analysis, able to synthesize new and changing information, and able to evaluate what needs to be done to accomplish tasks and solve problems. The results from this study in isolation do not indicate a higher order thinking skills crisis, but if they are part of a trend, future employers may have to spend more training dollars in developing missing skills (Kreitzberg and Kreitzberg, 2009). Educational programs that are able to establish and build higher order and critical thinking skills in students will graduate learners who are highly sought by employers (NCR CTE, 2010).

Distance education classes provide opportunities for learning focused social interaction to be available to almost every student when and where it is convenient for that student (Lang, 2005). If higher order and critical thinking skills were not demonstrated in these discussions, then the participating students may not have identified the discussions as socially interactive. It is possible that these students, many of whom take mostly distance classes, are not willing to engage and/or are not looking for a social component to their studies.

While neither group demonstrated anything but small forays into higher order and critical thinking skills, the asynchronous group did have a higher weighted cognitive level score overall and in each discussion. Given these results it seems that allowing time for reflection, processing, and or editing and review of discussion comments before posting, as occurs in asynchronous discussion, results in higher weighted cognitive behavior for discussants.

This study was at the exploratory level, and as such provides but a glimpse into the cognitive behaviors of online discussion students. Only when it is combined with additional studies of the same and similar type can irrefutable conclusions be drawn.

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# Student Achievement in an Equine Science Class: A Comparison of Lecture and Lab-based Outcomes

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## Abstract

The purpose of this study was to compare the effect of exposure to lab-based instruction to lecture-based instruction on student achievement as evidenced by test scores. Pre and post-tests were administered at the beginning and end of a 15-week long semester and student demographics, including previous experience with horses and horse ownership, were used to further examine the data. Both methods revealed increases in student test scores, but the lecture-based method showed a greater increase. The lab environment may have distracted the students and influenced the marginal growth in test scores for students participating in the labs. Students who owned horses may have already been familiar with the barn environment and been distracted (disengaged) with the information being shared in lab. The newness of the barn environment may have distracted non-horse owners from fully engaging with the content being shared in lab and resulted in little growth in test scores. These results suggest that equine labs may be more effective if separated into beginner and experienced sections. Additional research is needed to further understand this phenomenon.

## Introduction

Aristotle once said, "For the things we have to learn before we can do them, we learn by doing them." Agricultural education (K-12 and college) has evolved over the past century and now integrates more methods of instruction than ever before (Newsome et al., 2005). Examples of pedagogical methods used in the agricultural sciences include the following: 1.Informal instruction - a conversation between student and teacher to acquire and distribute information; 2. Direct instruction - more formal and includes the lecture-based method of teaching often used with large lecture sections with typically little hands-on experiences for students; 3. Inquiry-based learning (critical thinking, problem-based learning, hands-on learning, and experiential learning) - adaptable and can be modified to students of all academic levels; 4. Cooperative learning - uses small groups to accomplish tasks; and 5. Information processing strategies - used to assist students in memorizing important facts and can include graphic organizers, mind maps, and story webs. With a cadre of pedagogical options available to teachers, selecting the most appropriate teaching method depends heavily on the educational situation (Doyle and Carter, 1987).

The experiential teaching method is one that is often referred to as hands-on or problem-based teaching. There is a common adage attached to experiential learning, "Tell me and I will forget, show me and I may remember, involve me and I will understand," (Confucius). David Kolb (1984), an educational theorist, stated that knowledge is gained through personal and environmental experiences. Most of the dimensions of experiential teaching are analysis, initiative, and immersion; while other forms of academic learning are focused on structure and reproductive learning (Ewing and Whittington, 2007). Experiential teaching is trying to create an experience for the student to learn from (Day et al., 1998). Understanding the environment where the experience is to occur and its potential novelty is crucial to ensuring that distractions are minimized and uninterrupted learning can occur. However, little is known about the influence of potential distractions in a non-classroom based learning environment and this lack of information prompted this study.

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## Theoretical Framework

The theory base for this study was constructed around David Kolb's (1984) work with experiential learning. The first stage, *concrete experience* (CE), is where the learner actively experiences an activity such as a lab session or field work. The second stage, *reflective observation* (RO), is when the learner consciously reflects back on that experience. The third stage, *abstract conceptualization* (AC), is where the learner attempts to conceptualize a theory or model of what is observed. The fourth stage, *active experimentation* (AE), is where the learner is trying to plan how to test a model or theory or plan for a forthcoming experience (Kolb, 1984. p. 38). However, the model does not reflect the novelty of the learning environment and associated potential distractions which could influence learning outcomes.

Previous research has shown that the teaching method used can influence student achievement (Day et al., 1998; Newsome et al., 2005; Wulff-Risner and Stewart, 1997). Instructional theory suggests that creating a diverse instructional system will promote learning, but could the learning environment be so diverse that it limits student achievement? An early study by Borzak (1981) found that active experimentations allow students to take an active role in their learning; therefore "owning" their knowledge. This ownership happened more with the experiments than with the knowledge learned in lecture classes. With this increase in knowledge, it is assumed, there will be an increase in achievement. However, there have been studies (Brown, 1998; Burris, 2005) showing that students instructed using the problem-based approach during lecture classes also increase knowledge, subsequently increasing achievement (Sundblad et al., 2002). Studies have also found that when students are physically connected with material and more physically active in the classroom, they will retain more information (Burris, 2005; Hancock and Wingert, 1996). Can this "classroom" include a barn-based lab environment? There has been limited research studying the impact of lab-based environments on achievement. Results from a study done to measure the effect of previous equine experience on performance in an introductory level equine science class showed that previous experience had no impact on final grade; although, students with previous equine experience did not appear to have to work as hard to achieve the same grades (Pratt-Phillips and Schmitt, 2010). Additional information is needed to determine whether the learning environment can influence student achievement.

The purpose of this study was to compare the effect of exposure to lab-based instruction to lecture-based instruction on student achievement in an upper level equine management course at a land-grant university. The objectives and methodology are described below.

## Objectives

The objectives of this study were the following:

1. Determine the effects of the experiential teaching method (barn-based lab) on students' achievement rates in an undergraduate equine management course;
2. Determine the effects of a lecture-based teaching method on students' achievement rate in an undergraduate equine management course; and
3. Determine if specific student demographic characteristics influence student achievement for either teaching method.

## Methodology

This study was a comparison of the experiential (lab-based) and lecture-based teaching methods as related to student achievement on identical pre- and post-tests. A quasi-experimental, one group comparison design was established using pre and post-test results for an undergraduate equine management course at the University of Georgia. Additionally, demographic information, including previous horse experience and horse ownership, of the student participants, was collected. The experiential teaching method consisted of a hands-on laboratory style teaching environment where students participated in various activities with horses in a barn environment for approximately three hours per week during a fifteen-week semester. The students spent the first twenty minutes of the lab session in a classroom setting discussing the topic of the day and addressing any concerns associated with the lab work. The lecture-based teaching environment was strictly professor led and consisted of using PowerPoint slides and non-participatory teaching methods. The information discussed in the lab sections was previously discussed in the lecture section. Both the lab and lecture sections were taught by the same instructor to control for the potential influence of teaching style on learning outcomes. Twenty-one upper-level undergraduate students participated in both the lecture and lab sessions.

Data was collected during the first and last day of the semester, with approximately fifteen weeks between data collection for both teaching environments. The two-part survey instrument was designed to measure student achievement concerning knowledge of equine science and care, and collect demographic data. The professor in charge of the course designed the instrument to ensure that the questions were appropriate and effective in measuring student knowledge and comprehension. Additionally, questions were designed to reflect the nature of the content presented in the lecture and laboratory sections and build content validity of the instruments Having a pre-test safeguarded the threat of prior knowledge from affecting the outcome of the study and provided baseline data for comparison. The researcher scored all tests using an answer key, provided by the course instructor, to eliminate the threat of scorer variability as items were both quantitative and qualitative in nature.

Descriptive statistics, including frequencies, means, and standard deviations, and paired samples *t*-tests were calculated using the Statistical Package for the Social Sciences (SPSS) Version 18.0. Pre and post-test summated scores were created and growth scores (comparing post and pre scores) were calculated to determine the amount of change in students between pre and post measurements. Participant demographics, including whether they owned a horse, had taken previous equine science courses, and self-reported prior horse knowledge, were used as contextual variables to further compare scores.

## Results and Discussion

### Objectives 1 and 2: Determine the effects of the experiential and lecture-based teaching methods on students' achievement in an equine science course.

The researcher used a paired samples t-test to analyze the lab data and test for significant differences between pre- and post-test means. Both the lab-based ($t$ = -6.67; $df$ = 20; $p$ = 0.000) and lecture-based learning environments ($t$ = -12.08; $df$ = 20; $p$ = 0.000) produced statistically significant gains in knowledge scores at the 0.05 level (see Table 1). Specifically, on all but one question, student test scores on the pre-test and post-test increased. However, the lecture-based instruction produced larger gains in test scores between the pre- and post-test (average gain following laboratory-based instruction = 7.25; average gain following lecture-based instruction = 12).

**Table 1. Changes in Test Scores Following Exposure to Either Laboratory-based or Lecture-based Instruction (n = 21 students)**

| Laboratory-based Instruction | | | Lecture-based Instruction | | |
|---|---|---|---|---|---|
| Question | Pre-test Correct f (%) | Post-test Correct f (%) | Question | Pre-test Correct f (%) | Post-test Correct f (%) |
| 1 | 7 (33.3) | 12 (57.1) | 1 | 10 (47.6) | 20 (95.2) |
| 2 | 1 (4.8) | 11 (52.4) | 2 | 2 (9.5) | 16 (76.2) |
| 3 | 2 (9.5) | 19 (90.5) | 3 | 6 (28.6) | 17 (81.0) |
| 4 | 10 (47.6) | 13 (61.9) | 4 | 11 (52.4) | 20 (95.2) |
| 5 | 6 (28.6) | 19 (90.5) | 5 | 3 (14.3) | 19 (90.5) |
| 6 | 1 (4.8) | 2 (9.5) | 6 | 0 (0) | 7 (33.3) |
| 7 | 13 (61.9) | 13 (61.9) | 7 | 3 (14.3) | 20 (95.2) |
| 8 | 3 (14.3) | 12 (57.1) | -- | -- | -- |

Note. The laboratory test contained eight questions and the lecture test contained seven questions, each worth one point.

**Table 2. Comparison of Lecture-based and Laboratory-based Instruction Methods for Students Who Owned Horses**

| Instruction Method | Mean (SD) | t-value | P-value | Effect Size |
|---|---|---|---|---|
| Lecture-based Pre-Score | 1.70 (1.42) | -7.13 | < 0.0001 | Large |
| Lecture-based Post-Score | 5.60 (1.26) | | | |
| Laboratory-based Pre-Score | 2.70 (1.34) | -3.04 | 0.014 | Large |
| Laboratory-based Post-Score | 4.50 (1.43) | | | |

Note. The maximum possible score on the laboratory test was 8 points and the maximum possible score on the lecture test was 7 points.

The lecture-based teaching environment showed more of an increase in student achievement than the lab section and student post-test scores were higher for the lecture-based teaching environment than the lab section. Comparing growth scores and post-test scores for the lab and lecture sections resulted in statistically significant differences ($t$ = -2.81, $P$ = 0.011, effect size = large). A cadre of researchers have concluded that experiential teaching methods can have an impact on student achievement in comparison to the standard lecture-based classroom (Burris, 2005; Hancock and Wingert, 1996). Results of this study are contradictory to the aforementioned belief. Even though students improved academically with both types of instruction, their achievement rates were higher for the lecture-based instruction.

There may be a few reasons why the experiential learning showed less of an increase in achievement. One reason may be a "distractor factor." When students are in an outdoor (barn) environment with live animals there are many more things to look at and pay attention to than just the instructor. In the large group setting (21 students) it was easy for students in the back of the group to talk to each other without the instructor noticing. The weather may have played a part in the "distractor factor" as students may lose focus if they are too hot or cold. Drozdenko et al. (2012) found students talking in class, and temperature (too hot/cold) to be in the top three out of 36 distractions for a classroom. Outdoor humidity has been shown to have a positive effect on emotions such as frustration and sadness while solar radiation has a negative effect on sadness (Ciucci et al., 2011). Note taking in a laboratory section was also decreased, compared to a lecture, as most of the activities were hands-on and students were primarily standing in a barn, arena, or pasture and had nothing to write on such as a desk. Also, the topics addressed in the lab sections were previously touched on in the lecture section, this may have led to the increased lecture scores because students were having lecture material reinforced by the lab sections. Finally, the lecture-based instruction may have increased scores more due to the instructional methods of the instructor. The instructor asked a lot of questions during lecture and strongly encouraged students to be active learners and participate in the class. Due to laboratory activities there were fewer questions asked during labs. Critical thinking is a large component of any classroom, including it in lecture may increase achievement by making students think on their own while learning through lecture (Richardson, 2003). Understanding what is being taught instead of just possessing the knowledge will increase achievement with any teaching method.

### Objective 3: Determine if specific demographic characteristics influence student achievement for either teaching method.

Nine participants (43%) reported owning horses. Horse ownership played a role in the rate of achievement for the experiential (lab) teaching environment (see Table 2). Horse owners' experienced larger gains in test scores from lecture-based instruction compared to laboratory-based instruction (see Table 2). Although not shown, non-horse owners' post-test mean scores for both lab and lecture were higher in comparison to participants who owned a horse(s). This could be attributed to horse owners relying on prior knowledge, and not taking as many notes or studying as hard as non-horse owners.

**Table 3. Comparison of Lecture-based and Laboratory-based Instruction Methods for Students with No Previous Equine Course Exposure**

| Instruction Method | Mean (SD) | t-value | P-value | Effect Size |
|---|---|---|---|---|
| Lecture-based Pre-Score | 0.83 (0.41) | -13.69 | < 0.0001 | Large |
| Lecture-based Post-Score | 5.83 (0.75) | | | |
| Laboratory-based Pre-Score | 1.67 (1.63) | -2.37 | 0.064 | Large |
| Laboratory-based Post-Score | 4.17 (1.83) | | | |

Note. The maximum possible score on the laboratory test was 8 points and the maximum possible score on the lecture test was 7 points.

**Table 4. Comparison of Lecture-based and Laboratory-based Instruction Methods for Students with No Prior Experience with Horses Through Extracurricular Activities**

| Instruction Method | Mean (SD) | t-value | P-value | Effect Size |
|---|---|---|---|---|
| Lecture-based Pre-Score | 1.22 (0.44) | -9.73 | < 0.0001 | Large |
| Lecture-based Post-Score | 5.44 (1.33) | | | |
| Laboratory-based Pre-Score | 1.33 (1.00) | -7.49 | < 0.0001 | Large |
| Laboratory-based Post-Score | 4.89 (1.17) | | | |

Note. The maximum possible score on the laboratory test was 8 points and the maximum possible score on the lecture test was 7 points.

The influence of prior equine class participation on student achievement was also examined. Fifteen students reported previously taking an equine science class. Examples of classes included, but were not limited to: Pleasure Horse Management, and Equine Nutrition and Exercise Physiology. Participants who reported no previous equine course exposure exhibited a substantial increase in rate of achievement following exposure to lecture-based instruction when compared to laboratory-based instruction (see Table 3). The reasons for this are probably similar to, if not the same as, the reasons given for Objectives 1 and 2.

Finally, the influence of prior experience with horses through extracurricular activities on student achievement was examined. Again, students reporting no prior experience with horses through extracurricular activities showed higher and statistically significant gains in scores following lecture-based instruction compared to laboratory-based instruction (see Table 4).

## Summary/Implications

The purpose of this research was to determine the impact on student achievement following exposure to a fifteen-week lab (experiential learning experience) and fifteen-week lecture-based instruction. As evidenced in Table 1, students increased their performance during their fifteen weeks of instruction for both lecture and experiential based learning environments. Students with no prior horse experience, either through horse ownership or equine course attendance, had higher increases in achievement in lecture-based instruction (compared to laboratory-based) as well as greater increases than students with prior equine experience or class attendance.

The greater increase in achievement for the lecture-based instruction was possibly due to a "distractor factor". Taking this into consideration, having a very structured lab setting may have a positive effect on the increased rate of achievement. The instructor may choose to break students of comparable ability into smaller groups to lower the risk of distractions or having student with more prior knowledge lead a discussion for a smaller group. The instructor may also want to spend more time away from the live animals and distractions by having an indoor classroom to meet in before and after to go over expectations and reflect on what the students should have learned. Environmental factors may be reduced by using areas such as an indoor arena, or closing barn doors. The instructor should also strongly encourage the students to bring clipboards and take extensive notes during a laboratory session. Having a study to show different types of lab settings, some more controlled than others, would be ideal.

Future research should increase the sample size and the longevity of the study. The results in every objective were statistically significant with small standard deviations. This leads one to believe that a larger sample size will just solidify more what was found in this study. There should also be a control group used to establish a baseline for knowledge prior to instruction. Having different types of lecture such as multiple instructors or guest speakers, having a more varied sample (ethnicity, SES, etc), and lecture setting may result in different outcomes. Also, when giving pre-tests, the teacher can never be completely positive that he/she will cover everything that was tested. With this in mind, the instruments used to test the rates of achievement could be more structured in the future (i.e. making sure that everything tested was covered with same emphasis on each item).

Finally, something also worth noting is that there were eight lab related questions and seven lecture related questions on the pre and post-test. Re-analyzing the data and deleting one question from the lab questions may yield different results as far as the significance, means, and frequencies. Going back and checking for questions missed frequently and confirming that everything on the tests was covered in class is a necessity also. Using different instruments to test for achievement may also help. A future study could combine problem-based learning, critical thinking, and reflection to see if different results are found. Combining as many proven teaching methods as possible may give teachers more resources to pull from if they see one thing is not working for a class.

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# Differential Impacts of Online Delivery Methods on Student Learning: A Case Study in Biorenewables[1]

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## Abstract

In 2007, a Virtual Education Center for Biorenewable Resources was initiated that offered three distance education courses, one being Biorenewable Resources and Technology (BRT) 501 – Fundamentals of Biorenewable Resources and Technology, the subject of this study. The primary objective was to determine if course delivery method (video lecture format and the other in menu-driven auto-tutorial presentations (MDAP) delivered via Flash format), student major (agricultural and non-agricultural), and gender influence online student learning in BRT 501. We found that BRT 501 student performance was not significantly impacted by module delivery method. Students with agricultural majors were outperformed by students with non-agricultural majors, most of whom were engineering students, on the midterm and final exams, and course grade. Gender differences seen on the biomass-module first-attempt total quiz score disappeared for the final total quiz score on that module.

## Introduction

Technology has been a driver in the advancement of distance education throughout its history, from mail correspondence courses in the 1700s (Jeffries, 2010) to phonograph records in the early 1900s (University of Wisconsin Extension, 2005) and television which peaked in the 1970s (Jeffries, 2010) to the Internet used to deliver massive open online courses today (MOOC) (DeSantis, 2012). The number of students that take at least one higher education course online has grown from 9.6% of total enrollment in fall 2002 to 32% of total enrollment in fall 2011 (Allen and Seaman, 2013). Students desire more flexibility (Mills and Xu, 2005), particularly non-traditional students (Arbaugh and Duray, 2002) who are expected to make up most of the student population increase by 2020 (Hussar and Bailey, 2011). Online courses provide students with flexibility and better access to courses, which was positively associated with student learning and satisfaction (Arbaugh, 2005; O'Malley and McCraw, 1999). Early studies comparing student learning in face-to-face and online environments favored the latter, but many recent studies show no significant difference between them (Bourne et al., 2005; Chen and Jones, 2007; Hoadley, 2009; Terry et al., 2015).

New delivery technologies and online education pedagogical advancements have been instrumental in improving the quality of online instruction (Mirriahi and Alonzo, 2015). Internet technologies allow hybrid and online courses to offer easy access to a wide array of outside resources such as videos, articles, and links to other materials (Hoadley, 2009; Hanover, 2009).

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Terry et al. (2015) found this was a two-way street; students could record videos, presentations, and team activities and then upload them for the instructor and classmates. Online technologies enable asynchronous discussions and collaborations by graduate students, leading to improved learning and scholarship (Bowden, 2012). Mirriahi and Alonzo (2015) note that expansion of mobile technology use by students continues to create opportunities for additional distribution methods and course customization. This study compared two methods of content distribution.

In 2007, a Virtual Education Center for Biorenewable Resources (VEC) was initiated by Iowa State University, the University of Idaho, and the University of Kentucky and offered three online courses, including Biorenewable Resources and Technology (BRT) 501 – Fundamentals of Biorenewable Resources and Technology (Raman et al., 2006). BRT 501 was co-taught by faculty from all three institutions. The BRT 501 syllabus described the course as an introduction "to the science and engineering of converting biorenewable resources into bioenergy and biobased products" (Raman, 2010). Course topics covered the entire biorenewables system from biomass production through biomass conversion to products as well as economics. This study took place during biomass production, which covered production and economics for corn, soybean, hay and forages, and short rotation woody crops as well as a brief introduction to biotechnology.

### Goal

The goal of this study was to determine if student learning in BRT 501 was influenced by course delivery method. Two methods were used: (1) video lectures and (2) menu-driven auto-tutorial presentations (MDAP) delivered via Flash. The influence of student major and gender on learning were also studied.

## Materials and Methods

Dr. D. Raj Raman, then Associate Professor, Department of Agricultural and Biosystems Engineering and Associate Director of Educational Programs, Bioeconomy Institute, was the primary lecturer for BRT 501 and Katrina Christiansen, then Graduate Research Assistant, Department of Agricultural and Biosystems Engineering, served as the graduate teaching assistant. Darren Jarboe, then Program Manager for the Center for Crops Utilization Research and Ph.D. candidate in Industrial and Agricultural Technology, served as a special lecturer for the biomass production module, the section of the course during which the data for this study were collected. Jarboe and Raman developed the content for the biomass production module. The BRT 501 biomass production module content was delivered to students through WebCT using video lecture or MDAP. Raman and Christiansen wrote all the exam and quiz questions, including for the biomass production module. Jarboe reviewed the biomass production module exam and quiz questions. This study was deemed exempt by the Iowa State University Institutional Review Board for Human Subjects.

The standard for online delivery of BRT 501 content was an asynchronous video lecture with use of a tablet computer and pen to annotate, draw, and make calculations onscreen. The VEC was interested in exploring alternative content delivery methods and many were available. A Millward Brown (2009) survey conducted in December 2009 for Adobe Corporation estimated the Flash plug-in was on 99% of computers in mature markets, which represented 73% of the world's Internet users. Other media plug-ins with significant market share were Oracle Java (77%), Apple Quicktime Player (61%), and Adobe Shockwave Player (52%). Statowl.com (2010) showed the Adobe Flash plugin on 97% of computers, followed by Oracle Java (79%), Microsoft Windows Media Player (67%), and Apple Quicktime Player (60%). Flash was selected as the alternative delivery technology due to its widespread adoption.

Following course protocol, the biomass production lectures were released to students one at a time and the corresponding quiz was posted simultaneously. The quiz for each lecture remained available to students for two weeks. Students took BRT 501 quizzes using WebCT. Questions were in the form of true-false, multiple choice, matching, fill-in-the-blank, and calculation problems. In virtually all cases, the multiple choice and matching problems had randomized orders of responses, and the calculated problems had WebCT-generated parameter values so each student had a different set of numbers with which to work. The quizzes were graded by the software, scores were available to students immediately, and grades were posted to the WebCT grade book. Part I of the final exam, eleven questions, covered the material in the biomass production module. All grade data were downloaded from the grade book for analysis.

### Participants

The Iowa State BRT 501 course had 51 students enrolled for spring semester, 44 on-campus and seven online. Four students, three on-campus and one online, dropped the course prior to the biomass production module. One on-campus student chose not to take the biomass production module quizzes and was dropped from the analysis. Students were enrolled as graduate students (42) and upper-level undergraduate students (4) from various majors, most of which were technical in nature (e.g., engineering, agronomy).

BRT 501 students were predominately from mechanical engineering (ME) (33%) and agricultural and biosystems engineering (ABE) (30%). Students from chemical and biological engineering (CBE) and agronomy/horticulture (Agron/Hort) each made up 9% of students, and 4% of students were from civil, construction, and environmental engineering (CCEE). Seven students (15%) were from a major other than these five or undeclared. Ten students were female and 36 were male.

Bohn and Wolfe (1992) found that using ranking was better for non-parametric methods of data analysis than simple random sampling. Thus, after the course midterm exam, the 46 BRT 501 students were ranked based on academic performance in the first half of the class and then students were split into two groups based on their ranking. Students ranked 1, 4, 5, 8… were assigned to Group 1 while those ranked 2, 3, 6, 7… were assigned to Group 2. The serpentine method used is a form of randomly assigning students to groups (Horn, 2012). Adjustments to the groupings were made to balance for gender. A Wilcoxon rank-sum test was conducted on midterm scores to determine if the students in Group 1 (video lecture) and Group 2 (MDAP) had similar performance on assessment scores up to and including the midterm exam (Horn, 2012). The results indicated no significant difference, $z = 0.00$, $p < 1.00$. The mean ranks in Group 1 and Group 2 were each 23.5. Also, the two group's midterm exams were compared using a t-test and no significant difference was detected ($p < 0.81$).

Group 1 received the biomass production module through standard course video lectures and Group 2 received the MDAP. Both delivery modes contained nearly identical information presented as text, tables, and images. The video lecture content was delivered as a sequence of slides with voiceover and the MDAP content was delivered as slides through a menu driven Flash presentation with text. The written material was identical and the video voiceover followed the text written for the MDAP. PDFs of the slides for each lecture were available to all students. Furthermore, the slides included links to outside resources such as videos and animations, which were accessible to students in both groups.

## BRT 501, the Course

New online BRT 501 course video lectures and MDAP covering seven class periods were developed for the biomass production module. The content covered was:

- Production of herbaceous biomass: corn, soybean, and hay and forages
- Production of woody biomass: coppices and trees
- Transgenic plants

The lectures for each biomass crop included crop history; plant and seed nomenclature; classification; crop composition; biomass production operations; land quality and value; crop rotation; calculating costs of production; and challenges, advantages, and outlook. The biomass production content was delivered to students through WebCT starting in the ninth week of the semester and ending in the eleventh week. The presentations used slides with text, images, example problems, and internet videos. The videos demonstrated biomass production machinery and production practices. The course was not closed captioned, but if a student with a disability had requested this type of accommodation the university would have provided it.

WebCT had a feature that allowed content delivery to specific groups, which was used to provide the video lectures to Group 1 and the MDAP to Group 2. After the biomass production presentations were completed and all quiz attempts made, the content from both delivery platforms was available to all students.

Course assessments were WebCT-based quizzes, which reinforced student understanding of the course material and prepared students for exams, as well as the midterm and final exams. The biomass production module quizzes were given after the midterm exam; therefore, only the final exam contained biomass production questions. All course assessments were WebCT-based, timed, open-book, unproctored, and on the honor system. WebCT functions created unique assessments for each student as previously noted.

## Data Collection and Analysis

Assessment and grade data were collected from the WebCT grade book for all 46 students. BRT 501 student assessment data were collected for: all quiz attempt scores, midterm exam score, and final exam score. Student grades were also gathered. These were selected because they are good measures of student performance (Angus and Watson, 2009; Smith, 2007). The grade book also identified students as on-campus or online. Student classification as graduate or undergraduate; engineering or non-engineering major; and gender were also gathered from university records and information on the Internet.

Quizzes were developed and delivered to students to assess their acquisition of the biomass production module information presented. Frequent online assessments have been shown highly correlated with final exam or other summative assessment performance (Bonham et al., 2003; Smith, 2007). Raman and Christiansen developed the quizzes for all BRT 501 modules. The biomass production module quizzes were generated by Christiansen with oversight from Raman and Jarboe. This was done to maintain consistency in question style and type of content selected for assessments. Quizzes were given through WebCT and students had two weeks to take each quiz as many times as desired until they were satisfied with their score. A total of 30 quizzes were given in BRT 501, six of which covered biomass production module content.

The final exam questions were developed by Christiansen and Raman and the biomass-module questions were reviewed by Jarboe. Eleven questions on the final exam covered biomass production content and were worth 31% of the total points.

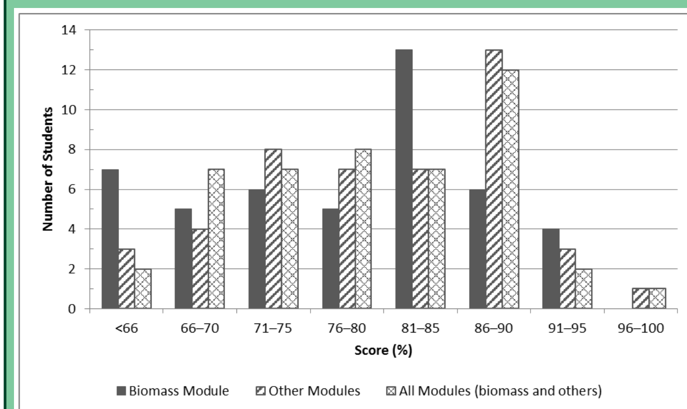
SAS Enterprise Guide 4.3 functions including summary statistics, correlations, and t-test were used to analyze the data collected. The mean, coefficient of variation, median, and range were calculated to determine the central tendency and distribution for each variable (Bryman and Cramer, 2009). The Pearson's product moment correlation coefficients were calculated to identify positive (stronger as it approaches 1) or negative (stronger as it approaches -1) relationships between two variables (Bryman and Cramer, 2009; University of California at Los Angeles, 2010). A t-test was used to assess if there was a statistically significant difference between the means for two unrelated samples and the p-value from the t-test was used to indicate statistical significance (Bryman and Cramer, 2009). Confidence intervals at the 95% level were calculated for the two population means, giving the range in which the mean was expected to fall.

Table 1. Summary statistics for BRT 501 student scores (in points unless noted).

| Student Variables | Mean | Mean (%) | Coefficient of Variation (%) | Median | Range | | Total Possible |
|---|---|---|---|---|---|---|---|
| | | | | | Minimum | Maximum | |
| **Biomass-module quiz scores** | | | | | | | |
| First-attempt total | 395 | 77.5 | 14.9 | 409 | 230 | 480 | 510 |
| Final total | 506 | 99.2 | 3.6 | 510 | 390 | 510 | 510 |
| **Score on remaining modules quizzes** | | | | | | | |
| First-attempt total | 1,509 | 80.3 | 11.3 | 1,562 | 1,135 | 1,820 | 1,880 |
| Final total | 1,842 | 98.0 | 3.4 | 1,860 | 1,472 | 1,880 | 1,880 |
| **Score on all quizzes** | | | | | | | |
| First-attempt total | 1,905 | 79.7 | 11.1 | 1,904 | 1,408 | 2,300 | 2,390 |
| Final total | 2,348 | 98.3 | 2.8 | 2,370 | 1,968 | 2,390 | 2,390 |
| Midterm exam score | 85.3 | 85.3 | 12.1 | 89.0 | 65.0 | 100.0 | 100.0 |
| Final exam score | 90.6 | 90.6 | 8.8 | 93.2 | 59.7 | 99.8 | 100.0 |
| Biomass-module final exam question score | 29.9 | 96.5 | 6.7 | 31.0 | 22.4 | 31.0 | 31.0 |
| Course grade | 3.57 | 89.3 | 15.1 | 3.67 | 1.33 | 4.00 | 4.00 |

n = 46

Figure 1. Distribution of student total scores for first quiz attempt on the biomass module, remaining modules, and on all modules.




Summary statistics (sample mean, coefficient of variation, median, and range) were computed for the following variables: (a) first-attempt total quiz score on the biomass module, (b) final total quiz score on the biomass module, (c) first-attempt total quiz score on remaining modules, (d) final total quiz score on remaining modules, (e) first-attempt total quiz score on all modules (biomass and others), (f) final attempt total quiz score on all modules (biomass and others), (g) midterm exam score, (h) final exam score, (i) course grade, and (j) final exam score on biomass production module questions. Correlations for these variables were also computed and analyzed. A t-test was conducted to determine if student performance on these variables was statistically different for three treatment classifications: delivery method, student major, and gender. Delivery method compared students in Group 1 and Group 2. Student major grouped students into those with an agricultural major (e.g., agricultural and biosystems engineering, agronomy) and those with a non-agricultural major (e.g., chemical and biological engineering, mechanical engineering). Students were also grouped by gender.

## Results and Discussion

### Overall Student Performance

Data were broken into ten student variables that <were calculated for all students taking BRT 501 (items a–j as described above). These variables enabled comparisons among teaching modules, delivery technologies, student major, and gender.

Summary statistics calculated for each student variable are summarized in table 1. Figure 1 shows the distribution of student scores for the first-attempt total quiz score on the biomass module. All but one student scored 96% or more for the final total quiz score on the biomass module. Figure 1 also shows the distribution of student scores for the first-attempt total quiz score on remaining modules. For the final total quiz score on remaining modules, 43 of 46 students scored over 96%, two additional students scored over 91%, and one student scored under 80%.

The first-attempt total quiz score on the biomass module was slightly lower than for the remaining course modules (77.5% vs. 80.3%). This trend was reversed for the final quiz score mean, which was slightly higher for the biomass-module than for the remaining course modules (99.2% vs. 98.0%). The material was likely new for the majority of the class and may have led to the relatively lower first-attempt scores. It also indicates that students were motivated to do the work necessary to increase their score and improve their course grade.

Figure 1 shows the distribution of student scores for the first-attempt total quiz score on all modules (biomass and others). Only four students scored less than 96% for the final attempt total quiz score on all modules (biomass and others), three scoring 91% or more and the remaining student scoring over 80%. The median scores for the final total quiz score for the biomass and remaining modules show a majority of students had extremely high scores, 99.2% and 98.0%, respectively.

The midterm exam was taken in week 8, prior to the biomass production module, and the final exam was taken in week 16. Figure 2 shows the midterm and final exam score distributions for students, respectively. The mean score for the biomass production module final exam questions total score was 29.9 of a possible 31 points (96.4%) with a range of 22.4 to 31.

Figure 2. Distribution of student midterm and final exam scores.

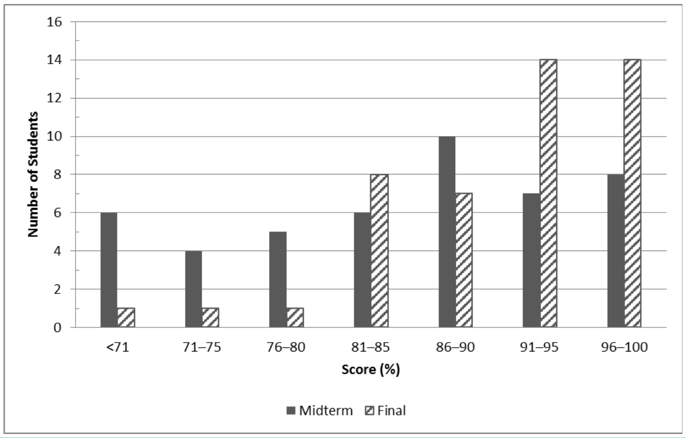
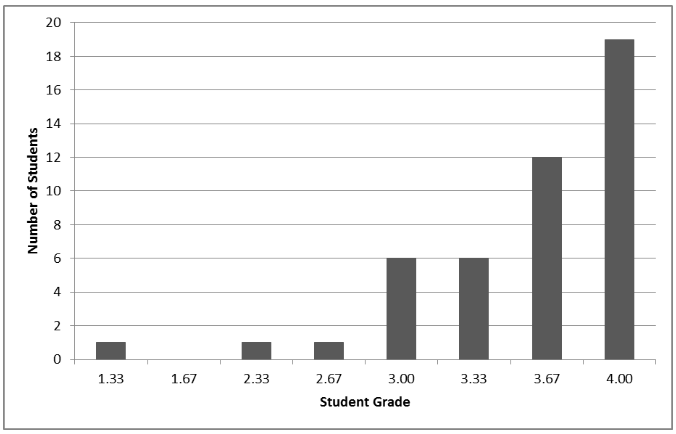



Figure 3. Frequency of course grades earned by BRT 501 students.




The course grade students received was derived from weighted assessment scores on quizzes (15%), project (20%), midterm exam (30%), and final exam (35%) (Raman, 2010). Figure 3 shows the distribution of student grades. The grades were on a four-point scale with A = 4, B = 3, C = 2, and D = 1. The 0.33 values are "+" the grade immediately below, while the 0.67 values are "–" the grade immediately above. Student performance on assessments was extremely high, with a few exceptions. This was expected in a survey course like BRT 501 where one major goal of the course is to expose students to the entire biorenewable resources and technology system. The modules do not go into such great depth that graduate students cannot understand the material, yet students are informed about ways they can integrate their research with other disciplines.

Pearson product moment correlation coefficients for the project variables are given in table 2. Since the midterm and final exam made up 30% and 35% of the course grade, respectively, it was expected that student performance on the exams would relate strongly to course grade. The lack of significant correlation between the first-attempt total quiz score on the biomass module and the midterm exam score, final exam score, and course grade was unexpected since the first-attempt total quiz score on remaining modules was positively correlated with them. This may be because the course focused on science, engineering, and economics up through the midterm exam and the biomass production module covered farming practices.

The first-attempt total quiz score on all modules (biomass and others) was positively correlated with first-attempt total quiz score on the biomass module and remaining modules as well as the midterm exam score, final exam score, and course grade. This was anticipated since Angus and Watson (2009) tested the connection between exposure to online quizzes and end-of-session examination performance and found them linked.

The final total quiz score on the biomass module was positively correlated with the midterm and final exam scores. The final attempt total quiz score on all modules (biomass and others) was positively correlated with the final total quiz score on the biomass module and the first-attempt and final total quiz score on remaining modules. This was expected since these are the two components that make up the final attempt total quiz score on all modules (biomass and others).

The biomass-module final exam question score total was positively correlated with midterm exam score, final exam score, and course grade, but not with first-attempt or final total quiz score on the biomass module. Student performance on the biomass-module final exam questions indicated they fit well with the rest of material on the final exam.

A t-test of means was used to determine if sample means classified by delivery method, student major, and gender were significantly different from each other for the variables studied.

## Delivery Method

Table 3 provides the mean, coefficient of variation, and the 95% confidence interval for the mean for both delivery methods for each variable. The differences in

Table 2. Correlation coefficients for BRT 501 grade book variables.

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Midterm exam score | 1.00 | | | | | | | | | |
| Final exam score | 0.76* | 1.00 | | | | | | | | |
| Course grade | 0.72* | 0.99* | 1.00 | | | | | | | |
| First-attempt total quiz score on the biomass module | 0.24 | 0.25 | 0.23 | 1.00 | | | | | | |
| Final total quiz score on the biomass module | 0.32* | 0.25 | 0.24 | 0.17 | 1.00 | | | | | |
| First-attempt total quiz score on remaining modules | 0.33* | 0.45* | 0.42* | 0.60* | 0.13 | 1.00 | | | | |
| Final total quiz score on remaining modules | 0.05 | 0.16 | 0.16 | -0.09 | 0.10 | 0.27 | 1.00 | | | |
| First-attempt total quiz score on all modules (biomass and others) | 0.33* | 0.43* | 0.41* | 0.76* | 0.15 | 0.98* | 0.20 | 1.00 | | |
| Final attempt total quiz score on all modules (biomass and others) | 0.14 | 0.22 | 0.21 | -0.04 | 0.36* | 0.29* | 0.96* | 0.22 | 1.00 | |
| Biomass-module final exam questions | 0.41* | 0.44* | 0.44* | 0.10 | -0.02 | 0.20 | 0.25 | 0.19 | 0.23 | 1.00 |

Statistically significant at $p < 0.05$.

summary statistics for some variables were large between the two groups. The removal of a low-scoring outlier in the video lecture group would have eliminated much of this difference and would not have had a meaningful impact on t-test significance. The decision was made to include the observation.

Delivery method t-scores indicate student performance was not significantly impacted by the module delivery method. The reason for this may be that participants were graduate students or undergraduate upper classmen who were high ability students. Similarly, Offir et al. (2008) found that high ability students could overcome the learning environment and be successful.

**Table 3. Student performance by delivery method.**

| Variable | Delivery Method | N | Mean | Coefficient of Variation (%) | 95% Confidence Level Mean |
|---|---|---|---|---|---|
| First-attempt total quiz score on the biomass module | Video | 23 | 392 | 14.7 | 368–418 |
| | MDAP | 23 | 398 | 15.3 | 372–424 |
| Final total quiz score on the biomass module | Video | 23 | 503 | 5.0 | 492–514 |
| | MDAP | 23 | 509 | 1.0 | 506–511 |
| First-attempt total quiz score on remaining modules | Video | 23 | 1,526 | 12.1 | 1,446–1,606 |
| | MDAP | 23 | 1,521 | 13.6 | 1,432–1,611 |
| Final total quiz score on remaining modules | Video | 23 | 1,830 | 4.7 | 1,793–1,868 |
| | MDAP | 23 | 1,855 | 0.8 | 1,848–1,861 |
| First-attempt total quiz score on all modules (biomass and others) | Video | 23 | 1,919 | 11.6 | 1,822–2,015 |
| | MDAP | 23 | 1,920 | 12.9 | 1,812–2,027 |
| Final attempt total quiz score on all modules (biomass and others) | Video | 23 | 2,333 | 3.9 | 2,294–2,373 |
| | MDAP | 23 | 2,363 | 0.7 | 2,356–2,370 |
| Midterm exam score | Video | 23 | 85.0 | 12.2 | 80.5–89.5 |
| | MDAP | 23 | 85.7 | 12.1 | 81.2–90.2 |
| Final exam score | Video | 23 | 91.1 | 6.5 | 88.5–93.7 |
| | MDAP | 23 | 90.2 | 11.0 | 85.9–94.4 |
| Biomass final exam question score | Video | 23 | 29.4 | 7.8 | 28.4–30.3 |
| | MDAP | 23 | 30.4 | 4.9 | 29.8–31.1 |
| Course grade | Video | 23 | 3.59 | 10.6 | 3.43–3.76 |
| | MDAP | 23 | 3.55 | 19.2 | 3.26–3.85 |

MDAP: Menu-driven auto-tutorial presentations delivered via Flash.

## Student Major

Students were deemed to have an agricultural major if their current major was agricultural engineering, agronomy, horticulture, or pre-veterinary medicine (undergraduate). The mean, coefficient of variation, and 95% confidence interval for the mean based on student major for each variable are shown in table 4. The t-scores for performance on assessments and course grade showed no significant difference between students with an agricultural major and students with a non-agricultural major, most of who were engineering students.

The differences in summary statistics for some variables were large between the two groups of majors. The removal of an outlier in the non-agricultural major group, a different student than for the delivery method analysis, would have eliminated much of this difference and would not have had a meaningful impact on t-test significance. The decision was made to include the observation.

**Table 4. Performance of agricultural and non-agricultural students.**

| Variable | Student Major | N | Mean | Coefficient of Variation (%) | 95% Confidence Level Mean |
|---|---|---|---|---|---|
| First-attempt total quiz score on the biomass module | Agricultural | 19 | 384 | 14.8 | 353–415 |
| | Non-agricultural | 25 | 403 | 15.8 | 380–426 |
| Final total quiz score on the biomass module | Agricultural | 19 | 503 | 5.5 | 489–516 |
| | Non-agricultural | 25 | 508 | 1.3 | 505–510 |
| First-attempt total quiz score on remaining modules | Agricultural | 19 | 1,510 | 12.6 | 1,418–1,602 |
| | Non-agricultural | 25 | 1,538 | 13.2 | 1,454–1,622 |
| Final total quiz score on remaining modules | Agricultural | 19 | 1,844 | 2.1 | 1,826–1,863 |
| | Non-agricultural | 25 | 1,841 | 4.2 | 1,808–1,873 |
| First-attempt total quiz score on all modules (biomass and others) | Agricultural | 19 | 1,895 | 12.1 | 1,784–2,006 |
| | Non-agricultural | 25 | 1,941 | 12.6 | 1,840–2,042 |
| Final attempt total quiz score on all modules (biomass and others) | Agricultural | 19 | 2,347 | 2.0 | 2,324–2,370 |
| | Non-agricultural | 25 | 2,348 | 3.4 | 2,315–2,382 |
| Midterm exam score | Agricultural | 19 | 82.2 | 13.5 | 76.9–87.6 |
| | Non-agricultural | 25 | 87.7 | 10.8 | 83.8–91.7 |
| Final exam score | Agricultural | 19 | 89.3 | 8.4 | 85.7–92.9 |
| | Non-agricultural | 25 | 92.8 | 6.1 | 90.4–95.1 |
| Biomass final exam question score | Agricultural | 19 | 29.5 | 8.5 | 28.3–30.7 |
| | Non-agricultural | 25 | 30.2 | 5.3 | 29.6–30.9 |
| Course grade | Agricultural | 19 | 3.49 | 13.8 | 3.26–3.72 |
| | Non-agricultural | 25 | 3.72 | 10.2 | 3.56–3.88 |

## Gender

The mean, coefficient of variation, and 95% confidence interval for the mean based on grouping students by gender for each variable are shown in table 5. Female students scored comparably to male students, which agrees with Marks et al. (2005), who found that gender was not related to learning performance.

The differences in summary statistics for some variables were large between the genders. The removal of an outlier in the male student group, a different student than for the delivery method or student major analyses, would have eliminated much of this difference and would not have had a meaningful impact on t-test significance. The decision was made to include the observation.

**Table 5. Student performance by gender.**

| Variable | Gender | N | Mean | Coefficient of Variation (%) | 95% Confidence Level Mean |
|---|---|---|---|---|---|
| First-attempt total quiz score on the biomass module | Female | 10 | 365 | 16.5 | 322–408 |
| | Male | 36 | 403 | 13.9 | 385–423 |
| Final total quiz score on the biomass module | Female | 10 | 507 | 1.3 | 502–512 |
| | Male | 36 | 505 | 4.0 | 498–512 |
| First-attempt total quiz score on remaining modules | Female | 10 | 1,521 | 11.5 | 1,397–1,646 |
| | Male | 36 | 1,524 | 13.2 | 1,456–1,592 |
| Final total quiz score on remaining modules | Female | 10 | 1,850 | 1.6 | 1,828–1,872 |
| | Male | 36 | 1,840 | 3.7 | 1,817–1,864 |
| First-attempt total quiz score on all modules (biomass and others) | Female | 10 | 1,886 | 10.9 | 1,739–2,034 |
| | Male | 36 | 1,928 | 12.6 | 1,846–2,010 |
| Final attempt total quiz score on all modules (biomass and others) | Female | 10 | 2,357 | 1.5 | 2,332–2,382 |
| | Male | 36 | 2,346 | 3.1 | 2,321–2,370 |
| Midterm exam score | Female | 10 | 86.5 | 12.1 | 79.3–93.8 |
| | Male | 36 | 85.0 | 11.9 | 81.5–88.5 |
| Final exam score | Female | 10 | 92.8 | 5.1 | 89.4–96.2 |
| | Male | 36 | 90.0 | 9.7 | 87.1–93.0 |
| Biomass final exam question score | Female | 10 | 30.2 | 6.0 | 28.9–31.5 |
| | Male | 36 | 29.8 | 7.0 | 29.1–30.5 |
| Course grade | Female | 10 | 3.70 | 8.9 | 3.46–3.94 |
| | Male | 36 | 3.54 | 16.7 | 3.34–3.74 |

## Summary

This study compared student performance in BRT 501 for two online course delivery methods (video lecture and MDAP), student major (agricultural and non-agricultural), and gender. Student performance was not significantly impacted by module delivery method. Students with agricultural majors performed similar to students with non-agricultural majors, most of whom were engineering students. Female and male student scores showed no significant difference in assessment scores or course grade.

There are limitations that impact the usefulness of the study results. This sample was one class at a single institution, which may limit generalizability of the results. The sample size of 46 may be too small to show statistically significant differences for some variables that would be significant with a larger sample.

### Recommendations for Future Research

The VEC institutions are in a unique position to explore the value of institutional linkages already in place and develop linkages with new institutions, measuring the impact of cooperative programming delivery on student learning and educational cost management. The identification and creation of models that relate how to effectively develop successful joint educational efforts could help higher education better serve students.

Undergraduate students and students from multiple disciplines and institutions could also be studied. The inclusion of these additional categories of data could reveal the effects of different institutions, graduate and undergraduate, and between disciplines, making the results applicable to a more general population.

An experiment that offers BRT 501 online, similar to the Introduction to Artificial Intelligence MOOC at Stanford University (DeSantis, 2012), could explain the reasons for student participation in the course, why students completed all aspects of the course while others did not (student retention), and identify support structures that enhance the likelihood students complete the course. Developing viable online distance education programs based on sound research findings has become and will continue to play a key role for higher education to serve students effectively and competitively.

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# Student Perspectives on a New Online Biomass Production Module for Fundamentals of Biorenewable Resources and Technology[1]

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## Abstract

In 2007, a Virtual Education Center for Biorenewable Resources was initiated that offered three online courses, one being Biorenewable Resources and Technology (BRT) 501 – Fundamentals of BRT. The objective was to assess student perceptions on two delivery methods, course assessments, module material, and student learning. Twenty students completed the survey of qualitative aspects of student experiences in BRT 501. The biomass production module brought non-farm students closer to the knowledge level of farm students as demonstrated by students' self-assessed knowledge and their BRT 501 assessment scores. Students desired a stronger connection with the course instructor and peers, whether electronically or in-person. This may reflect a relationship between student-instructor connectedness and grade point average (GPA). Market signals to students in the form of scholarship GPA minimums and employer interview requirements as well as higher GPA leading to better jobs with higher incomes may influence student interest in connectedness to the instructor.

## Introduction

Online delivery continues to penetrate higher education, which is demonstrated by students taking at least one online course growing from 19.6% in 2006 to 32.0% in 2011 (Allen and Seaman, 2013). As online education has become a mainstream method of delivery, students expect a good experience, similar to or better than in the classroom. Technology has driven improvements in the online course experience, which is beneficial to students (Palmer et al., 2014). The use of technology has the potential to narrow the transactional distance (space and/or time) that Moore (1997) considered important in the teacher-learner relationship. Learner-instructor interactions were significant for higher perceived learning (Arbaugh and Benbunan-Fich, 2007; Marks et al., 2005). Lee and Rha (2009) found that student-student and student-instructor dialogue, verbally or electronically, led to significantly higher student achievement for critical thinking learning. Thus, increasing opportunities for student-instructor and student-student interactions with technology may improve student experience and increase retention in online courses.

Instructional technology also needs to be accessible and seen as improving the learning experience. Howland and Moore (2002) found that students lacking computer technical experience had difficulties in their online course while proficient students did not; therefore, students must be comfortable and proficient with technology for a good learning experience. Universities and colleges provide technical support for students to

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assist them with the use of online education technology, which has been found to be very important for student success in online courses (Herrington et al., 2006, Lee et al., 2011). Ross et al. (2003) found their students thought the addition of video was more effective than using only books (90%) and the video of relevant subject matter was entertaining and enjoyable to watch. Thus, technology has the potential to provide students with a high quality learning experience.

In 2007, a Virtual Education Center (VEC) for Biorenewable Resources was initiated (Raman et al., 2006). The Center offered three courses through online distance education, including Biorenewable Resources and Technology (BRT) 501 – Fundamentals of Biorenewable Resources and Technology. The BRT 501 syllabus (Raman, 2010) described the course as an introduction "to the science and engineering of converting biorenewable resources into bioenergy and biobased products." Topics included the entire biorenewables value chain, from biomass production and harvest to biomass preparation and conversion to techno-economics and environmental concerns. The VEC was interested in learning if other methods would be suitable for online delivery of BRT courses. The standard for BRT 501 content delivery was video lectures with a tablet computer and pen to annotate, draw, and make calculations onscreen. The selection of a viable alternative technology for the online delivery method was necessary. Flash player was selected as the alternative delivery method due to its widespread availability on multiple computer operating systems (Millward Brown, 2009; Statowl.com, 2010).

This study sought to better understand the student learning experience in BRT 501. Students were surveyed about their experience in the course offered spring semester 2010 at Iowa State University. The objectives of the study were to: (1) identify student characteristics or demographics that impact BRT 501 student learning for both the standard video lecture and menu-driven autotutorial presentations (MDAP) delivered via Flash delivery methods (see Figure 1), and (2) determine if alternative delivery method modifications to BRT 501 would improve the student learning experience.

## Materials and Methods

This study was deemed exempt by the Iowa State University Institutional Review Board for Human Subjects (Iowa State University, 2010). The lead instructor made an announcement about the research project in the class period prior to the start of the biomass production module. Students were made aware of the potential risks and benefits of participating in the study through a consent letter distributed via WebCT that had to be viewed before students could access the survey. Students had the option to opt out of the survey. The survey results were embargoed by Iowa State Engineering Distance Education and released after spring semester grades had posted.

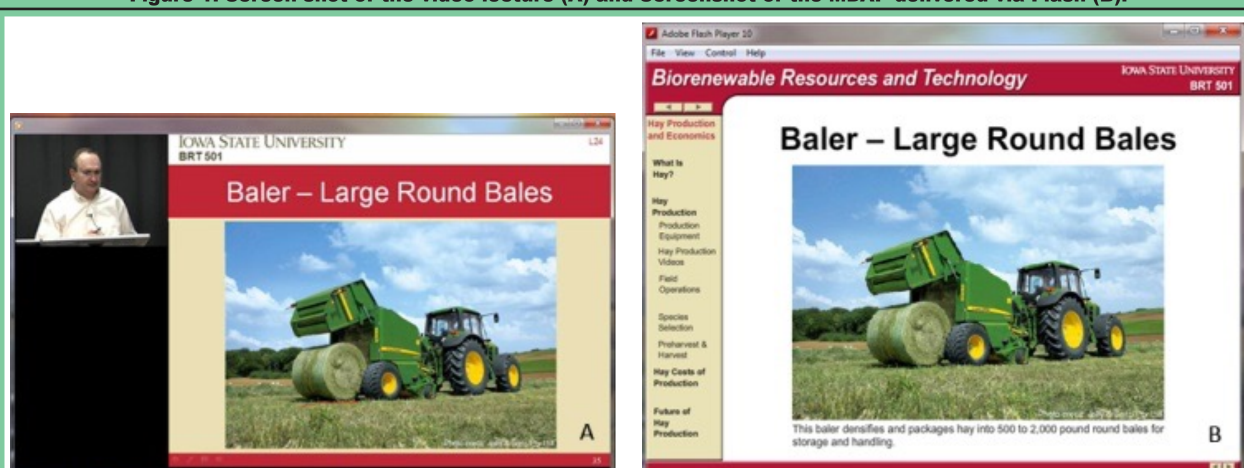
### Participants

The Iowa State BRT 501 course had 51 students enrolled for spring semester 2010, 44 on-campus and seven at a distance. Four students, three on-campus and one at a distance, dropped the course prior to the biomass production module. One on-campus student chose not to take the biomass production module quizzes and was excluded. Students were enrolled as graduate students (42) and upper-level undergraduate students (4) from various majors, most of which were technical in nature (e.g., engineering, agronomy).

After the course midterm exam, students were ranked based on academic performance to date (i.e., upon homework, quiz, and exam scores). Students were subsequently split into two groups based on a serpentine selection through their rankings. Specifically, Group 1 students ranked 1, 4, 5, 8… and Group 2 students ranked 2, 3, 6, 7… Adjustments to the groupings were made to balance for gender. Group 1 received the biomass production module through standard course video lectures and Group 2 received MDAP.

The 10 female students were split evenly in the two groups, which required some shuffling of students. A Wilcoxon rank-sum test was conducted on midterm scores to determine if the students in the video lecture and MDAP groups had similar performance on assessment scores up to and including the midterm exam (Horn,

**Figure 1. Screen shot of the video lecture (A) and Screenshot of the MDAP delivered via Flash (B).**



2012). The results indicated no significant difference (z = 0.00, p < 1.00). The mean ranks in the video lecture and MDAP groups were each 23.5. Also, the midterm exams for the two groups were compared using a t-test and there was no significant difference (p < 0.81).

The video lecture content was delivered as a sequence of slides with voiceover and the MDAP content was delivered as slides through a menu driven Flash presentation with text. The written material was identical, but spoken words on the video may have provided additional content. WebCT had a feature that allowed content delivery to specific groups, which was used to provide the video lectures to Group 1 and the MDAP to Group 2. After the biomass production presentations were completed and all quiz attempts made, the content from both delivery platforms was available to all students. The quizzes and final exam were scored and graded within each delivery method and then normalized across the entire class.

### Data Collection and Analysis

The survey instrument had 37 questions to gather information on demographics, online course and computer experience, module content and delivery, self-reported student learning, communication, and production agriculture experience. The survey variables for the study were: (a) module – best and worst, (b) biomass production knowledge before module, (c) biomass production knowledge after module, (d) biomass production video usefulness, (e) classmate interaction, (f) online and classroom module comparison, (g) quiz comparison for different modules, (h) computer proficiency impact on learning, (i) current major, (j) degree pursued, (k) employment status, (l) farm background and participation, (m) gender, (n) instructor visible on screen, (o) instructor availability, (p) internet proficiency, (q) non-traditional student, (r) educational experience overall, (s) quizzes reflected material, (t) self-assessed learning, (u) software proficiency: design, (v) software proficiency: internet, (w) software proficiency: productivity, (x) student able to learn independently, (y) study time, and (z) online class enrollment in the future.

Bryman and Cramer (2008) was referenced for the statistical plan and analysis. SAS Enterprise Guide (Slaughter and Delwiche, 2010) was used for computation and analysis of summary statistics, correlations, and t-tests. Cohen and Holliday (1982, p. 93) suggested the following scale for interpretation of the Pearson's product moment correlation coefficient values: very low (r = 0.00–0.19), low (r = 0.20–0.39), modest (r = 0.40–0.69), high (r = 0.70–0.89), and very high (r = 0.90–1.00). This scale was used to evaluate the significant correlations identified.

The categories used for t-test analysis of the survey data were: (a) delivery method: video or MDAP, (b) computer software proficiency, (c) student: domestic or international, (d) instructor visible onscreen was important or not, (e) student: at distance or on-campus, (f) peer to peer interaction, (g) online course taken previously or not, (h) online class enrollment in the future or not, (i) student had farm background or not, and (j) classroom or online course better for learning.

## Results and Discussion

Twenty of the 46 students enrolled in BRT 501 completed the 37-question survey. Of the 20 students completing the survey, eight received biomass production module information through video lectures and 12 through MDAP. Two students were female and 18 were male; only one was a non-traditional student, defined as 30 or more years old. Three students were enrolled in school part-time while employed full-time and 17 were full-time students; 30% were international students. Nearly all participants were graduate students, 15 M.S. and four Ph.D. (one student did not respond) with 75% engineering and 25% other science majors such as agronomy or horticulture. Tables 1 and 2 show the student demographics broken out by delivery method.

### Delivery Methods

There are two reasons we believe students in the study desired connectedness with the instructor and peers. One reason is students pay for a service and expect a high level of performance for their tuition dollars. Another possibility is students may believe connectedness with the instructor will help them achieve a better course grade (Arbaugh and Benbunan-Fich, 2007; Bernard et al., 2004). One currency for students is money; another is their course grade, which students expect to translate into money in the future (Siebert et al., 2002). Siebert et al. (2002) found that one key student objective is a high grade point average (GPA). This is rightly so since GPA has been found to be associated with greater income after graduation (James et al., 1989; Preston et al., 1990). Students read market signals such as scholarships that require a minimum GPA (Iowa

**Table 1. Demographic information for Biorenewable Resources and Technology 501 students in each delivery method group.**

| Delivery Method | Agricultural Major | Engineering Major | Graduate Student | On-campus | Male Students |
|---|---|---|---|---|---|
| Video Lecture (n=23) | 11 | 12 | 19 | 21 | 18 |
| MDAP (n=23) | 8 | 9 | 21 | 19 | 18 |

MDAP: Menu-driven autotutorial presentations delivered via Flash.

**Table 2. Demographic information for Biorenewable Resources and Technology 501 students participating in the survey.**

| Delivery Method | Agricultural Major | Engineering Major | Graduate Student | On-campus | Domestic Student | Male Students | Non-traditional Student[a] | Employed Full-time[b] | Taken Online Course Previously[c] | Farm Background |
|---|---|---|---|---|---|---|---|---|---|---|
| Video Lecture (n=8) | 2 | 5 | 8 | 6 | 6 | 8 | 0 | 2 | 3 | 2 |
| MDAP (n=12) | 8 | 9 | 12 | 10 | 8 | 10 | 1 | 1 | 7 | 3 |

[a]Non-traditional students were students greater than 30 years old.

[b]All students employed were employed full-time and were only part-time students. The rest were full-time students.

[c]All the part-time students who were employed full-time had taken an online course previously.

MDAP: Menu-driven autotutorial presentations delivered via Flash.

State University, 2012; University of Illinois, 2012) or employers setting GPA standards that must be met to be considered for a job interview (Gaul, personal communication). Student comments about the importance of better connectedness with the instructor may be related to their expectations that connectedness translates into better understanding of homework assignments, projects, and exams, leading to better grades, and eventually large economic benefit.

Students liked the convenience and accessibility offered by an online course, with one student stating it was their only option to pursue a M.S. engineering degree. This agrees with the findings of Arbaugh (2005) and Harlen and Doubler (2004).

The correlations for the survey variables significant at $p < 0.05$ are discussed below and were evaluated using Cohen and Holliday's (1982) scale described above in Data Collection and Analysis. Biomass production knowledge before accessing the biomass production module was highly positively correlated with biomass production knowledge after the module ($r = 0.72$). The farm student mean for biomass production knowledge before and after the module was good (4.0/5.0 and 4.2/5.0, respectively), whereas the nonfarm student mean for biomass production knowledge before the module was poor to acceptable (2.3/5.0) and acceptable to good after the module (3.4/5.0).

Participation in the farming operation by students with a farm background was very highly negatively correlated to self-assessed learning ($r = -0.94$) and students' self-assessed ability to learn independently ($r = -0.99$). The latter was surprising because farmers are generally considered self-starters and independent. Since these students knew much of the material presented, they may have felt learning did not take place and thus, they did not explore their ability to learn independently. The mean for self-assessed learning for farm students and nonfarm students was average (3.2/5.0 and 2.9/5.0, respectively, not significant at $p < 0.05$). The scores for ability to learn independently were nearly identical at the acceptable to good level.

## Comparisons between Groups

Students were grouped using these characteristics and t-scores were calculated for categories shown in *Data Collection and Analysis* above. The results of the calculations are presented in table 3.

Domestic and international students differed significantly on internet proficiency. All students considered themselves proficient with use of the internet ($p = 0.03$). Domestic students considered themselves very good (4.7/5.0) using the internet while international students considered themselves good (4.0/5.0). Song (2005) suggested this may reflect that more domestic students have internet access at home or that their access is higher speed.

Student responses about knowledge before and after the biomass production module were collected. Students who grew up on a farm reported their self-assessed biomass production knowledge before ($p = 0.01$) and after ($p = 0.04$) completing the biomass production module as significantly higher than students who did not grow up on a farm. Students without a farm background showed a significant increase in self-assessed biomass production knowledge ($p = 0.01$), whereas students with a farm background did not ($p = 0.37$). There was a significant increase in self-assessed biomass production knowledge for all BRT 501 students ($p = 0.01$) since 75% of the class did not have a farm background. This indicates the module was useful in bringing the self-assessed biomass production knowledge of three-quarters of the participating students closer to that of students who grew up on a farm. The self-assessment finding is supported by student scores on the biomass production quizzes (mean = 99%) and final exam questions (mean = 96%) for the BRT 501 course (Jarboe et al., 2012).

Splitting students into those who thought they would have learned more in a traditional classroom setting (classroom group) and those who did not (no preference group), there were significant differences in the perceived ability of students to learn independently ($p = 0.01$), the biomass quizzes represented the lecture/presentation material ($p = 0.02$), and self-assessed learning ($p = 0.05$). The classroom group also considered their ability to learn independently as acceptable to good (3.4/5.0), whereas the no preference group thought their ability to learn independently was good to very good (4.3/5.0). Both groups thought the biomass quizzes reflected the lecture/presentation material at least reasonably well (classroom = 3.4/5.0 and no preference = 4.2/5.0), although the no preference group more so. For self-assessed learning, the classroom group considered their learning to be low to average (2.7/5.0), while the no preference group felt their learning was average to good (3.5/5.0).

Institutions of higher learning are expanding distance and online education offerings (Allen and Seaman, 2013) and video lectures are a viable teaching method

**Table 3. Summary statistics for Biorenewable Resources and Technology 501 students participating in the survey on the biomass production module.**

| Variable | N | Mean | Standard Deviation | Range Min. | Range Max. |
|---|---|---|---|---|---|
| Biomass production knowledge before biomass module | 20 | 2.70 | 1.22 | 1 | 5 |
| Biomass production knowledge after biomass module | 20 | 3.60 | 0.75 | 2 | 5 |
| Biomass production video usefulness | 20 | 2.65 | 0.93 | 1 | 4 |
| Farm participation level | 5 | 4.20 | 1.30 | 2 | 5 |
| Quiz difficulty comparison | 20 | 3.00 | 0.73 | 1 | 4 |
| Biomass quizzes reflected the material | 20 | 3.60 | 0.75 | 2 | 5 |
| Instructor availability | 14 | 3.29 | 0.61 | 3 | 5 |
| Internet proficiency | 20 | 4.50 | 0.69 | 3 | 5 |
| Productivity software proficiency | 20 | 3.65 | 0.81 | 2 | 5 |
| Design software proficiency | 20 | 3.70 | 0.80 | 2 | 5 |
| Self-reported study time | 20 | 2.10 | 0.91 | 1 | 5 |
| Self-assessed learning | 20 | 2.95 | 0.83 | 1 | 4 |
| Students ability to learn independently | 20 | 3.65 | 0.81 | 2 | 5 |
| Would have learned more in classroom or online | 17 | 2.88 | 0.70 | 2 | 4 |
| Overall educational experience for biomass module | 20 | 3.35 | 0.81 | 2 | 5 |

that serves the needs of students. There are indications that video lectures supplemented by supporting materials, online community, and instructor videos to answer questions and form a bond with students are a viable option (Offir et al., 2008; Mills and Xu, 2005; Reisetter and Boris, 2004). Brick and mortar colleges and universities may be able take advantage of this by offering students increased value. Expansion of online content use in higher education, particularly lectures by recognized content experts, would allow student-instructor and student-student contact time to focus on enhancing student learning through group work, hands-on laboratories, class discussions, student presentations, and other methods, time in which students could create their own learning under facilitation of the instructor. Flash delivery technology may have a role in the development of animations, examples, and other visual tools. This type of instruction also has the potential to strengthen the network students gain by being on campus and creates an opportunity for universities to remain relevant.

The *Introduction to Artificial Intelligence* online course offered in fall 2011 by Dr. Sebastian Thrun, Stanford University and Dr. Peter Norvig, Google, used YouTube for distribution (Thrun and Norvig, 2012a) and was an extension of their classroom course. The online course attracted 160,000 students with over 23,000 students completing the course requirements, a 14% retention rate (DeSantis, 2012). Thrun and Norvig did offer support mechanisms to students such as an online community and video office hours, which are potential methods that could create connectedness in BRT 501, particularly for the online version of the course. More extensive use of an online community to identify questions and exchange information would enable students to create connectedness (Lee and Rha, 2009; Thrun and Norvig, 2012b). It could also provide the instructor with material to discuss during a weekly video. These additions to BRT 501 would likely enhance student learning.

Use of asynchronous online systems that enable students to complete degree and certificate programs more quickly have the potential to improve four-year graduation rates and the prospect that students could graduate in three years, especially through coordination and cooperation with high schools using advanced placement classes and other methods of credit acquisition. This could be a great recruiting tool for colleges and universities and offer an opportunity to reduce student debt loads.

One reason students attend college is to improve their employment options. As noted earlier, online education was the only option for one of our students to pursue a M.S. degree in engineering. Online education can help students gain the competencies employers desire and offer people solutions as they progress in their career. Lifelong learning can be offered that enables students to advance in their career or change careers. Online distance education programs can serve this role, especially those that meet employee and employer needs. This will have the side benefit of creating a closer connection with employers that may become research and outreach program clients.

One of the limitations of video lectures is the bandwidth necessary for delivery. Many rural communities in the United States do not have broadband internet, which limits access (Katz et al., 2011). Developing nations also have limited broadband infrastructure except in major metropolitan areas (Al-Ghazawy, 2009; Kim et al., 2010). Courses using either video lecture or MDAP could be loaded onto DVDs and shipped to areas without broadband access.

In the developing world, the advancement of technology can leapfrog the educational distribution methods of developed countries. This can lower system development costs and open educational opportunities that would not be available otherwise. Online education offers access to world class educators for higher education and can reach into the K-12 system. This is an opportunity for colleges and universities to expand their reach and continue growing their student populations (Katsomitros, 2011) even as the student population in their traditional service area stagnates or declines.

## Summary

The biomass production module brought students without a farm background closer to the knowledge level of students with a farm background as demonstrated by students' self-assessed knowledge and their BRT 501 assessment scores. Students desired a stronger connection with the course instructor and peers, whether electronically or in-person. This may reflect a relationship between student-instructor connectedness and grade point average (GPA). The MDAP used for this study was less personal due to the lack of an instructor's image, particularly compared to the video lecture where emphasis on specific portions of the materials, non-verbal cues, and connection with the lecturer could be seen. The inclusion of material that might accomplish this could be done in a MDAP, but would be time consuming and more costly. Because of the stronger instructor-student connection that is facilitated by video lecture, and because this connection has value to students, this study suggests that video lectures are preferable to the MDAP for online content delivery.

The study could have been improved by securing additional participants from other VEC graduate level courses. Undergraduate students and students from multiple disciplines and institutions could be studied. The inclusion of these additional categories of data would reveal the effects of different institutions, graduate and undergraduate students, and between disciplines, making the results applicable to a more general population.

### Recommendations for Future Research

A study of BRT students at all three VEC institutions (Iowa State University, University of Idaho, and University of Kentucky) that explores performance across modules and institutions may be useful. The VEC institutions are in a unique position to take advantage of linkages already in place among the institutions and add linkages to new institutions so the impact of cooperative program delivery on student learning and educational cost management could be measured. An experiment that offers BRT 501 online, similar to the *Introduction to Artificial Intelligence* course at Stanford, could offer the opportunity to understand the reasons for student participation in the course, why students completed all aspects of the course while others did not (student retention), and identify support structures that enhance the likelihood students complete the course. Developing viable online distance education programs based on sound research findings has become and will continue to play a key role for higher education to serve students effectively and competitively.

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# Engaging American Indian/Alaska Native (AI/AN) Students with Participatory Bioexploration Assays[1]

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## Abstract

American Indian and Alaska Native (AI/AN) students can experience a disconnect between their indigenous culture and the Eurocentric focus of U.S. science, technology, engineering, and mathematics (STEM) classrooms. As a result, some AI/AN students are less motivated to participate in educational activities that seem irrelevant or detached from their daily existence. An educational methodology utilizing AI/AN culturally-relevant medicinal plant knowledge as a foundation for inquiry-based bioexploratory lectures and laboratory experiments was tested for its potential to promote enhanced engagement in STEM instruction for AI/AN students. Workshop modules were held with 40 AI/AN high school student participants in Alaska and 12 middle and high school Lakota students and ten college Lakota students in North Dakota. The STROBE technique, an observational method previously validated to measure engagement in medical school lectures, was used to determine the level of engagement among students during the lecture, discussion, and laboratory portions of the workshops. From 1718 discrete student observations, students exhibited engagement behavior 1247 times, for an average of 72.5%. College students displayed higher levels of engagement (80.0% average) compared to high school students (70.3%). This research suggests that emphasizing traditional AI/AN culture in a participatory learning environment has the potential to enhance engagement of AI/AN students in STEM disciplines.

**Keywords** Science education, student engagement, Native American students, STEM, STROBE method, traditional ecological knowledge, inquiry-based learning

## Introduction

American Indian and Alaska Native (AI/AN) students frequently struggle with standardized curricula in United States public classrooms, resulting in low levels of AI/AN student matriculation and achievement. AI/AN students are 73% more likely to be placed in special education programs (US National Caucus of State Legislators, 2008), and are 117% more likely to drop out before receiving a high school diploma compared to non-AI/AN students (McCarty, 2009). Only 64% of those students who do graduate pursue postsecondary education, perpetuating a severe underrepresentation of AI/AN students in the ranks of higher education (deVoe et al., 2008; Tynan and Loew, 2010).

There are a multitude of factors that may disadvantage AI/AN students, both at home and at school. Outside of class, students frequently face inadequate academic preparation, legal problems, acute and chronic health issues, behavioral issues, lack of parental support, teen pregnancy, poverty, substance abuse, and child care difficulties (Bowker, 1992; Demmert et al., 2006; Everett Jones et al., 2011; Faircloth and Tippeconnic, 2010; Ledlow, 1992; Swisher and Hoisch, 1992).

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Inside the classroom, a heightened focus on standardized tests, Eurocentric based curricula, and limited multicultural content, can fail to engage AI/AN students (Beaulieu et al., 2005; McCarty, 2009). In addition, traditional AI/AN students have little motivation to participate in educational activities that seem irrelevant to their own cultural practices and contributions to history. As Bradley and Reyes (2000) noted, "*schooling for Alaska Native students has been largely designed and implemented by non-Alaskans from the 'lower 48.' In most cases, the public school curriculum… does not reflect Native values, culture, or experiences.*" The lack of cultural appreciation and inclusion in school curricula is frequently compounded by teachers' lack of understanding about students' cultural background (Freng et al., 2006). Taken together, these factors tend to disconnect AI/AN students, creating a chasm between the experience of their own lived realities and the presented educational material. This paradox has led to a lack of engagement and motivation for AI/AN students in U.S. schools, which is a contributing reason why students in general drop out of school (Mac Iver and Mac Iver, 2009).

Alternative frameworks for re-engaging AI/AN students in school have been widely investigated, and evidence suggests that academic performance improves when AI/AN culture is incorporated into the classroom curriculum in meaningful ways. Educational programs where the values, ideas, social mores, and language of the respective communities are promoted and embraced, have been highlighted as a primary means of improving academic performance (Beaulieu et al., 2005; Guillory and Williams, 2014). Employing Native culture as a foundation of curriculum has the potential to connect a student's educational experience to his or her own lived reality, which is essential to enhance student success in the classroom (Agbo, 2001), while cultivating a sense of "place" that makes STEM curriculum more impactful (Nadelson et al., 2014).

Recently, a system of simple field bioassays was developed into an educational toolset that enables students to explore the bioactivity of extracts from culturally-familiar wild edible or medicinal plants. The assays evaluate plant potential to combat chronic and infectious human diseases, and require students to master basic biological and chemical laboratory principles in order to complete the assessments (Kellogg et al., 2010a). The purpose of this study was to ascertain the effects that participatory science curricula on student engagement in the classroom. Engagement of the AI/AN students was monitored and coded by trained observers using the STROBE method; an instrument previously validated as a means to objectively measure students' interest and attentiveness in medical school (O'Malley et al., 2003).

## Methods

### Subject and site selection

The study population consisted of 52 students from Alaska and North Dakota. More specifically, the study population included 40 high school AN students in Alaska, and 10 college students plus 12 middle school and high school AI students in North Dakota (Table 1). The study was conducted at summer science camps held at the University of Alaska at Fairbanks and the United Tribes Technical College in Bismarck, North Dakota.

### IRB approval

Observational monitoring of student engagement behaviors was an uncomplicated and unobtrusive method of data collection, and thus was determined by the North Carolina State University (NCSU) Institutional Review Board of Human Subjects in Research (IRB) to be outside the requirement for regulation on human subject research. In addition, the NCSU IRB did not require informed consent, since no personal information was collected, students remained anonymous to the observers, and the research involved public behavior in a public school or college setting.

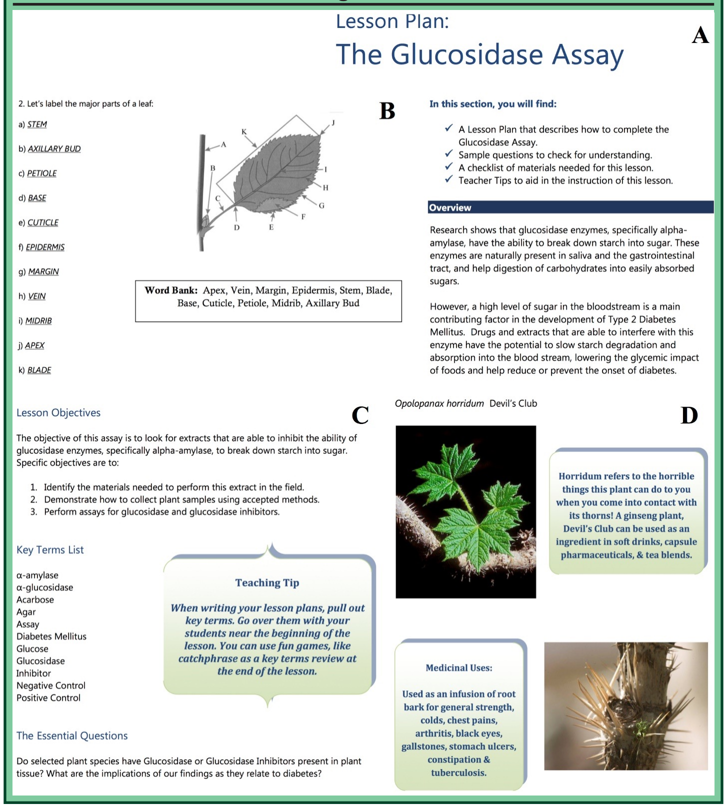
### Field bioassays

The portfolio of field bioassays was previously developed as a research tool to investigate bioactive properties of wild indigenous plant material in a non-laboratory setting (Kellogg et al., 2010b). Assays created to screen for antioxidant and anti-glucosidase activities, helminthes lethality, wound healing, and protease inhibition were specifically selected in this study to be developed into classroom modules. Each of the selected bioassays addressed health concerns that were particularly relevant to the AI/AN students who participated in the exercises. The antioxidant screen is a colorimetric multi-well plate assay that investigates the quenching of free radicals. The ability to reduce oxidative radicals has been correlated with reduced incidence of chronic diseases, including cancer, type 2 diabetes, and heart disease. The enzyme-based anti-glucosidase screen investigates an extract's potential to reduce serum glucose levels, a biomarker of hyperglycemia and the development of insulin resistance. Cultures of the non-parasitic flatworm *Planaria spp*. treated with plant extracts can gauge worm lethality (an indication that the extract could be used to combat infections of other, closely related parasitic worms), or can demonstrate

**Table 1. Location of participatory STEM workshops with Alaska and North Dakota students.**

| Workshop | Location | Students | School Level | Duration of Workshop | Elder Participation |
|---|---|---|---|---|---|
| AK1 | Alaska | 15 | High school; at-risk youth | 2 hours | Plant field collection |
| AK2 | Alaska | 12 | High school; gifted youth | 2 hours | Plant field collection |
| AK3 | Alaska | 13 | High school; gifted youth | 2 hours | Plant field collection |
| ND1 | North Dakota | 10 | College | 2 days | Plant field collection; discussion of plant uses |
| ND2 | North Dakota | 12 | High school and middle school | 2 days | Plant field collection; discussion of plant uses |

Figure 1.




potential wound healing capabilities by allowing students to monitor the rate of tissue repair for injured flatworms. Proteases are essential tools for a number of infectious agents, including the human immunodeficiency virus (HIV); the protease bioassay investigates the extracts' potential inhibition of a non-pathogenic protease.

Also included were sections on lab safety, plant collection techniques, plant nomenclature and physiology, and notable medicinal plants of the region. Elders and schoolteachers in Anchorage and Fairbanks, AK, and Bismarck, ND assisted in the development and validation of these student activities and lesson plans, and teaching materials were revised according to the recommendations of the panels (Figure 1).

Training teams from North Carolina State University and Rutgers University conducted field bioassay workshops in cooperation with elders from the local native communities. These workshops featured elder-guided fieldwork to identify plants with medicinal value as recognized in traditional ecological medicine. These plants were highlighted in the prepared lesson plans, and students were tasked with employing the bioassay procedures to validate the bioactive potential of selected plants.

## STROBE observational method

Engagement is the one of the essential elements in learning, signifying attention and interest in the material being presented, and is an indicator of student valuation of various learning activities (Deci and Ryan, 2000; Willms, 2003). In order to assess engagement levels, visible human behaviors (such as looking at the instructor, writing, reading classroom content, or performing lab experiments) were quantified and measured by external observers.

To measure in-class student engagement, the STROBE method – a validated classroom observational tool – was employed. STROBE allows a trained observer to gauge engagement without interfering with instructor activities (Kelly et al., 2010), and yields quantifiable data from randomized, discrete observations of individual students. While the lesson was in session, observers scanned the classroom every five minutes in a "STROBE cycle" which was repeated from 10 – 24 times, depending on the length of the workshop session. Due to the small number of participants in each section, it was possible to observe each student directly during the STROBE cycle, as opposed to a subset of students as is common in larger classes (O'Malley et al., 2003), and their activities were coded as described in Table 2.

The workshops began with introduction of instructors and the field bioassay system. Workbooks for the laboratory and discussion portions were distributed to students, and then necessary safety information for the

**Table 2. Coding scheme for classroom STROBE observations.**

| Engaged Behavior | | Disengaged Behavior | |
|---|---|---|---|
| On task: listening/watching/speaking | E1 | Actively off task (e.g. talking) | D1 |
| On task: writing or reading | E2 | Passively off task (e.g. sleeping) | D2 |
| On task: hands-on activity | E3 | | |

**Table 3. Sample instructional activities of one workshop and associated STROBE observational intervals.**

| STROBE Interval | Teacher Actions and Instructional Activities | Students Engaged | Students Disengaged |
|---|---|---|---|
| 1 | Introduction of instructors | 7 | 8 |
| 2 | Introduction to the bioassay process | 8 | 7 |
| 3 | Instruction on procedures for plant collection | 11 | 4 |
| 4 | Instruction on procedures for plant collection | 13 | 2 |
| 5 | Field collection of plant samples | 10 | 5 |
| 6 | Field collection of plant samples | 15 | 0 |
| 7 | Field collection of plant samples | 15 | 0 |
| 8 | Field collection of plant samples | 14 | 1 |
| 9 | Plant extraction procedure in student teams | 12 | 3 |
| 10 | Plant extraction procedure in student teams | 14 | 1 |
| 11 | Plant extraction procedure in student teams | 8 | 7 |
| 12 | Student groups begin to finish plant extraction procedures | 6 | 9 |
| 13 | Student groups begin to finish plant extraction procedures | 5 | 10 |
| 14 | Most groups finish plant extraction activity | 4 | 11 |
| 15 | One group finishing plant extraction activity | 5 | 10 |
| 16 | One group finishing plant extraction activity | 7 | 8 |
| 17 | Transition to discussion of extraction procedures with student groups reporting | 12 | 3 |
| 18 | Explanation of procedures for anti-oxidant assay | 7 | 8 |
| 19 | Instruction on weights and measures | 11 | 4 |
| 20 | Instruction on positive and negative controls | 7 | 8 |
| 21 | Student groups test plant extracts for anti-oxidant presence | 3 | 12 |
| 22 | Student groups test plant extracts for anti-oxidant presence | 8 | 7 |
| 23 | Student groups test plant extracts for anti-oxidant presence | 11 | 4 |
| 24 | Discussion of anti-oxidant properties of plants | 11 | 4 |
| Total observations | | 224 | 136 |

labs and instructions on field collection of plant material were given prior to moving outdoors. Plant specimens were identified, catalogued, and harvested together in the field, and brought back to the classroom for extraction and bioassaying. Lab experiments, involving groups of 2-3 students, involved preliminary extraction of the plant material, and colorimetric bioassays described in the workbooks. The lab period concluded with a summary of the results from each groups' experiments and a discussion of the findings and conclusions. The behaviors of each student were cataloged for each STROBE cycle as the workshop progressed. An example of the data collection, along with the classroom activities correlating to each STROBE cycle, is presented in Table 3.

### Statistics

Statistical analysis was conducted using two-way ANOVA analysis as well as the student t-test (Prism 6.0, GraphPad Inc., La Jolla, CA), with statistical significance determined at the $P < 0.05$ level.

## Results and Discussion

### Alaska Native Workshops

A two-hour bioassay workshop with 15 AN middle school and high school youth was held on the campus of the University of Alaska at Fairbanks (AK1). Two researchers collected STROBE observational data in this session and compared notes to reduce the potential for bias in the observations. The engagement of the 15 students is summarized in Figure 2. Student engagement rose during the first 50 minutes of the workshop session, peaking between 30 and 50 minutes (intervals 6 and 10). During this 20-minute period, students were immersed in the field collection and extraction portion of the workshop. Fieldwork was led by Alaskan Native elders to direct plant collecting, ethical practices of harvesting, and the benefits of plants that grew around the campus area. After collecting, the students began hands-on extraction of the plants they had obtained. The engagement of the students was evident in the rise of E3 engagement (hands on activity) during this time frame. The lowest engagement was during a period after the majority of groups had completed the extraction procedure and were waiting for the other groups to catch up before proceeding on to the next laboratory experiment (interval 13-16). Within a total of 360 student-observation points, students expressed engaged behaviors in 224 instances, yielding a 62% overall rate of engagement.

The second workshop took place with 12 AN high school students who had been classified as gifted by their local teachers (AK2). The field portion of the workshop was also led by Alaskan Native elders to guide the students in ethical plant collecting practices, and which plants have been used traditionally as medicines. The students demonstrated exceptionally high engagement behaviors during the first 75 min of the workshop, covering field collection, extraction of the plant material, and antioxidant bioassay screening (Figure 3). The students evidenced high levels of hands-on engagement through the elder-led plant collection (intervals 6-9), as well as through the plant extraction and assaying (observations

**Figure 2. Workshop intervals of at-risk AN youth, Fairbanks, AK. Percent of students who were engaged in the lesson was measured using the STROBE method. Engaged students were categorized by the activity they were engaged in: listening/watching/speaking (E1, ), writing or reading (E2, ), and hands-on activity (E3, ).**

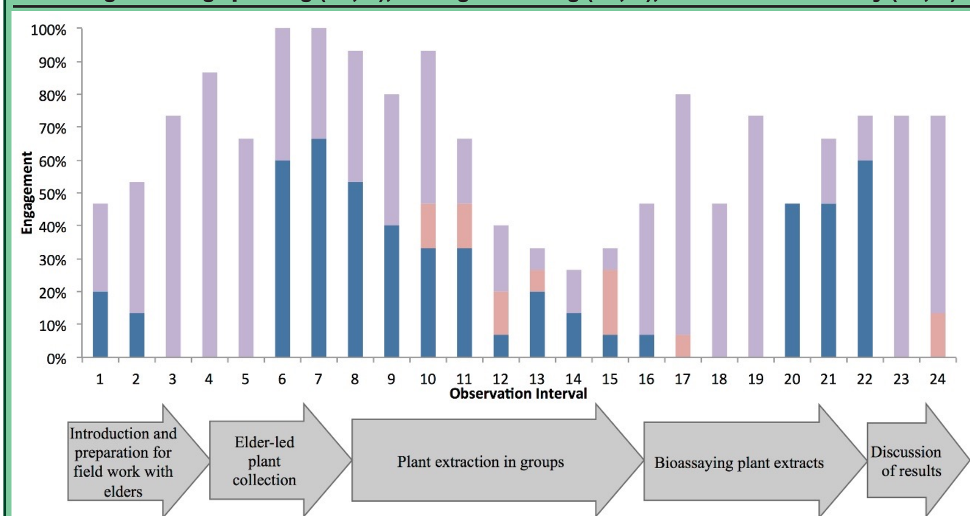
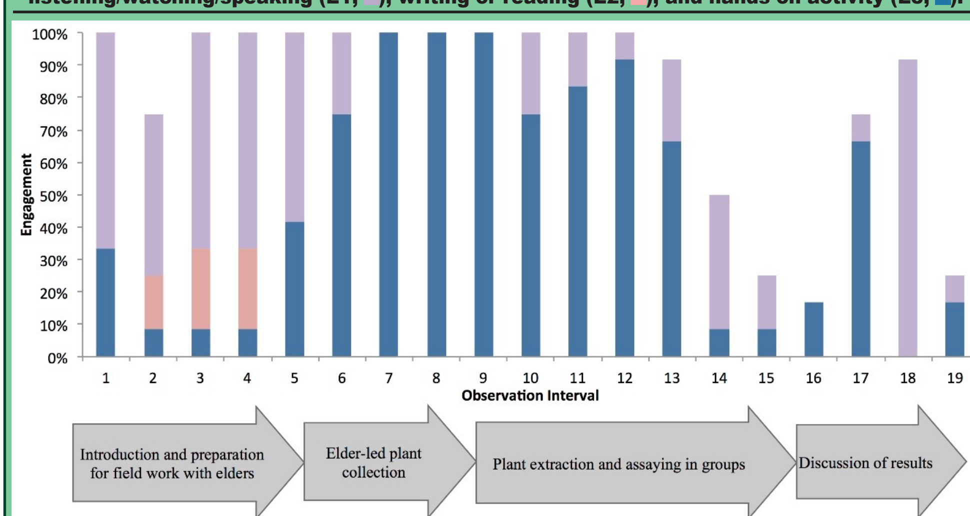



**Figure 3. STROBE engagement intervals of gifted AN youth, Fairbanks, AK. Percent of students who were engaged in the lesson was measured using the STROBE method. Engaged students were categorized by the activity they were engaged in: listening/watching/speaking (E1, ), writing or reading (E2, ), and hands-on activity (E3, ).**



10-15). Engagement began to wane 70 minutes into the session, during an instructor-led demonstration of *Planaria* worm dissection. Of a total 228 student-observation points, students were engaged in 186 instances, representing an 81.5 % overall engagement rate for all observations. The third Alaska workshop took place on the University of Alaska Fairbanks campus with 13 gifted AN high school students (AK3). Engagement was high (>70% student engagement) for the majority of the session, through the field collections, extraction, and bioassay protocols. The field work was led by AN elders from the community, and during the plant collection hands-on engagement (E3) was at 100%. Toward the end of the workshop, the students showed lower engagement as student groups finished up assay activities and had to wait for another experiment to begin. Of the 286 student observation points, engagement was recorded for 235 instances, yielding an 82.1% rate of engagement for all observations. North Dakota AI College Workshops

Ten AI college students participated in the field bioassay workshop at the United Tribes Technical College (UTTC) in Bismarck, North Dakota, which was run in an extended three-part format covering two days (ND1). The first session involved the description of relevant medicinal plants as part of their indigenous pharmacopeia, and then field collections of similar plant species. The initial discussion centered on similarities and differences between traditional native science methods and Western science approaches. Local community elders led the discussion on AI pharmacopeia and native scientific methods, and also directed students in the field while collecting plants. They guided the identification of beneficial plants that are traditionally incorporated in medicinal practices, and shared ethical and sustainable protocols for harvesting plants from the wild. Students were highly engaged during the discussion portion of the morning (observation 3-5) listening and speaking with the elders. The students transitioned to hands-on engagement as the workshop shifted to field collection of medicinal plants. Overall, from the 130 student-observation points of the first part of the workshop, students exhibited engagement 89% of the time (Figure 5 interval 1-12).

The following morning, students began the laboratory extraction of the plants collected during the previous day's session. Student engagement was observed in all students during the demonstration periods at the beginning of the workshop (observation 13-22, Figure 5), and while student groups were performing extractions, engagement remained relatively high. For the extraction, students were engaged 78.5% of the time from the 140 student-observation points (Figure 5, interval 13-22). The third session

**Figure 4. Workshop observation intervals of gifted AN youth, Fairbanks, AK. Percent of students who were engaged in the lesson was measured using the STROBE method. Engaged students were categorized by the activity they were engaged in: listening/watching/speaking (E1, ), writing or reading (E2, ), and hands-on activity (E3, ).**

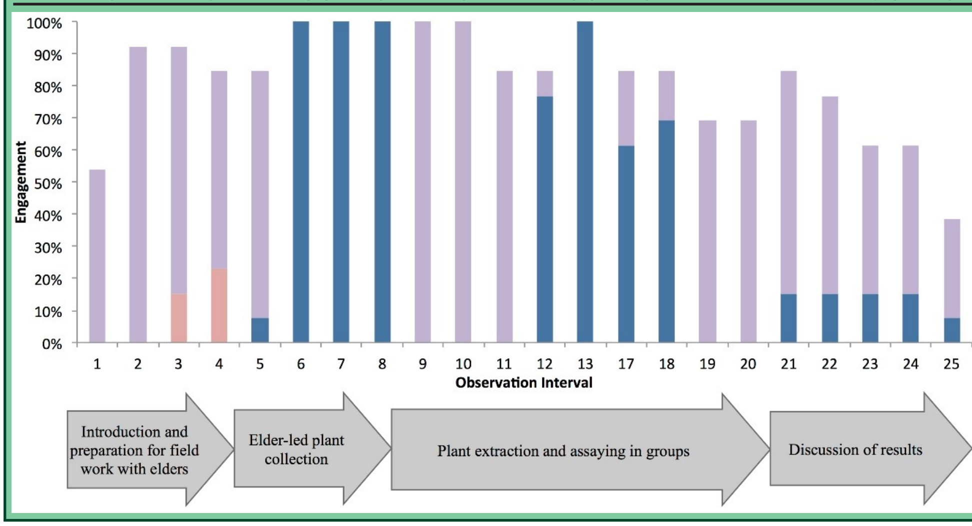
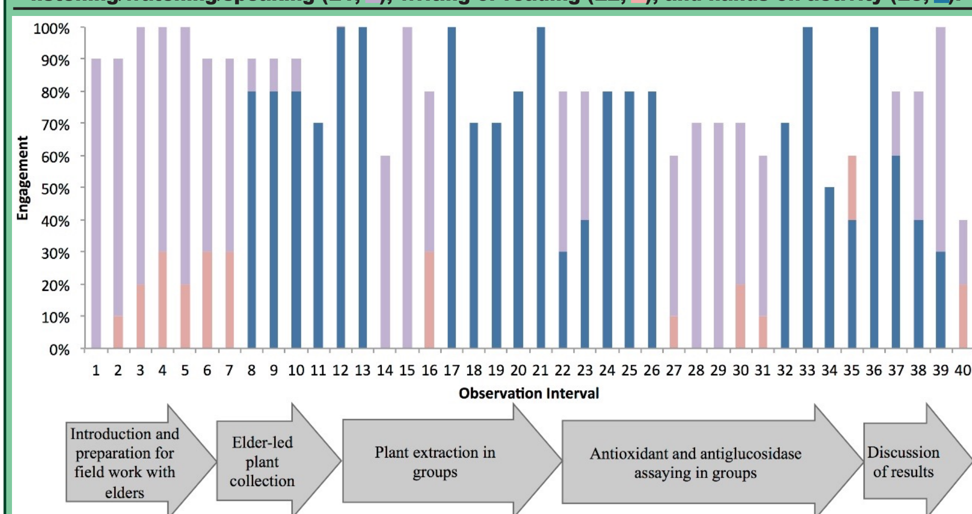



**Figure 5. STROBE engagement intervals during a three-part workshop involving AI college students from United Tribes Technical College, Bismarck, ND. Engaged students were categorized by the activity they were engaged in: listening/watching/speaking (E1, ), writing or reading (E2, ), and hands-on activity (E3, ).**




The third session of the workshop took place in the afternoon of the second workshop day. Engagement was lower overall in this session compared to the morning (Figure 5, interval 23-40), perhaps because this session addressed topics purely related to scientific methods and did not include discussions of the cultural aspects of the plants or bioassays. Students completed plant extraction and performed the antioxidant and antiglucosidase bioassays. Hands-on engagement was dominant during the bioassaying of the plant extracts (observations 24-26 and 32-35, Figure 5), when groups were actively conducting the two bioassays. The lowest engagement points (observations 34-35, Figure 5) occurred when student groups were completing the assays and awaiting further instruction or for other groups to complete their work. Of the 130 student-observation points, students were engaged in 97 instances, for an overall engagement rate of 74%.

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## North Dakota AI High School and Middle School Workshops

A workshop geared towards high school and middle school students was provided as part of a science day camp sponsored by UTTC in Bismarck, ND (ND2). Twelve students participated in a weeklong science day camp, and received a monetary stipend for attending and participating in the entire camp, including the bioassay workshop. The workshop was divided into three sections spanning two days. The first portion of the workshop centered around collecting medicinal plants from the grounds around campus. Community elders participated in the discussion on AI ethnopharmacognosy, and also led students in the field while collecting plants. The elders guided students in the identification of medicinal plants and taught sustainable practices for harvesting plants. Students were moderately engaged during the discussion portion of the morning (observations 1-6 Figure 6) listening and speaking with the elders. The students' engagement increased and transitioned to hands-on participation as the workshop shifted to field collection of medicinal plants (observation 7-12). In general, participant engagement was high during this session (observations 1-13, Figure 6), exhibiting engagement behavior in 72.2% of the 104 student-observation points.

The second session, involving the extraction of plants and preparation of the extracts for bioassay analysis, was interrupted by a local television reporter and crew who visited the workshop to interview both participants and researchers for a local news feature. This provided a significant distraction during the extraction and analysis stage of the workshop, and was reflected in the lowest engagement scores of the three sessions (observations 14-17, Figure 6); of the 120 student-observation points, engagement behavior was recorded in only 58 instances, of 48.3% of the observations.

The third portion of the workshop took place on the second day of the camp. By this time, the students had become more familiar and more comfortable working with the presenters, and engagement was high during the assaying and data collection portions of the session (Observations 22-37, Figure 6). Students exhibited 100% engagement during four observations toward the end of the session, when the discussion turned to the incidence of type 2 diabetes among the participants' families, and how traditional medicinal plants can help mitigate the effects of the disease. A number of participants were interacting with the presenters, describing how their relatives suffered from diabetes. In 180 student-observation points, engagement was detected in 76.6% of the observations (Figure 6).

The average engagement of AI/AN students during each workshop interval (introduction, plant collection, extraction, bioassaying, and result discussion) is shown in Figure 7. Averages are compared between intervals (Figure 7A) or between workshops (Figure 7B). For the majority of the workshops, plant collecting was the most engaging activity for the students. Plant collecting incorporated both hands-on participation and cultural input from participating community elders, thus it is difficult to differentiate between the two effects on student engagement. The plant extraction, another intensive hands-on component, also evidenced high levels of engagement among the students. The exceptions to this, AK1, and ND2 (Figure 7B), are significantly lower, though this is due to unique circumstances that arose those two workshops (in AK1, the extraction period continued on while only one student group remained to complete the plant extraction, and so the other groups were idle and disengaged from the lesson; in ND2, the appearance

**Figure 6. STROBE engagement intervals of a three-part workshop involving AI high school and middle students at the United Tribes Technical College, Bismarck, ND. Engaged students were categorized by the activity they were engaged in: listening/watching/speaking (E1, ), writing or reading (E2, ), and hands-on activity (E3, ).**

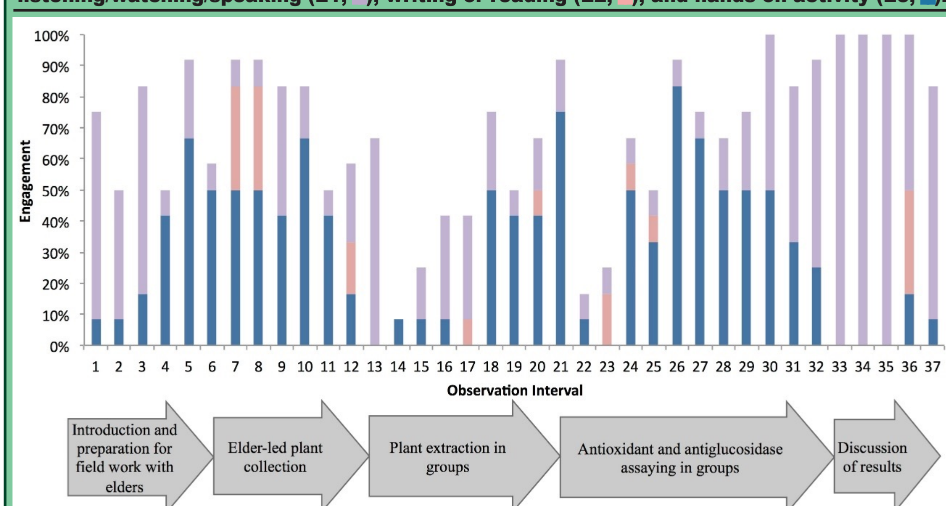
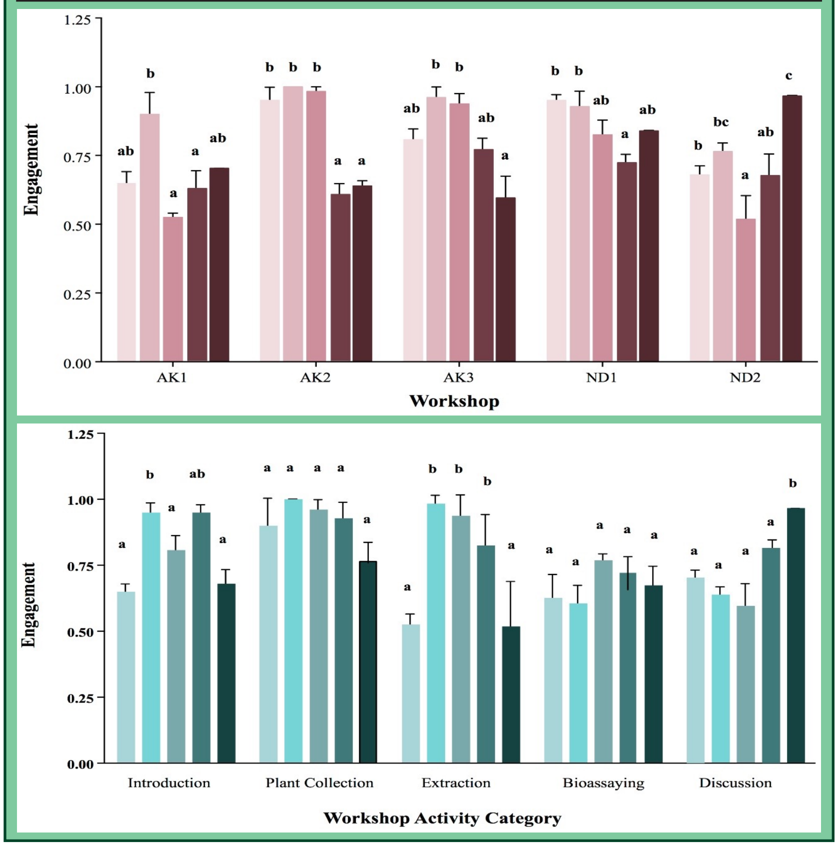


**Figure 7. Average engagement of AI/AN students in Alaskan and North Dakotan workshops. (A) Averages compared across activities ( - introduction - plant collection; - extraction; - bioassaying; - discussion of results). (B) Averages compared between workshops ( - AK1 - AK2; - AK3; - ND1; - ND2). All values are expressed as the mean ± SEM of each observation window. Different letters designate significantly different values (P < 0.05).**




of a television crew disrupted the workshop). Another trend across workshops was a drop-off in engagement throughout the discussion sections of each workshop (Figure 7B). This could be attributed to student fatigue after working through multiple hours of lessons and discussions and experiments. However, the second North Dakota workshop featured elders participating in the discussion section, interacting with the students on the medicinal plants and bioactivities that the students discovered, and how the traditional uses of the plants correspond to diseases that affect AI/AN communities. In this workshop, engagement was significantly higher than the other workshops (Figure 7B), and indeed was the highest participation section of the ND2 workshop (Figure 7A).

## Summary

Maintaining student engagement in lectures and labs is a constant struggle for educators, This challenge is made greater when there is a disconnect between the aspirations and attitudes of the learners and the content to be learned. This study indicates that these youth can be more engaged by western science education when culturally relevant, experimental, and hands-on methods are used. Engagement heightens the connection between students and the learning environment, and has been shown to be a powerful motivator for students actively interacting and participating in the educational process (Deci and Ryan, 2000; Willms, 2003). College students displayed generally higher levels of engagement (80.0% average) compared to high school students (70.3%) ($p < 0.05$), though the reasons why this occurred are beyond the scope of this current study.

These educational modules, based upon field bioassays, incorporate several methods that have proven effective in classrooms regardless of student demographic makeup. The system utilized in this study presented a novel bioexploration scenarios to AI/AN students using inquiry-based approaches to STEM laboratory instruction, which has been shown to engage and motivate students at all levels by providing novel problem solving opportunities (Ahlfeldt et al., 2005; Anagnopoulos, 2006; Kelly et al., 2010). The method also used physical movement in the classroom, through plant collection and bench-top extraction and bioassay experimentation, and movement has been shown to boost engagement and increase comprehension simultaneously (dePorter et al., 1999). From Figure 7, plant collection and extraction yielded high levels of engagement from students in all workshops. In addition, hands-on engagement levels increased substantially during the field collection, plant extraction, and bioassay portions of the workshops, reinforcing the notion that the participatory nature of these modules has promise to engage students in the material being delivered by the instructor.

The potential efficacy of this system of bioassays in engaging AI/AN students could also be attributed to the method's similarities with traditional forms of AI/AN education. Native educational systems were based upon generations of accumulated knowledge about the natural world, and had evolved into a complex experiential process, which included learning by doing, watching, listening, and experimenting under the mentorship of elders community members (Hall, 1996). The studied bioassay laboratory and lecture system, akin to traditional learning methodologies, emphasized hands-on learning in a participatory format that featured environmental knowledge as a focal point of the educational process (Guillory and Williams, 2014). Hands-on activities have demonstrated higher interest levels from students (Kellogg et al., 2010a), and this is another aspect of the bioassay system that aided in higher engagement levels during the field collection, extraction, and bioassaying portions of the workshops. Taken together, the structure of this culturally-based educational system helped to incorporate learning structures that were familiar to the students from their lives beyond the classroom.

In addition, by focusing on AI/AN traditional medicinal plants and diseases (like diabetes and metabolic syndrome) that constitute a major public health concern in the communities, the method highlighted here incorporated crucial elements of the students' realities outside the classroom into the formal educational structure. This is a key element in effective education with AI/AN students in order to maximize student success (Agbo, 2001). Utilizing aspects of the students' lives also provided opportunities to talk about themselves and relate the content to their personal lives and interests, which has been shown to allow students to personalize learning and make meaningful connections from the lesson using their own words and be an essential part of learning (Marzano et al., 2009). The incorporation of culturally relevant information – traditional medicinal plants, harvesting practices, and health concerns within the AN or AI community – that heightened engagement with the students during discussions. This was evident in the discussion section of the second North Dakota workshop (ND2), where elders participated in the final discussion of medicinal plants and diseases that affect AI/AN communities, where the engagement was significantly higher than other workshops.

In order to more completely evaluate the effects that a hands-on bioassay curriculum emphasizing AI/AN culture and values would have on student engagement, additional studies are essential. The majority of published studies on student engagement rely upon student self-reporting (Ahlfeldt et al., 2005; Appleton et al., 2006) rather than direct recordings during the class session by an impartial observer. Thus, there are no quantifiable results available to compare the quantified engagement rates observed in this study to other similar educational situations.

We are currently pursuing opportunities to evaluate the impact this curriculum has on student retention, including a control student group (one experiencing standard classroom educational curriculum), as well as pre- and post-course analysis for both the test and control classes. This proposed analysis will determine the significance of the curriculum not only on student engagement but on student performance and retention, as well as the potential for culturally-sensitive educational experiences like those presented here to encourage post-secondary educational pursuits in STEM disciplines.

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# A Proactive Model for Recruiting Students into Agriculture Disciplines


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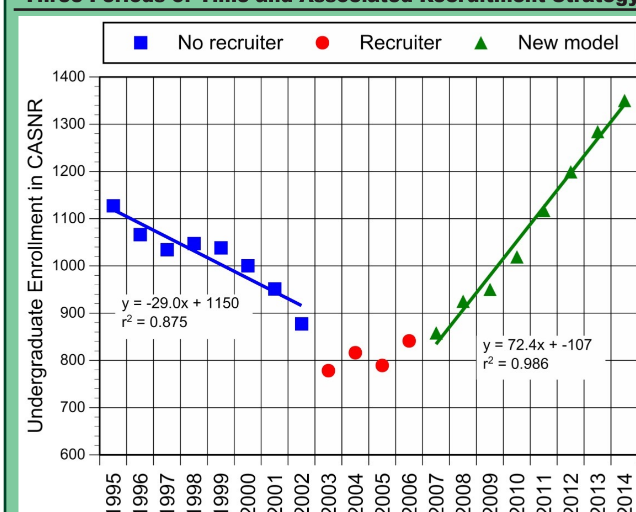
## Abstract

Recruitment of students into any field of agriculture is sometimes hampered by traditional perceptions of agriculture as being a study of “cows, sows, and plows.” Contrary to this misperception, modern agriculture encompasses discipline specializations that have wide appeal. Dispelling this myth of agriculture and replacing that image with the dynamic and cutting edge reality is the first challenge that we face in recruiting students. A second challenge that exists is the decline in the numbers of high school graduates entering college as evidenced by static and even declining higher education enrollments occurring in the last couple of years. We have developed a cadre of effective strategies for recruitment of high quality students that have enabled us to sustain an enrollment growth from 2007 to 2014 of 57.34%, much greater than that of the university as a whole and colleges of agriculture in a nine university land grant comparison group. Many of these strategies involve student engagement and input into the recruiting process, including the use of AgAmbassadors. These well-trained and talented student advocates of the college are used as peer-recruiters at college fairs and leaders of agriculture campus tours that end with a visit to a professor in the desired discipline area. Other strategies used are student critique and review of printed recruitment material, use of social media, targeting influencers and advocates about job opportunities and career options, and generous scholarship and mentor support. Today’s students are driven by a desire to “make a difference” and impact the world around them in a positive manner. Agriculture and all of its various disciplines offer an excellent opportunity to satisfy those needs.


## Introduction

From 1995 to 2002, the College of Agricultural Sciences and Natural Resources (CASNR) experienced a troubling and persistent decline in undergraduate enrollment from 1127 students in 1995 to 877 students in 2002 (Figure 1). In an attempt to reverse this decline, the college hired an undergraduate recruiter whose primary focus was to attend college fairs across the state and pass out brochures about the college and its majors. This limited and highly traditional approach was not wholly successful and subsequent enrollment ranged from 778 to 841 until 2006, when the recruiter separated from the college. The position remained vacant until 2008. When a new dean for the college was hired in 2007, one of the first priorities was to develop the holistic, proactive recruitment model described in this publication. As a result of its implementation beginning in 2007, undergraduate enrollment increased steadily from 858 to 1350 in 2014. This publication presents some of the challenges for recruiting students into agricultural disciplines and the approaches that have proven to be successful for CASNR since 2007.

**Figure 1. Changes of Enrollment in the College of Agricultural Sciences and Natural Resources during Three Periods of Time and Associated Recruitment Strategy**




Enrollment trends for the College of Agricultural Sciences and Natural Resources prior to having a dedicated recruiter, during the period of initial investment in a dedicated recruiter, and after implementing a holistic and proactive model for recruitment under the direction of a new CASNR dedicated recruiter.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## Challenges for Recruitment into Agricultural Disciplines

Many challenges exist for recruitment of students into agriculture disciplines, one of which is the antiquated perception of agriculture as a modern profession. As a result, students, when presented with agriculture as an option, are often unaware of the wide range of career options available to graduates of its many discipline areas. Very rarely is agriculture viewed as a cutting edge and technologically advanced research area. An outdated view of agriculture evokes images of farmers plowing, cows and sows, field production, and hard work for little reward. In one study using focus groups, middle school students equated the word farmer with “an old man, dressed in overalls, smelling dirty, and chewing on a straw” (Holz-Clause and Jost, 1995). The tremendous diversity of disciplines including genetics, research, engineering, and economics were not mentioned by the students in the study.

This imperfect picture of agriculture is also exacerbated by negative historical associations among groups underrepresented in today’s higher education population, particularly Hispanic and black students (Nichols and Nelson, 1993; Talbert and Larke, 1993). Throughout our nation’s history, much of the manual labor performed on farms has been conducted by minority workers (Talbert et al., 1999), which contributes to the view of agriculture as labor intensive coupled with low pay and prestige. Careers in agricultural education and food production are “stigmatized in the minds of students, particularly African American students” (Morgan, 2000). In a pre-college intervention program targeted toward underserved, economically-disadvantaged urban youth, students equated a career in agriculture with going “back to the fields” and the author speculated that this could be associated with recollections of sharecropping or slavery (Jones, 1997). Adverse associations with careers in agriculture persist today. “*Agriculture is viewed by many Latinos as a “dead-end career where only the negative perceptions of hard work, long hours, stoop labor, low wages, and working in harsh conditions are the norm. This negative perception will continue to challenge us in the coming years if not addressed*” (Romero, 2011).

Modern agriculture has also been depicted negatively in scare tactic marketing campaigns as consisting of large industrial farms raising animals in a factory-like setting as shown in Chipotle’s on-line video series “FArmed and Dangerous” (http://www.hulu.com/farmed-and-dangerous) and reinforced by its commercial “The Scarecrow” (https://www.youtube.com/watch?v=lUtnas5ScSE), a companion to its new app-based game. These very negative depictions of farming can have an impact, both overt and subtle, on young viewers that persists when they are considering career options. Whether production occurs by large corporate farms, by small farmers, or by producers of organic produce, it is still “agriculture”.

The merit of attaining an agriculture degree has not been helped by inaccurate and misleading online reports of the value of various college majors. In April of 2011, the Daily Beast came out with a list of the twenty most useless degrees. Among these, horticulture was identified as #2, agriculture as #3, nutrition as #10, and animal science as #20 (Daily Beast, 2011). In late July 2012, Terence Loose, a Yahoo blogger, posted an article entitled “College Majors That Are Useless” (Loose, 2012) and identified agriculture as useless degree #1, animal science as #4, and horticulture as #5. This article stimulated a flurry of responses refuting the conclusions reached and pointing out flaws in the survey used as a source for those conclusions. Even if online articles such as these are later challenged as perpetuating misconceptions about specific majors or the data sources are found to be flawed, the widespread access to this misinformation does not help to convey a sense of agriculture disciplines as a destination for choice for students struggling with career decisions.

A second challenge for recruitment of students into agriculture disciplines is the declining size of the pool of recent high school graduates (Prescott and Bransberger, 2012), who typically make up the bulk of incoming college freshmen. The number of high school graduates peaked in the 2010-11 academic year nationally and the Western Interstate Commission for Higher Education predicts short-term declines in all four geographical regions of the country studied. Demographic shifts are also expected with an increase predicted only for numbers of Hispanic high school graduates. The report also suggests that this may make recruiters search more aggressively for students like their traditional pool of students, but outside of their normal recruiting area (Prescott and Bransberger, 2012). Anecdotal evidence indicates that this may already be happening with recruiters from neighboring states targeting high talent Tennessee high school graduates more aggressively.

A third challenge that may soon have a major impact on the size of freshman classes recruited into the University of Tennessee for fall of 2015 is the passing of Governor Bill Haslam’s Tennessee Promise (http://news.tn.gov/node/11955). In this proposal, two years of community college or college of applied technology would be made available to graduating high school seniors in the state of Tennessee without obligation to pay tuition or fees. The Governor’s plan also reduced the amount of the Hope scholarship for freshmen and sophomores at state universities from $4,000 to $3,500 per year. Some of the potential impact of the Tennessee Promise implementation is that many confirmed freshmen may opt out of attending the university and choose local community colleges instead. Ultimately, this may have only a slight effect on enrollment as CASNR may gain upper level students as transfers from the community colleges.

Overall, the public perception of agriculture, the projected declines in the number of high school graduates, and the potential impact of education legislation in Tennessee have made it important to implement a proactive model for recruitment that encompasses multiple avenues of communication, effective use of the internet and social media, and peer-to-peer interaction.

## Methods

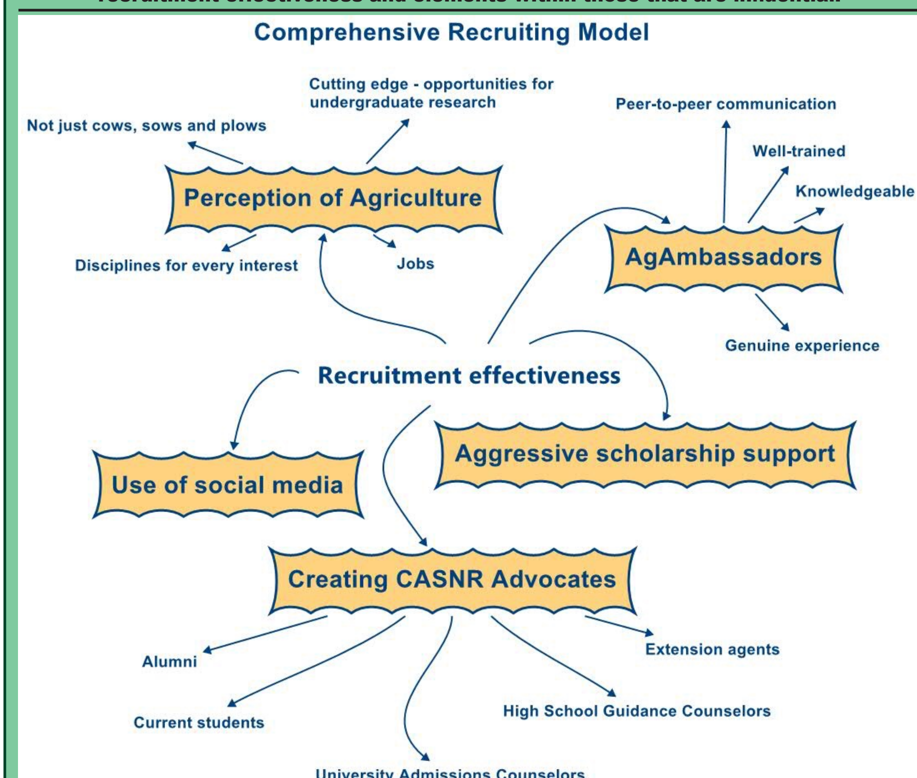
### Development and Implementation of a Proactive Model for Recruitment

In developing details of a new proactive model for recruitment, the need to incorporate more than one approach and leverage assets by creating advocates for the college was clearly recognized. The conceptual diagram in Figure 2 shows the elements that comprise the recruitment strategy first implemented in 2007 and fine-tuned annually, although the core elements remain the same. A public education aspect was central to dispelling the myths about agriculture as a career option. Ironically, one of the most important targets for this educational campaign about agriculture was the university's own admissions office. The admissions counselors had little knowledge or appreciation of agriculture and the lack of knowledge impacted recruitment and even the acceptance rate into the college (6% lower for CASNR than for the university as a whole in 2008). The time invested in participating in Admissions training and educating the personnel about CASNR and its career options was well rewarded in terms of recruitment effectiveness at a campus level.

One aspect of the model that has proven to be important is correcting the perception of agriculture as a career field. This has involved depicting agriculture as being a discipline that can satisfy students looking for many different things in a career area. Those seeking an artistic and creative outlet may be attracted to landscape design; those interested in working with people might be attracted to public horticulture or agricultural education. There are program choices in the college that appeal to business, technology, applied production, and research-minded students. On the web page for prospective students, we feature a table (https://ag.tennessee.edu/casnr/Pages/CASNRundergraduatemajors.aspx) that helps students choose majors in the college based upon interest and inclination.

Another trend that has helped with portraying agriculture as a viable career option has been the recent growth in job opportunities and demand for agriculture graduates. Reports concerning the need for more agriculture graduates to satisfy the demand have appeared in the last several years (Doering, 2013; McClure, 2014) and this demand has been underscored by the growth in the number of employers participating in the annual CASNR Career Fair. In 2013, the Coalition for a Sustainable Agricultural Workforce (CSAW) surveyed the six largest life science companies representing "97% of the private sector scientific workforce in biotechnology, crop protection, and seed" including Bayer Crop Science, Dow Agro Sciences, Dupont Pioneer Hi-Bred, Dupont Crop Protection, Monsanto and Syngenta. From this survey, a growth of 6.3% above and beyond replacement hires was predicted over the workforce that existed in 2012 by the year 2015 (CSAW, 2013). A recent news release from USDA, reports that agriculture is one of the best fields for new college graduates with nearly 60,000 high-skilled jobs expected each year in the U.S. and only 35,000 graduates available to fill these jobs (USDA, 2015).

**Figure 2. Diagram of various facets to consider when enhancing recruitment effectiveness and elements within those that are influential.**




Availability of jobs may not be the only motivating factor influencing students to choose agriculture. The fields of agriculture and natural resources are all about feeding the world and safeguarding the environment. The Millennial Generation identifies "making a difference" as more of a focus than financial success for a satisfying career (Smith and Aaker, 2013). This search for meaningful work and a potential to impact the future in a positive manner could not find a better home than in the agricultural and environmental science disciplines. This is reflected in our recruitment material and echoed by current students who have had the opportunity to participate in various high impact practices (Kuh, 2008) that positively impact retention and student engagement, such as 1) undertaking service learning (putting their education to work in volunteer service), 2) partnering with faculty to do undergraduate research projects, or 3) taking advantage of international experiences where they can see the practical application of what they have learned to improve lives.

## Creating CASNR Advocates or Recruiting the Influencers

A college's primary recruitment focus will always be the individual prospective student. When budgets are lean, leveraging effectiveness is important. One strategy to do this is to create CASNR advocates. The recruitment model (Figure 2) contained a strategy of targeting the primary "influencers" of prospective students and their families. These include university admissions counselors, university orientation leaders, high school guidance counselors, and community college advisors. Influencers such as admissions counselors and advisors each speak to hundreds of students each year and investment in creating an advocate for the college typically yields a persistent recurring benefit. CASNR "recruits" influencers with the goal of inspiring and educating those that might impact the decisions of prospective students to become advocates for CASNR. This allows the college to increase its recruitment "staff" greatly with minimal cost.

The vast majority of the incoming first-year class are classified as Millennial students, defined as those born in the years from 1982 to 2004 (Howe and Strauss, 2000). The generational traits of these students help to design strategies that recruiters can use to attract them to specific colleges and careers. This generation is characterized as being very close to their parents and high school seniors and their parents are jointly making the college decisions (Howe and Strauss, 2007). By extension, authority figures such as high school guidance counselors, community college advisors, Extension agents, agriculture teachers, and other middle and high school officials are viewed as credible sources of information. Thus, targeting influencers for recruitment purposes is both efficient and effective. Up-to-date college recruitment materials, including our Major Selection Guide, which provides a short and to-the-point table matching student interest with appropriate CASNR majors provide busy educators with need-to-know information without excess wording. Large group campus visits ranging from 10 to 200 students are available with these visits designed to be both educational and entertaining with hands-on and engaging activities.

We support the efforts of university Admissions Counselors by participating in all local admissions events for prospective students as well as those for guidance counselors and university Ambassadors, to the extent of even providing refreshments for some of these events and offering the agriculture campus facilities and meeting rooms. We offer to take over email or in-person conversations with prospective CASNR students particularly when students are seeking more detailed information about the major that might exceed the more generalized knowledge of Admissions Counselors. This lessens the student load of Admissions Counselors, particularly during college fairs, and strengthens the collaboration between the CASNR recruiter and the university recruiting team.

Current CASNR students become some of our best advocates and word of mouth promotes the services, faculty advising, and the complete college experience provided by the college. This is evident from the number of transfer students we receive from other colleges on campus (eight times as many transfer in than out) and from the number of CASNR Legacy Families who have now had multiple generations graduate with CASNR degrees. CANSR alumni who come back to offer internships through their companies are CASNR advocates as well and have proven to be excellent unpaid recruiters for the college. Keeping alumni engaged with personalized thank you notes, invitations back into the classroom, and updates using the CASNR Chronicle electronic newsletter help tremendously.

## Effective use of AgAmbassadors

The millennial generation is heavily influenced by peers and many life decisions are impacted by these relationships (Howe and Strauss, 2007). Using peers as part of the recruitment process is an effective way to communicate about the college experience, agriculture majors, and career options. AgAmbassadors are a group of CASNR students selected to serve the college in recruiting of prospective students, representing and supporting the college at various events, and promoting public awareness of opportunities in the field of agriculture. AgAmbassadors are chosen by their peers in a competitive process that focuses on speaking ability, personality, and knowledge about agriculture and CASNR and receive an AgAmbassador scholarship.

The training of CASNR AgAmbassadors actually begins during the selection process. As part of their second round interview, AgAmbassador applicants are asked to prepare and present a five-minute presentation on a CASNR major other than their own. While this practice is used to test an applicant's interest level in the program, it also begins their training in public speaking and their education about CASNR majors. Furthermore, it encourages them to consider what information is most useful to prospective students. While public speaking is an essential component of the position of AgAmbassador, the selection process is holistic. An applicant's presentations and interview question responses are rated individually for quality. Then, the interview is rated in its entirety based on four key characteristics of successful AgAmbassadors: personable, professional, knowledgeable, and capable of public speaking. This provides an opportunity for students with less public speaking experience to excel in other areas of importance to the overall success of the AgAmbassador team. Final selection is based on excellence in these four characteristics as well as the composition of the overall AgAmbassador team. Quality of applicants, major distribution, diversity (race, gender, transfer student, homeschooling, geographic background, etc.), second time interviewing, and academic year distribution are all considered in an effort to create an AgAmbassador team that is more than the sum of its parts. The interview and selection process gives applicants a taste of what it means to be an AgAmbassador, but their formal training comes in the fall at the annual Fall Training Retreat. This retreat occurs the two days prior to the first day of classes and all AgAmbassadors (both new and returning) are required to attend. New AgAmbassadors gain the most new information from the retreat, however, the retreat offers reminders, updates and team building for returning AgAmbassadors, as well as the opportunity to lead, share their experiences, and conduct training. Returning AgAmbassadors lead all non-administrative training sessions in order to encourage a mentoring relationship with new AgAmbassadors, an opportunity for leadership development, and fresh takes on old training topics.

The retreat starts with a demonstration on how to give an “Ag Campus” tour. The group then moves off-campus to a nearby 4-H lodge for enhanced team building. Other team building activities include regularly spaced ice breakers and energizers, a long break for canoeing, dinner at a local restaurant, and a night filled with s’mores around the camp fire. The entire retreat ends with a team builder activity in which students write a nice thought about each of their group members. AgAmbassadors rely as much on each other as they do their advisor. While these team building activities only take up a small fraction of the overall retreat time, they are integral to the success of the group and the execution of their mission.

The educational goal of the Fall Training Retreat is to prepare AgAmbassadors for attending college fairs, leading agriculture campus tours, and answering the questions of prospective students and their families. The foundational training, “Being an AgAmbassador,” covers the AgAmbassador mission statement, job description and requirements, expectations and accountability, rewards of being an AgAmbassador, and the additional expectations and rewards of being a returning AgAmbassador. Frequently asked questions regarding the AgAmbassador program are addressed. The group then creates group guidelines for supporting each other as well as the organization’s expectations for the advisor. The AgAmbassadors act as para-professional recruiters for the college as well as the institution, so they are trained on the incoming first-year and transfer student admissions and new student processes. This portion of the retreat is then brought to life with a session on frequently asked questions from prospective students and their parents.

The scope of the training is then narrowed specifically to the college. CASNR majors are discussed in detail so that AgAmbassadors understand their various concentration and minor options, common careers, and faculty involved in recruitment. Highlights and interesting facts for the majors are also discussed in order to grab the attention of prospective students. Training then shifts to CASNR programs. Overviews of each CASNR-sponsored student organization and study abroad trip are given. The CASNR Dean’s Scholars honors program is explained with its requirements and benefits. As the AgAmbassadors primarily recruit incoming first-year students, the CASNR Living and Learning Community first-year residential program is also presented. Finally, the entire training experience culminates with the staging of a mock CASNR college fair booth.

The Fall Training Retreat also serves several administrative purposes. Students add each other’s phone numbers into their personal contact lists to ease future communications. AgAmbassador profiles are written up for use on the CASNR AgAmbassador website and hallway display. Individual and group photos are taken. The AgAmbassadors also make posters for an upcoming CASNR event. Finally, the Fall Training Retreat ends with an evaluation of the Retreat’s sessions and operations.

The CASNR AgAmbassadors have also found it helpful to the organization to hold a Spring Retreat, which occurs the day before spring semester courses begin. However, the Spring Retreat focuses primarily on team building and leadership development. AgAmbassadors are each asked to develop a leadership project related to the AgAmbassador mission statement. These leadership projects are presented at the Spring Retreat and then implemented over the spring semester. The AgAmbassadors then host a luncheon with faculty members associated with recruitment in order to build relationships. Finally, the AgAmbassadors end the day with a fun teambuilding activity, such as bowling. While the Spring Retreat does not involve formal training, it has proven itself a beneficial way for the AgAmbassadors to regroup and prepare for the upcoming spring semester.

As part of the AgAmbassador experience, each participant is required to undertake a leadership project. These give the students the opportunity to apply critical thinking skills to determine what would best benefit the college and then plan and execute their project concept. The projects undertaken by the AgAmbassadors have been quite diverse. Some examples include developing a CASNR survey for current undergraduate and graduate students, faculty, and staff regarding Ag Campus resources and services; leading an initiative to get a coffee shop on the Ag Campus; and creating the CASNR AgAmbassador Scholarship for Student Advancement and a corresponding Chili Cook-off Fundraiser.

## The Web Presence

One of the first conclusions reached in 2007 was how difficult it was for students interested in attending the college to find relevant information about its programs and the admissions process. Information was available, but it was scattered over the college website as well as embedded in the individual web pages of each department. The dean hired a graduate student majoring in communications to design a one stop web portal that prospective students could go to first, which

**Figure 3. The website portal initially used in 2008 to aggregate the widely scattered online resources and information into one access point for prospective students.**


could then serve to link them to information that they wanted such as seeing a video about CASNR, choosing an academic program, applying for scholarships, registering for a campus tour, and answering a variety of potential questions (Figure 3). Linking students to potential scholarship opportunities and making sure that they apply for all of the aid available has also been a potent recruitment tool. In two of the past years since 2007, the dollar amount of scholarship aid given from just CASNR alone has exceeded one million dollars. This amount of scholarship aid is among the highest on campus even though CASNR is the 5th ranked college among nine with respect to enrollment. This generous amount of scholarship support has been significant to parents of prospective students as well, particularly since the decision of what college to attend is heavily influenced by the parents (Howe and Strauss, 2007).

## Bringing Technology into Campus Tour Scheduling

In fall of 2012, CASNR began using iPads for recruitment purposes during college fairs and for recruitment presentations for several reasons. First, iPads grab the attention of prospective students. At the time of purchase, only one other Tennessee institution of higher education (a private university) utilized iPads in their college fair recruitment booth. With at least forty institutions at each college fair, and sometimes over 200, prospective students are given a plethora of options to explore in a short period of time. Gaining the students' attention at college fairs is so important that strict "Articles of Good Practice and Ethical Standards" were established by the hosting organization (Tennessee Association of College Registrars and Admissions Officers, 2013). These articles forbid excessive recruitment tactics that unfairly steal the attention of prospective students, such as candy giveaways or displays involving audio. By using the latest in technology, institutions can set themselves apart from a sea of college fair booths in a manner that is respectful yet attention-grabbing.

Second, usage of iPads and other forms of trendy technology conveys the message that the institution of higher education is high-tech as well. Institutions would find it very difficult to travel with their top technology and research equipment, but highlighting everyday technology can be just as effective. In today's fast-paced, high-tech world, there is a sense of annoyance with outdated learning tools, such as paper forms and heavy textbooks. Therefore, institutions that utilize the technology of today and tomorrow as everyday tools are far more enticing to today's up-to-date student.

Third, iPad photo slideshows can help dispel the stereotypes associated with agriculture. Photos of real students experiencing hands-on agricultural learning can help to dispel these myths. However, the field of agricultural sciences and natural resources is so diverse; no one photo could accurately represent the college. Therefore, thirty seconds of watching an iPad photo slideshow can open a student's eyes to the wide range of options that exist in agriculture far better than looking at static images or even having a thirty-second conversation with a recruiter.

Fourth, the usage of iPads during college fairs and other recruitment events allows institutions the opportunity to educate prospective students about online resources. In today's world of higher education, the ability to navigate an institution's website is just as important as the ability to navigate the actual campus grounds. Having an iPad handy allows recruiters to show prospective students where to go to sign up for a campus tour or learn more about a specific major. This helps prospective students by encouraging them to visit the college website and providing them with a starting point for their online research.

Fifth and perhaps most important for the institution, iPads can be used at recruitment events to collect contact information from prospective students. Most institutions utilize paper information cards for this purpose. However, this later requires a significant cost in time in order to type this information into a computer program, so that it may be used for tracking and communicating purposes. There is also a significant risk to the accuracy of the information as handwriting can often be difficult to read and decipher. When prospective students type their own contact information into an iPad application, it allows for immediate merging into the institution's admissions data system and usage of that data. This practice increases the efficiency and accuracy of the overall recruitment process.

### Getting the prospective student on campus

"If we can get them on campus, we can get them to commit to CASNR." The visits arranged by our CASNR recruiter specifically to the agricultural campus have always been very successful at converting prospective students into those committed to attend CASNR. We offer one-on-one walking tours of the campus with a CASNR AgAmbassador as well as an introductory advising appointment with a faculty member from the prospective student's preferred department. Most prospective students and their families are amazed that a professor would spend an hour talking to them about career goals and academic opportunities and are encouraged by the thought that these advising appointments will be a regular occurrence once admission to CASNR has been granted. However, as our campus tour program grew more and more popular, there became a need to streamline the scheduling process in order to assure the highest level of service to each prospective student.

The first step in the process is for families to register for a campus tour on our website. This online SharePoint form asks for name, address, phone number, primary (student) and secondary (parent) emails, class level, planned major(s), and number of visitors in the group. Families may then select from the dates and time available. These potential dates and times are selected by CASNR a semester ahead based on availability, with same-week potential tour dates blacked out to encourage families to plan ahead. However, an "Other" option is available to families who cannot find a preferable timeslot. This same form is also used for those who call to request a tour, filled out by whoever takes the call.

Once a tour request is submitted, the family receives a confirmation email. The Program Coordinator of Recruitment and the AgAmbassador Scheduling Coordinator also receive a notification email. The AgAmbassador Scheduling Coordinator then contacts potential AgAmbassador tour guides and departmental faculty. Once those appointments are confirmed, the AgAmbassador Scheduling Coordinator inputs the appointments into the SharePoint system, automatically generating Outlook calendar invites for the AgAmbassador tour guide and professor, as well as the Program Coordinator for Recruitment and Dean's Office staff. This ensures that the AgAmbassador and professor have the appointment on their calendar. It also allows the Dean's Office staff to anticipate upcoming tours. Once the schedule is finalized, a campus visit itinerary email is sent to the prospective student and all those involved in the tour. A reminder email with the same content is also resent three days prior to the campus visit. This reminder email has significantly lowered our number of "no-shows," with families either remembering to plan for their visit or canceling the tour before the day of the tour. Once the tour has been completed, the AgAmbassador Scheduling Coordinator clicks an internal form button and a thank you email is automatically sent out the following day. Overall, the process has significantly increased internal communication and knowledge of campus tours, as well as doubled the external communication to prospective students.

### Comparison of enrollment trends to the university and peer group

Total college enrollment data from 1995 to 2014 were divided into three periods based upon whether there was no college recruiter (1996 to 2002), an initial college recruiter (2003 to 2006), and implementation of the new recruitment model encompassing a recruiter and much more as described earlier (2007 to 2014). A peer comparison group was constructed based upon several criteria. Each university in the comparison group was required to have the following characteristics:

- Be a land grant university in the southeastern region of the U.S. or adjacent to the region
- Have a similar structure for its college of agriculture with comparable programs offered.
- Have similar enrollments as those of CASNR
- Have enrollment data for the colleges of agriculture available for the entire comparison period.

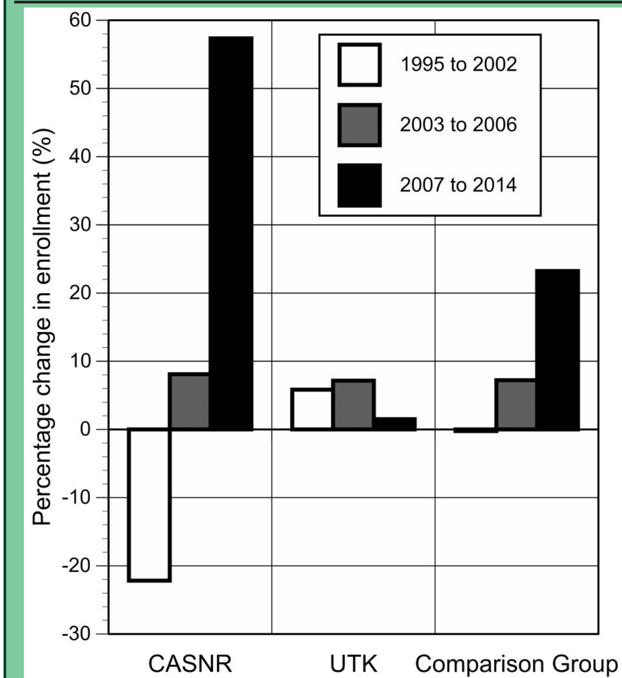
Nine universities were selected to generate comparison enrollment change data including the following: Auburn University, University of Arkansas, Louisiana State University, Mississippi State University, Kansas State University, University of Georgia, University of Missouri, Virginia Tech University, and West Virginia University. Annual enrollment (fall semester) data were obtained for the colleges of agriculture from these nine universities chosen as a comparison group for the period from 1995 to 2014 and then, percentage change in enrollment was calculated for each of the three periods to allow comparison to that of CASNR for each of the three periods examined in more detail.

## Results and Summary

Enrollment data were subjected to linear regression and significant models were described for the period of 'no recruiter' ($y=-29.0x + 1150$, $r^2 = 0.875$) and the period of the 'new model' ($y = 72.4x + -107$, $r^2 = 0.986$) (Figure 1). The positive growth in enrollment under implementation of the new model was consistent throughout the period from 2007 to 2014, which provides tangential evidence for its effectiveness. The percentage growth for the three periods defined above for CASNR was compared to percentage growth during the same period for the university as a whole (Figure 4). From 1995 to 2002, CASNR's enrollment declined 22.18%, whereas the university grew its enrollment by 5.83%. From 2003 to 2006, CASNR grew at a comparable rate (8.10%) to the university (7.15%), but in the years from 2007 to 2014 when the recruitment model was put into place, CASNR's enrollment grew 57.3% compared to only 1.5% for the university.

When the change in enrollment for CASNR was compared to that of the peer comparison group (Figure 4), CASNR had a greater decline in enrollment (-22.18%)

**Figure 3. Comparative Change in Enrollments during Three Periods of Time from 1995 to 2014**




Comparison of the percentage of undergraduate enrollment growth in the College of Agricultural Sciences and Natural Resources during three periods of time compared to the change in enrollment at the university as a whole and a comparison group consisting of nine comparable land grant colleges predominately from the southeastern region of the U.S., including Auburn University, University of Arkansas, Louisiana State University, Mississippi State University, Kansas State University, University of Georgia, University of Missouri, Virginia Tech University, and West Virginia University.

than did the comparison group (-0.17%) for the period from 1995 to 2002. During the time that CASNR first invested in a recruiter (2003 to 2006), a positive change in enrollment of 8.1% occurred relative to 7.22% for the comparison group. After implementation of the more comprehensive recruitment model from 2007 to 2014, CASNR experienced a growth of 57.34% compared to 23.23% in the comparison group.

The only other university in the comparison group to experience growth of similar magnitude to CASNR was Mississippi State University with a growth of 58.23% relative to CASNR's 57.34% from 2007 to 2014. The elements that contributed to the successful growth in enrollment at MSU were related by George Hopper (personal communication), the Dean of the College of Agriculture and Life Sciences, when he indicated, "*Without question, we have had a plan for managed enrollment growth in place since 2005 and have implemented it all along the way. New curricula, recruiters, target markets, new scholarships, summer youth camps, enhanced job placement opportunities with alumni including paid professional experiences and internships in residency, etc.*" The growth experienced at MSU was clearly the result of carefully implemented strategy and many elements in common with the strategies employed by CASNR.

It is evident from these outcomes that it is not enough merely to hire a recruiter. A proactive recruitment plan must encompass best use of resources available including all forms of communication from written to electronic, effective use of student resources for critique and engagement as peers, and an awareness of what makes the college unique and appealing to the prospective student and their primary influencers. All of these various factors have been taken into consideration in the proactive recruiting model presented here. We know that not all these techniques will prove to be of value to every college of agriculture facing recruitment challenges, but we hope that they may provide ideas that may be adapted by others to attract talented students to lucrative and impactful careers in modern agriculture for the future.

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# Student Reflections on Personal and Professional Growth After a 16-week Immersive, Experiential Learning Program in Equine Science[1]

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## Abstract

Higher education plays a key role in the creation of a competent and adaptable workforce. In 2006, an immersive, 16-week, experiential learning program was created to foster professional development in upper-level equine science students. The objective of this study was to assess participants' perception of content knowledge, hands-on skills, career preparation, and personal growth gained from the program. Students (n=27; 61% response rate) provided reflective feedback via Likert-type (4=very much; 3=somewhat; 2=slightly; 1=not at all) questions, and open-ended queries to elaborate on ordinal responses. In general, students felt that the program played a key role in preparing them for a career in the horse industry or the animal, veterinary or medical sciences (mean response 3.82±0.09). While students indicated the program was effective in facilitating desired improvement in equine-related knowledge and hands-on skills (3.77±0.08 and 3.74±0.09, respectively) and enhanced understanding of research (3.63±0.12), personal growth in transferable skills was also a prominent outcome (3.48±0.11). Eighty-nine percent of respondents reported improvements in communication, and/or the ability to work with and value others, as the most useful outcomes related to transferable skills. Overall, results suggest that learning content and technical skills in an immersive, authentic environment additionally facilitates gains in interpersonal competencies.

## Introduction

Recent surveys find many college graduates unprepared for employment, with increasing employer emphasis on transferable skills (e.g., communication, collaboration, problem-solving, scientific literacy) rather than specific knowledge or technical proficiencies (Fischer, 2013; Hart Research Associates, 2015). As a result, educators must devise alternative ways to deliver student-centered, authentic experiences that promote both personal and professional growth (Brickman et al., 2009; National Research Council [NRC], 2009). Immersive, experiential learning programs can offer new ways to supplement traditional classroom- or laboratory-based curricula and develop soft skills desired by employers (Hodge et al., 2011).

Experience-based learning allows students to create new knowledge through transformation of experience (Kolb, 1984). Kolb's learning cycle generally begins with students participating in a concrete experience, upon which they reflect, generalize and draw inference through abstract conceptualization, adjust their worldview to incorporate this new information, and then form and test these new hypotheses through active experimentation and a subsequent concrete experience. Experiential learning in authentic contexts, reflecting student career interests and declared learning objectives, creates deeper understanding than didactic learning, due to the active, practical and relevant nature of the lessons learned (Manolis et al., 2013). This type of learning is also

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based in constructivist learning theory, with contextual learning influenced by prior experience (Dewey, 1938), and characterized by dynamic ownership by students of personal knowledge creation (Splan et al., 2011).

Appropriate time for reflection is a large component of experiential learning, although it can be a major limitation in assessing the ability of experiential learning paradigms to effect developmental change in an individual. Personal growth often requires fundamental reframing and altering of one's belief systems, and is often a long-term process (Hodge et al., 2011). Reflection during the experience may provide instructors or facilitators some measure of formative assessment, but students may not realize some program impacts until they have sufficient time to reflect upon the experience or are challenged to transfer their new knowledge to a new situation.

Another key feature of undergraduate learning programs which are successful in promoting personal and professional growth is individualized and group mentoring of students by faculty and staff. Mentoring is often reported to have both career and psychosocial benefits, including academic performance, retention, self-esteem and self-confidence (Kram, 1985; Campbell and Campbell, 1997). A mentoring model for educational settings (Brzosa et al., 1987) identified mentor functions of informal contact, role modeling, direct assistance, demonstration, observation and feedback, and professional development planning assistance. These mentor functions are characteristic of undergraduate agricultural sciences programs, which, by nature, are often experiential in design and offer rich opportunities for faculty- or peer-mentoring of students (Wolfe et al., 2008).

With this theoretical background in mind, a novel undergraduate learning context was created in 2006 at a major land-grant university which removed students from the typical academic setting and fully immersed them in an intense, highly-authentic learning environment congruent with their motivations and desired career paths. The program targeted equine science students, whose anticipated careers often require a high degree of both technical skill and content knowledge, in addition to general social and scientific competencies (Splan and Porr, 2011).

Initially, the program was located on the university's equine teaching center on the main campus, and was conducted during the summer months from 2006-2009 under the direction of one of the authors. In 2010, the program was relocated to a large, university-owned, equine research and extension center roughly 400 km from campus, and was expanded to also include spring and fall semesters for academic credit, and was executed in cooperation with a second faculty member and staff member.

The program drew heavily on experiential learning theory. Students were treated as a cohort responsible for daily herd health and reproductive management of 40-50 horses, and, in addition to their on-site equine coursework, participate in equine science and management-related field trips, industry events, workshops and seminars hosted within the mid-Atlantic region. Further, the students assist faculty and graduate students with ongoing equine research projects. Increased emphasis on scientific literacy, data fluency and research experience was added to the curriculum in 2010 to improve student understanding of knowledge creation and application in both personal and societal contexts, and to better prepare students for STEM-based careers (Brickman et al., 2009). As a result, students were given more opportunity to conduct group or individual experiments, and exercises in scientific writing and review of recent scientific literature related to equine, animal and human health sciences were added. Technical competence in horse handling, horse management, and basic laboratory skills was developed through demonstration, guided practice and then independent practice. In addition to these program-wide learning objectives, students also developed three to four personal learning objectives at the beginning of the semester, which were then incorporated by program faculty and staff into the curriculum as the semester unfolds. Students met informally with instructors throughout the semester to assess progress on learning objectives and reflect on knowledge, skills, or insight gained.

The program was open to students enrolled in any college or university across North America. Cohort size is limited to six to eight students per semester (n=18-24 students per year). Recruitment consisted of thrice-annual emails to instructors and faculty in undergraduate equine science programs at two- and four-year institutions across the country, information on the facility website and through social media. Up to 80 students generally applied annually for a position in spring, summer or fall components of the program, making acceptance into the learning experiences competitive in nature. Participant selection was based on academic merit, year of expected graduation, articulated career objectives, previous experience, student interviews and input from references. Students with junior or senior standing were preferred, and recent graduates (within six months) were allowed to participate in the summer program.

In 2011, the program was expanded internationally through a partnership with the British Equestrian Federation (BEF). Undergraduate students in equine science programs across the United Kingdom competed for an experiential learning and research internship position during the summer session. One student per year was selected by BEF personnel and university faculty on the basis of an application, research paper, and face-to-face interview via free commercial voice and video over internet protocol software. To the authors' knowledge, this represents the first collaborative partnership between an international governing body of equestrian sport and an undergraduate equine science program in the United States.

Despite perceived program success, no formal evaluation of impact has been conducted to date. Therefore, the purpose of this descriptive and exploratory cross-sectional study was to examine efficacy of an experiential learning program designed to deliver personal and professional learning gains, as determined by previous program participants.

## Materials and Methods

All students who had participated in the program from its inception in the summer of 2006 through summer 2011 (n=43), were invited via electronic and social media to complete an anonymous, online, 19-question survey, administered through the university survey application, in February 2012. The 'cutoff' date of summer 2011 was chosen to allow survey participants at least six months of post-program reflection time. All survey materials and procedures were approved by the university's Institutional Review Board prior to data collection and participants provided consent via completion of the anonymous survey instrument. Response rate was 61%. Students completed multiple choice questions related to year and semester of experience, career aspirations and current job placement, and also provided reflective feedback via Likert Scale (4=very much; 3=somewhat; 2=slightly; 1=not at all) and open-ended queries to determine program impact.

A panel of 4 individuals with expertise in survey methods (n=2) and equine-related experiential learning (n=2) reviewed the instrument and found it to possess face and content validity. As the instrument included a series of questions designed to examine the pedagogical construct of experiential learning, reliability was gauged using Cronbach's alpha, which was found to be 0.91.

## Results and Discussion

Mean responses for perceived benefits of the experiential learning program are shown in Table 1. Emphasis on research in equine science was added in 2010, so only responses from 2010 and 2011 are included for this item.

*Current occupation and career aspirations.* The majority of respondents (41%) were currently enrolled in post-baccalaureate education programs, including graduate school (19%), veterinary school (15%) and pharmacy school (7%), at the time of the survey. Another 30% were employed in the equine industry as breeding managers (7%), veterinary technicians (7%), or as a riding instructor, tack store retail associate, Cooperative Extension equine program associate or veterinary assistant (16%). Two respondents were currently employed in the non-equine area (human embryologist and small business manager), while the remaining students (22%) were still enrolled as undergraduates at their home institution at the time they completed the survey. Considering their ideal career choice, only 37% of respondents indicated they would like to pursue a career in the equine industry. The remaining students indicated preference for a career in the veterinary or animal sciences (44%), human health or medical sciences (15%) or Cooperative Extension (4%).

*Perceived program benefit.* Students were asked to share general perceptions of program impact on improvement of knowledge and hands-on skills related to equine care, handling or herd health management via Likert-scale questions, and then asked to identify the 'most important or useful' learning gains in subsequent reflective, open-ended queries. As seen in Table 1, students indicated the program improved their knowledge and hands-on skills related to equine care, handling or herd health management; improved their knowledge of the sporthorse industry; increased their knowledge of research in equine science and enhanced their life skills.

**Table 1. Perceived benefit of immersive equine science learning program[1].**

| Perceived benefit of program | Mean±s.e. |
|---|---|
| Played a key role in preparing me for my chosen career | 3.82±0.09 |
| Improved my knowledge related to equine care, handling or herd health management | 3.77±0.08 |
| Improved my hands-on skills related to equine care, handling or herd health management | 3.74±0.09 |
| Improved my knowledge of research in the equine industry | 3.63±0.11 |
| Improved my knowledge of the sporthorse industry | 3.63±0.11 |
| Improved my transferable skills | 3.48±0.11 |

[1]Likert scale: 4=Very Much, 3=Somewhat, 2=Slightly, 1=Not at all

**Table 2. Student responses when asked to identify the most important or useful "life skill" gained during enrollment in the program, from those students who identified interpersonal growth as the primary outcome (n=23 of 27 participants)**

| Participant (random order) | Student Reflection |
|---|---|
| 1. | Communication skills with others working together as a team. Value of opinions or observations from others. |
| 2. | Working as a team. |
| 3. | PATIENCE with others whose top priorities may conflict with your own. |
| 4. | It definitely taught me team work and the value of hard work. |
| 5. | Communication with others is key to making a team run, and that everyone has their own opinion so it is important to listen and respect what they have to say. |
| 6. | Keeping calm and collected in tense situations will lead to a much better outcome for everyone. |
| 7. | Working as a team. |
| 8. | Helped me learn how to better lead my peers. |
| 9. | To learn to take more of a leadership role when working in a group. |
| 10. | Communication and conflict resolution. |
| 11. | If anything I think I learned more about myself going through the program. How I deal with people, how I need to change how I deal with others. Communication is everything, you don't have to like everyone but you must tolerate and respect them enough to work with them. |
| 12. | To be able to work with people with different personalities and attitudes. |
| 13. | I feel that I had good "life-skills" before my program, but this experience gave me great opportunities to practice with different people to work towards the same goal. We were also given great opportunities to "think critically". |
| 14. | Having the opportunity to work with others from different backgrounds improved my ability to communicate clearly. |
| 15. | Using my teamwork skills along with critical thinking to solve problems. |
| 16. | Working with others. |
| 17. | I learned about working with people with different skill levels and abilities to maximize productivity. I also think working with people with different personality and priorities was important to enable the group to still function. |
| 18. | Communication is vital. |
| 19. | Improvement in communication. |
| 20. | Patience (especially with other people) is a virtue. |
| 21. | Critical thinking and communication. |
| 22. | Working with others. Developing respectful means of communication and maturing in the way that I communicate with others. |
| 23. | Collaboration and leadership within a diverse group of peers and mentors. |

The most significant gain in knowledge reported by students was in herd health management (44%), followed by reproductive management (37%), marketing (8%) and training (8%). Foal and young horse handling skills were the most useful skill-based outcomes identified by program participants (63%), followed by herd health management (26%) and reproductive management (11%) skills.

In answering open-ended queries, communication skills and the ability to work with colleagues with different viewpoints or personalities were identified as the most important learning gains in life skills by nearly all (85%) students (Table 2). Interestingly, when asked to describe the program's most profound impact, students generally reflected on transferrable skills or personal growth, rather than specific content knowledge or technical proficiency gains. Representative responses are shown in Table 3. For students who participated in the residential program (2010-2011, n=18), on-site housing was largely seen as a positive and critical feature of the program, both in its ability to promote personal growth and allow participants to experience herd and breeding management in a real-world, around-the-clock setting.

In general, students who participated in the immersive program at either location indicated they enjoyed their experience (3.81±0.11), were confident that it played a key role in preparing them for their chosen career, and all but one (96%) indicated they would recommend the program to other students.

**Table 3. Selected narrative reflections on overall impact on personal and professional growth.**

| |
|---|
| (Summer, 2007): "This program really improved my confidence in my knowledge of equine reproduction and the fact that it was definitely something I wished to pursue further. I became more comfortable around the horses and felt that the hands-on experiences helped me understand what I was learning in the classroom." |
| (Summer, 2008): "It showed me that I would rather work in equine-related industry or extension than directly on a farm." |
| (Spring, 2010): "This program had a huge impact on my personal growth. Before partaking in the Middleburg program I had what I thought to be a pretty good grasp on my education and also work ethic. However one of the most valuable lessons I learned during my internship is that sometimes the hardest part of the job is learning to work with others. This is a skill that is typically not emphasized during ones college career, which is a shame because I find it to be one of the most limiting factors for most students entering the work force upon graduation. The impact that this program had on my personal character is one that I can only wish for others that go through the program. I not only became more self-aware of my actions and their impact others and the work atmosphere as a whole but also left with the realization that I had done my education a disservice for the three prior years of my undergraduate studies by not taking full advantage of all the opportunities that where available." |
| (Summer, 2010): "This program taught me that I wanted to explore research a little bit more, but that I also really enjoy working in the industry, especially in breeding and youngstock. From that I decided that pursuing a Masters degree would be good option for me. This program taught me to work with many different personalities and attitudes and how to get everyone to work together despite their differences. It also taught me to step up and be a leader when needed, but to also sit back and let others lead when needed." |
| (Spring, 2011): "The program had the greatest impact on my professional growth in the way that it opened my eyes to the very wide variety of aspects of the equine industry that one can be involved in, which was indeed a large part of what I was seeking from the experience. I also experienced a wealth of personal growth, as it was another huge step in the journey of learning how to live, work, and socialize with people that I may or may not have normally chosen for those roles in my life." |
| (Summer, 2011): "I was able to gain skills I could not have hoped to procure elsewhere. The hands on work with both the reproduction and management aspects of the equine industry was invaluable. We were able to have contact with very prominent figures in the sporthorse industry that could be utilized at a later time if you were looking for a career in the industry. Also, given my desire to be active in research, I was given the opportunity to participate in research beyond the summer. I could not have jumped on a project so easily at my institution." |

## Summary

In general, students felt the program delivered significant benefits to their knowledge and hands-on skillset in the equine area, and played a key role in preparing them for their chosen career. An advantage arises over didactic instruction as experiential learning techniques foster a depth of learning and cognitive recall necessary for transfer (Furman and Sibthorp, 2013). Although improvement in soft skills were not the driving motivation for program enrollment, students indicated they improved in these areas as a result of program structure, and the extended hours students spent working, and often living, together with other students and faculty/staff on-site during their 16-week experience. Previous work with college students participating in residential learning communities have indicated similar gains (Bobilya and Akey, 2002), but to our knowledge this is the first report of transferable skills gains in a faculty-led, immersive, integrative learning program for equine science students. Given the call from employers for increased transferable skillsets among college and university graduates, educators and administrators may wish to consider faculty-led semester- or summer-long immersive learning experiences among undergraduate students.

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# Demographic Factors Associated with Student Success in Two Upper-Year Agronomy Courses

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## Abstract

Understanding the factors that determine college students' success could enhance the university experience for students and could help direct resources at students who most require them. This study was conducted to determine the factors that influence students' course performance in two upper-year agronomy courses at the University of Saskatchewan. The study was based on data collected from students (n=274) who completed the two courses (PL SC 345 and AGRN 375) between 2013 and 2015. Female students performed better than their male counterparts, exhibiting a 4.3% higher ($P < 0.05$) average final grade compared with male students. Diploma students performed more poorly than undergraduate students from all other majors, a trend that was statistically significant in two years but consistent across all three years of the study. Sophomores had 3.5% to 9.5% lower final grades compared with juniors and seniors, although the differences were statistically significant in only one year. A significant, positive relationship was identified between the number of hours spent in class (attendance) and final course grade, wherein each hour spent in class improved final course grade by nearly 1%. These results provide course instructors with practical information that may aid them in their pursuit of student excellence in future upper-year agronomy courses.

## Introduction

Grain and oilseed prices have increased over the past decade, which has resulted in a strong rural economy that has contributed to increased enrollment in agricultural colleges. Without corresponding increases in new faculty, increased enrollment can produce academic units that struggle to provide consistent course offerings with ever fewer teaching resources, which adversely impacts student success rates (Vitale et al., 2010). Nevertheless, student performance in college courses continues to be critical to the success of academic institutions (Seidman, 2005). Instructors and administrators typically are concerned with student success because it is an important metric used for the assessment of learning and instructor effectiveness (Barkley and Forst, 2004). Moreover, there are often high costs associated with poor student performance, especially if it results in decreased student retention (Kuh et al., 2007). Understanding why some students excel while others do not is critical to improve student success in individual courses, as well as student retention rates.

Student performance is notoriously difficult to measure, and even more difficult to predict due to the complexities involved in academic excellence (Vitale et al., 2010). Students vary widely in their previous experience, cognitive abilities, comprehension, personality, socioeconomic backgrounds, and numerous other factors. Several studies have reported that students' prior academic performance, as measured by GPA, is a good predictor of student grades attained at university (Barkley and Forst, 2004; Martin, 1989; McKenzie and Schweitzer, 2001). Prior field experience has been shown to have a positive impact on the final grades of students enrolled in agricultural undergraduate courses (Mousel et al., 2006; Wildman and Torres, 2002). Absenteeism also can influence final grades in university courses (McMillan et al., 2009). Large, required courses often have high rates of absenteeism, and this negatively impacts student performance (Romer, 1993). Absentees may not gain the same level of competence or acquire the same volume of knowledge outlined in the course objectives compared with students who regularly attend classes (McMillan et al., 2009).

Other factors, which are demographic in nature, could impact student success rates. Demographic factors and their influence on student performance should be of increasing concern as the demography of the student population changes in agricultural colleges (Buchanan, 2008; Lyvers Peffer, 2011). An increasing number of students enrolled in agricultural colleges are urban, female, and from a visible minority (Reiling et al., 2003). Generally, females perform better than males throughout their university careers in subjects that require verbal competence (Burke, 1989). Lancaster and Robinson (2011) reported that females tended to score higher than males in an introductory plant science course. However, this may not be true for all courses

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in agriculture as Lim et al. (2014) reported that females in agricultural economics scored nearly three percent lower than men. Likewise, White et al. (2015) observed that gender had no influence on the critical thinking ability of animal science students. Student classification (year of study) may also influence student performance, although recent studies have produced ambiguous results. White et al. (2015) noted that classification had no influence on students' critical thinking ability, while Mousel et al. (2006) cited classification as a major factor determining student success in an introductory forage crops management course.

In order for an academic program or course to remain successful, it must address the interests and needs of its students (Lyvers Peffer, 2011). At the University of Saskatchewan (U of S), PLSC 345 (Pesticides and Crop Protection) and AGRN 375 (Current Issues in Agronomy) are offered to students as part of the curriculum for undergraduate or diploma (vocational) students majoring in agronomy. These courses also serve as open or controlled-elective courses for students in other majors. Moreover, the U of S offers a two-year diploma program that is separate from the undergraduate program, yet undergraduate and diploma students can take the same courses simultaneously. Collectively, these factors lead to a diverse classroom setting and it is important to understand how this diversity influences the demographics of the classroom and also, whether demographic factors affect student performance. Therefore, the objectives of this study were to determine if demographic factors influenced student performance in these courses and to assess whether an association exists between class attendance and student performance in one of the courses (AGRN 375).

## Methods

This study relied on data collected from students enrolled in two upper-year plant science (PLSC 345) and agronomy (AGRN 375) courses in the College of Agriculture and Bioresources at the University of Saskatchewan. Plant Science 345 is a pesticides course that consists of three 50-minute lectures each week, with no laboratory session. Agronomy 375 is a course designed to explore current and topical issues vexing crop production, and consists of two, 80-minute lectures each week, with no laboratory sessions. Both courses run the entire semester, which includes 14 weeks of lectures.

Data presented in this manuscript were collected for both classes at the end of the second (winter) semester from 2013 to 2015, to assess the factors associated with student success in upper-year agronomy courses. Within each course and year, only students who remained enrolled in the course for the entire semester were considered for the study. Gender, classification (year of study), major, and overall course performance were determined from course enrollment records. Majors were classified into four discrete categories: two-year diploma students (DIPL), undergraduate students majoring in Agronomy (AGRN), in Bioresource economics (BPBE), or in other (OTHER) majors (Crop science, Soil science, or Environmental science). Student classification was based on current year of study and included sophomores, juniors, and seniors. Course performance was based on final course grades (n=274) that were determined from examinations, written and verbal composition, and participation; the weight of each criterion varied with each course, but the instructor was common to both courses in all three years. In one of the courses (AGRN 375), the number of absences was recorded for each lecture to evaluate the relationship between absenteeism and student performance.

All analyses were carried out with SAS (version 9.2; SAS, Cary, NC). Descriptive statistics for demographic variables were calculated using PROC FREQ. Analysis of variance (ANOVA) was conducted on the data using the general linear model procedure (PROC GLM) appropriate for a completely randomized design. Gender, major, classification and their interactions were included as fixed effects in the model. Data were pooled across courses but analyzed within years. Variables included in the model were declared significant at $P \leq 0.05$, with means separated using a Fisher's protected least significant difference. Pearson correlation values (PROC CORR) were used to assess the strength of the relationship between final grade and gender, major, and classification. To determine the relationship between absenteeism and final grade, the number of absences was converted to the number of hours that each student attended class, and these values were then regressed against students' final grades using linear regression (PROC REG).

## Results and Discussion

The demographic information for the classes within each year is shown in Table 1. A total of 274 students were included in the study. The largest class size was in 2014, when 95 students completed the two courses, whereas the smallest class size was in 2013 and was comprised of only 88 students. Statistical analyses indicated there were no significant interactions between any of the response variables and therefore, results

**Table 1. Number of observations for gender, major, and classification in two upper year agronomy courses from 2013-2015.**

| | Total | | 2013 | | 2014 | | 2015 | |
|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % |
| Gender | 274 | | 88 | | 95 | | 91 | |
| Male | 164 | 60 | 55 | 63 | 59 | 62 | 50 | 55 |
| Female | 110 | 40 | 33 | 37 | 36 | 38 | 41 | 45 |
| Major[z] | 274 | | 88 | | 95 | | 91 | |
| BPBE | 22 | 8 | 3 | 3 | 9 | 9 | 10 | 11 |
| AGRN | 145 | 53 | 45 | 51 | 49 | 52 | 51 | 56 |
| DIPL | 64 | 23 | 16 | 18 | 24 | 25 | 24 | 26 |
| OTHER | 43 | 16 | 24 | 27 | 13 | 14 | 6 | 7 |
| Classification | 274 | | 88 | | 95 | | 91 | |
| Sophomore | 86 | 31 | 30 | 35 | 32 | 34 | 24 | 26 |
| Junior | 123 | 45 | 33 | 38 | 40 | 42 | 50 | 55 |
| Senior | 65 | 24 | 25 | 28 | 23 | 24 | 17 | 19 |

[z]Abbreviations: BPBE, Bioresource Policy, Business, and Economics; AGRN, Agronomy; DIPL, Diploma; OTHER, Other (includes Crop Science, Soil Science, Environmental Science)

were reported based on the main effects of gender, major, and classification.

Participants in the study were 40% female (n = 110), with 2015 being the year with the greatest number of female students completing the courses (Table 1). Gender had a significant impact (P < 0.05) on student performance in all years of the study (Table 2). Females consistently performed better than their male counterparts, regardless of major or classification. On average, the final grades achieved by female students were 4.3% higher than for male students (Table 3). Pearson correlation analysis revealed a positive association between final grade and gender in all years of the study (Table 4). Taken together, this implies that all else being equal, student grades in upper-year agronomy courses are correlated with gender.

It is possible that these gender-based differences stem from females performing better than males throughout their university careers in subjects that require verbal competence (Burke, 1989), as is required in both courses reported here. It is also plausible that females exerted more effort or had more motivation than males to obtain higher final grades because of a perceived lack of prior field experience, which can impact student performance (White et al, 2015). Females may perceive this in concert with the need to become more highly motivated in such courses, or they may be more willing to develop better academic skills when necessary (Aitken, 1982). Males, on the other hand, may perceive that they already know or have experience with the subject matter, and this may lead to complacency or perhaps, it may undermine their motivation. Students with more experience tend to perceive a small number of gains in applied courses (Evans et al., 2009). Further research is required to determine the underlying causes of these gender-based differences. Data regarding the impact of gender on student performance in agricultural courses is conflicting, but the results of this study are concordant with others who have noted significant differences between genders in regard to student performance (Burke, 1989; Lancaster and Robinson, 2011; McMillan et al., 2009). In contrast, other studies reported no significant effect of gender on course performance (Lyvers Peffer, 2011; Mousel et al., 2006; Torres and Cano, 1995; White et al., 2015).

Academic major had a significant effect on classroom performance in two of three years (Table 2), although the trends were consistent across all three years (Table 3). Nearly one quarter (23%, n=64) of the students included in the study were diploma students (Table 1), and they performed more poorly than students from all other majors. The average final grade for diploma students in 2013 was 14.7% and 6.9% lower than for BPBE and AGRN students, respectively (Table 3). Likewise, diploma students exhibited 11.5% and 9.3% lower final grades in 2014 than BPBE and AGRN students, respectively. In both 2013 and 2014, Pearson correlation analysis revealed a significant association between major and final grade (Table 4). There were no significant differences in final grades between the other majors included in this study.

These results suggest that academic major can influence student performance. Moreover, this study revealed that agricultural diploma students are consistently outperformed in upper-year agronomy courses by students from all other majors (Table 3). There are two possible explanations for these differences. First, diploma students are often in their second (sophomore) year when they enroll in upper-year undergraduate agronomy courses, and they may lack the collegial and field experiences necessary to achieve the higher grades characteristic of juniors and seniors. Prerequisites and prior experiences have a profound impact on student performance across a variety of courses (Mousel et al., 2006; Vitale et al., 2010; White et al., 2015). Second, diploma students often take fewer courses, most of which are applied in content and thus, they may lack the some of the basic competency skills attained in liberal arts courses that are required to excel in upper-year

**Table 2. Significance (P) of the effect of various factors on final grades in two upper year agronomy courses from 2013-2015 (n=274).**

| Source | df | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| | | | *P* value | |
| Gender (G) | 1 | **0.020** | **0.047** | **0.025** |
| Major (M) | 3 | **0.048** | **0.038** | 0.178 |
| Classification (C) | 2 | **0.044** | 0.801 | 0.603 |
| G X M | 2 | 0.293 | 0.761 | 0.233 |
| G X C | 2 | 0.536 | 0.207 | 0.139 |
| M X C | 4 | 0.833 | 0.611 | 0.339 |
| G X M X C | 6 | 0.054 | 0.579 | 0.458 |

**Table 3. Mean final grade as affect by sex, major, and classification in two upper year agronomy courses from 2013-2015, where n=274.**

| Factor | Level | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| Sex [x] | Male | 71.6 b | 71.2 b | 70.0 b |
| | Female | 76.4 a | 74.6 a | 74.6 a |
| | LSD | 3.5 | 3.1 | 3.2 |
| Major [x] | BPBE [y] | 83.0 a | 76.2 a | 78.4 |
| | AGRN | 75.2 a | 74.0 a | 72.3 |
| | DIPL | 68.3 b | 64.7 b | 68.6 |
| | OTHER | 74.4 a | 78.7 a | 73.3 |
| | LSD | 4.7 | 5.9 | NS[z] |
| Classification [x] | Sophomore | 67.5 b | 66.5 | 69.8 |
| | Junior | 75.2 a | 75.4 | 72.1 |
| | Senior | 78.3 a | 76.0 | 75.0 |
| | LSD | 4.2 | NS[z] | NS[z] |

[x]Means followed by the same uppercase letters are not significantly different within years based on LSD *P* < 0.05

[y]Abbreviations: BPBE, Bioresource Policy, Business, and Economics; AGRN, Agronomy;

DIPL, Diploma; OTHER, Other (includes Crop Science, Soil Science, Environmental Science)

[z]NS; not significantly different

**Table 4. Pearson correlation coefficients of student characteristics with final grade in two upper year agronomy courses from 2013-2015.**

| | 2013 | | 2014 | | 2015 | |
|---|---|---|---|---|---|---|
| Factor | ρ | *P*-value | ρ | *P*-value | ρ | *P*-value |
| Gender | 0.256 | **0.016** | 0.130 | **0.048** | 0.225 | **0.032** |
| Major[z] | 0.259 | **0.021** | 0.180 | **0.034** | 0.051 | 0.634 |
| Classification | 0.465 | **<0.001** | 0.366 | **0.001** | 0.161 | 0.126 |

[z]Abbreviations: BPBE, Bioresource Policy, Business, and Economics; AGRN, Agronomy;

DIPL, Diploma; OTHER, Other (includes Crop Science, Soil Science, Environmental Science) undergraduate courses. As a result, diploma students may possess lower cognitive skills compared with their undergraduate counterparts, including reduced communication skills, problem-solving, and critical thinking abilities (Brooks and Shepherd, 1990; Johnson, 1988). This may lead to lower GPAs if both types of student are enrolled in the same course and the course is taught at the undergraduate level; GPA is known to be a good predictor of student success in college courses (Nolan and Ahmadi, 2007; Vitale et al., 2010).

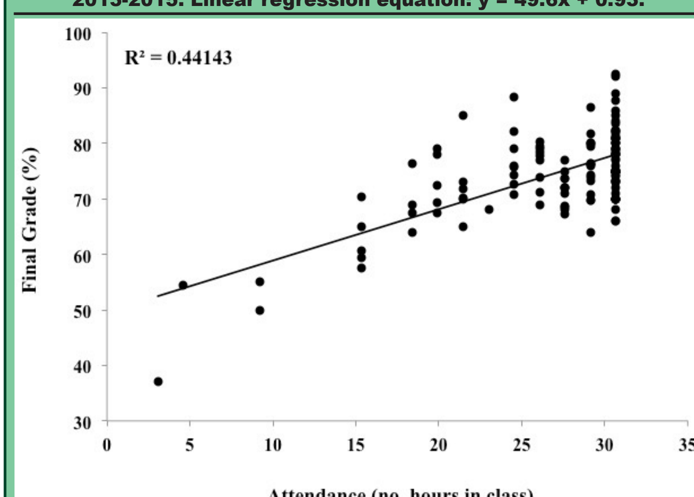
Nevertheless, the results of this study indicate that diploma students still performed at an acceptable level in undergraduate agronomy classes, despite significantly lower final grades. This suggests that combined diploma and undergraduate courses represent a feasible approach to maintaining both types of programs without the additional teaching staff that would be required if separate programs were offered. Moreover, combined courses could allow undergraduate students to attend courses aimed at diploma students, which are often applied in nature. Such courses would not likely be offered to undergraduate students for credit, but may be of significant interest to them nevertheless.

An interesting finding of this study was that the differences between BPBE students and students majoring in AGRN or OTHER were not statistically significant (Table 2). However, BPBE students did perform better than students from the other majors across both courses in all years (Table 3). Martin (1989) also found that agricultural economics students (BPBE) performed better than students from other majors in an agricultural economics class. Because BPBE students typically take agronomy courses as open or unrestricted electives, these students probably possess a genuine, unfettered interest in the course material and are intrinsically motivated, which likely contributes higher final grades in these courses (Ryan and Deci, 2000). Further research employing appropriate survey questionnaires is needed to test this idea.

Student classification by year of study influenced final grades, but was statistically significant in only one of the three years (Table 2). Sophomores had significantly lower final grades than juniors (7.7%) and seniors (10.8%) in 2013 (Table 3). Although not statistically significant (Table 2), there was a consistent trend in the data whereby sophomores always achieved lower grades than did juniors and seniors (Table 3). This may be due to the appreciable number (23%) of diploma students in the classes, most of who were sophomores. Given the aforementioned results, we can expect that these diploma students likely performed at a lower academic level than the undergraduate students and may have downwardly biased the final grades of sophomores. Nevertheless, the results of this study agree with Mousel et al. (2006), who reported that classification was a major determinant of student success in an introductory forage crops management course. Likewise, Rossano and Burk (2013) documented that sophomores were at a 7% disadvantage compared with upperclassmen in a 300-level equine management course. The current study also found a 7% disadvantage for sophomores in 2013, while disadvantages of 9.5% and 3.5% were noted in 2014 and 2015, respectively (Table 3). Pearson correlation analysis revealed a significant association between classification and final grade in 2013 and 2014 (Table 4). These results contrast with White et al. (2015), who suggested that student classification does not influence students' critical thinking abilities and may not influence student performance.

Linear regression indicated that the amount of time spent in class (AGRN 375) positively affected student performance as determined by final course grade (Figure 1). For every hour spent in class, a student's final grade was predicted to increase by 0.93%, almost a full percentage point. This suggests that class attendance is important to student success in this course, which agrees with the findings of Marburger (2001), Eash et al. (2006), McMillan et al. (2009), Lancaster and Robinson (2011) and others. It is important to note, however, that the regression only explained a moderate amount of the variance (R2 = 0.44), which was surprising and may indicate that attendance is less important than anticipated. In this course, and indeed many college courses, course notes are routinely posted online and available to students on-demand. By posting course material online, instructors may inadvertently discourage students from regularly attending classes, and it is possible that students can glean enough information from the posted material to succeed in a course. Support for this assertion comes from both the moderate R2 value in the regression equation as well as from the y-intercept in the regression equation (Figure 1), which showed that spending 0 hours in class resulted in a predicted final grade of approximately 50%. Strategies to manage this are difficult but include providing course material in class only, or providing partial online notes so that students must attend class to acquire all of the course material.

**Figure 1. Relationship between final grade and class attendance (number of hours in class) in an upper year agronomy course from 2013-2015. Linear regression equation: y = 49.6x + 0.93.**



## Summary

This study documented several factors that collectively impact student performance in upper-year agronomy courses, including student gender, major, and to a lesser extent, student classification and class attendance. Females performed better than males, while diploma students had significantly lower final grades than undergraduate students from other majors. Sophomores had lower final grades than juniors and seniors in all three years of the study, although the differences were statistically significant in 2013 only. Final course grade improved markedly (one percentage point) with each hour a student spent in class, which indicates that students who attend class more regularly are more likely to succeed than those students who do not. Unfortunately, the factors most associated with adequate student achievement in this study are factors that neither the student nor the instructor can control (i.e. gender, major, classification). Nevertheless, these results provide course instructors with practical information that may aid them in their pursuit of student excellence in future upper-year agronomy courses. For example, students in a demographic that is expected to struggle in these courses could be monitored closely with regard to student effort and attendance, with adequate time apportioned out of class to address specific needs (Vitale et al., 2010).

Mousel et al. (2006) attributed differences in course performance between majors to differences in agricultural background, with students that lacked an agricultural background being disadvantaged. Although information regarding agricultural background was not collected in the current study, this is not anticipated to be the major factor underlying current grade differences given that diploma students, who often have substantial prior field experience, had the poorest course performance. Instead, it is more likely that the learning styles and cognitive abilities of students contributed to the differences in grade distributions observed in the current study. Future studies are required to assess the impact of prior field experiences and learning styles on student performance in these courses to determine the causes of the differences reported in this study.

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# Incorporating Online Interactive Educational Activities in Animal Science Courses[1]

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## Abstract

The use of technology inside the classroom is continuously growing and options for learning platforms are increasing. University of Nebraska-Lincoln undergraduate students enrolled in four different Animal Science courses had the opportunity to utilize online interactive activities developed through a software program called SoftChalk. The activities were developed as an additional resource for students to use as a review method on key course concepts. At the completion of the semester, the students were asked to complete a survey on the usefulness of the SoftChalk activities. The survey also assessed the student's overall opinion and perceived effect that activities had on their learning experience. Students (82.68%; n=149) indicated SoftChalk activities helped them retain course material longer. While 85.94% of students noted the activities helped them feel more prepared for the exams and quizzes, only 61.72% of students felt that by completing these activities they had improved their critical thinking skills. Students (83.59%) acknowledged the review activities positively impacted their grade in the course. These interactive learning activities allowed for reevaluation of course material presented in a distinctive way.

**Key words:** interactive activities, animal science, education, softchalk

## Introduction

As online technology continues to grow, so do the possibilities for use of technology in the classroom. Faculty are steadily gaining more interest in exploring different ways to make learning more engaging and enjoyable for students (Maiga and Bauer, 2013). Many online resources are being used to assist in the enhancement of the students' learning, such as course Facebook groups, Google Docs, Khan Academy and other online tools.

Using activities and games in class encourages active learning, as well as collaboration, and interactivity (Ruben, 1999). Therefore, by using different types of blended learning resources we are increasing the students chance to understand the content being presented. Maiga and Bauer (2013) found while interactive activities and games can be incorporated into almost any type of course, having it incorporated in courses with increased volume of information present, such as Animal Science courses, can assist the student in processing information in a more meaningful manner.

The objective of this study was to create online interactive course review activities, through an online curriculum development program (SoftChalk LLC, www.softchalk.com), that were beneficial to the student's learning. SoftChalk is a content building tool that allows instructors to incorporate multiple interactive resources, develop custom design templates, and organize content information into one location. The materials can be shared across multiple learning management systems (About SoftChalkTM Cloud, 2015).

Additional objectives of this study were to determine if the students found the activities beneficial to their learning experience, if the students found the activities played a beneficial role on their grade and if they were able to better comprehend the key concepts in the course as a result of the online interactive activities.

## Methods

### Course Enrollment

The study included four Animal Science courses at the University of Nebraska-Lincoln during the fall semester of 2014. A core course all Animal Science students are required to take and three species specific courses that were content driven were chosen for the study. The courses involved were ASCI 240: Anatomy and Physiology of Domestic Animals (core course, 59 students enrolled), ASCI 251: Introduction to Companion Animals (51 students enrolled), ASCI 252: Introduction to the Horse Industry and Management (29

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students enrolled), and ASCI 450: Horse Management (20 students enrolled). The four courses were offered in an on campus traditional face-to-face lecture format and lasted one semester over a total of sixteen weeks.

## Activity Conditions

A variety of activities were created through the e-learning content creator SoftChalk. SoftChalk was used in the courses to incorporate online interactive activities as a resource to assist in student's perceptions of comprehension and retention of key course concepts. Examples of interactive activities used were crossword puzzles, photo albums, sorting, DragNDrop, flashcards, hotspot, labeling, quiz popper, and tabbed info (Table 1). One example of an activity would be the labeling activity (Figure 1 and Figure 2). This activity will usually contain an image which has labels that can be matched to their corresponding location on the image. While the types of activities were chosen by the instructor, not all the types of activities were used in all four courses of this study. Activities were accessible to the students through the university's course content management system, Blackboard. The activities included a set number of points, determined by each instructor, to be earned and linked to the gradebook in Blackboard. A tracking tool in SoftChalk enabled instructors to view the highest scoring grade for each student, most recent score, how many attempts each student made on the activity and the date they completed the activity. The students were allowed to participate in the activity with an unlimited number of attempts.

During the study, each course used different conditions to add online interactive activities in their courses (Table 2). Three of the four courses made the SoftChalk lessons optional. The course that made the activities a requirement (ASCI 252) and two of the courses that made it optional (ASCI 251 and ASCI 450) offered course points if the activities were completed. The activities were optional in ASCI 240 and recommended as an additional study resource for students. Each of the course instructors chose to use activities in different portions of their course during the semester: ASCI 240 used a total of 16 activities throughout the entire semester, ASCI 450 used a total of 16 activities in the second, third and fourth modules out of four modules in the course, ASCI 252 used 9 activities in the first and second modules out of four modules in the course, and ASCI 251 used a total of 7 activities in the second module out of four modules in the course.

**Table 1: Descriptions of SoftChalk activities.**

| *Activity* | *Description* |
|---|---|
| *Crossword puzzles* | A word puzzle containing clues to the words which belong as the correct answer to the puzzle |
| *Photo albums* | Contains a series of images with descriptions of the image |
| *Sorting* | Contains a maximum of five sorting groups and cards that can contain information or an image to match to that specific sorting group |
| *DragNDrop* | Can consist of eight matching pairs where the student will drag the correct item to its matching pair |
| *Flashcards* | Can consist of a series of cards that can contain a term, definition and image on the card which students can use to quiz themselves |
| *Hotspot* | An image that have information over certain areas of the image which students can use to learn more information about that image or can be quizzed over the image |
| *Labeling* | Contains an image which has labels that can be matched to their corresponding location on the image |
| *Quiz popper* | Contains up to seven different types of quiz questions such as: true/false, multiple choice, multiple answer, short answer, matching ordering, and essay. This activity allowed students to answer practice test questions over the newly learned information |
| *Tabbed info.* | Contains tabs of up to eight pages of information which can contain text and image to go along with the particular information on the tab. |

**Table 2: Use and application of the online activities across the four courses.**

| *Course* | Activities Required/*Optional* | *Points* Offered from Completing the Activities[z] | *Participation Tracked* |
|---|---|---|---|
| *ASCI 240* | Optional | No | Yes |
| *ASCI 251* | Optional | Yes | Yes |
| *ASCI 252* | Required | Yes | Yes |
| *ASCI 450* | Optional | Yes | Yes |

[z]Points offered for an activity in each course varied depending on the instructor.

**Figure 1: Incomplete SoftChalk labeling activity example.**

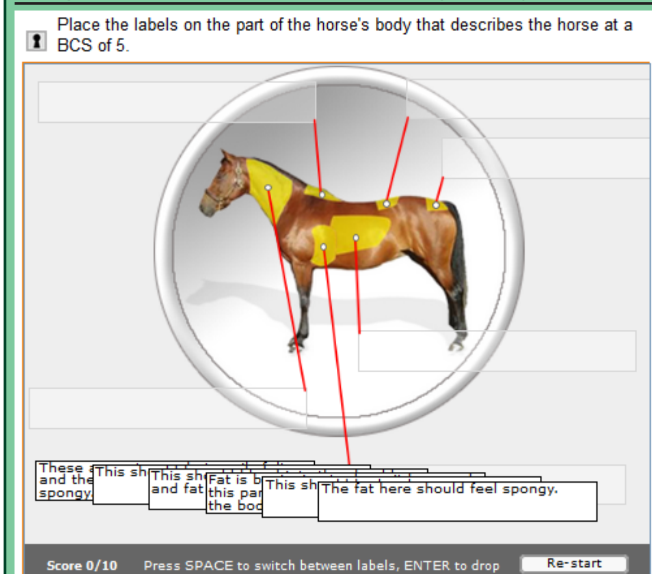
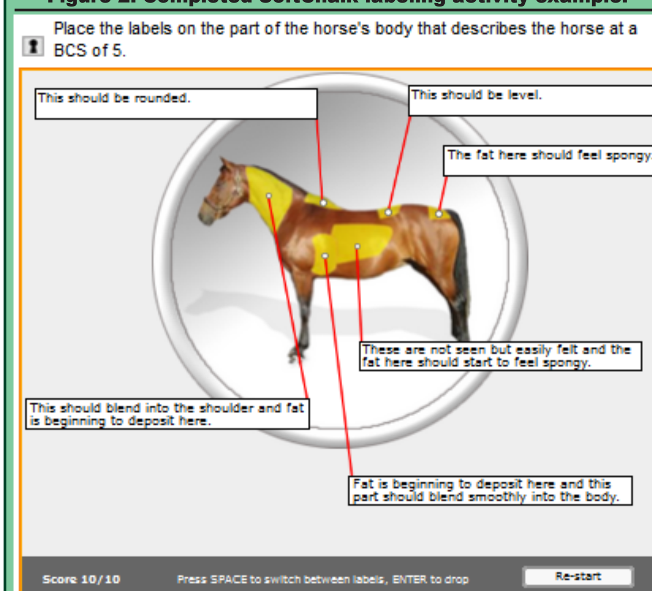



**Figure 2: Completed SoftChalk labeling activity example.**



### Activity Evaluation

An optional survey was developed to be completed by undergraduate students enrolled in the participating classes at the end of the semester. While there was a total of 13 students of the 159 in the study that were enrolled in two of the four classes concurrently, the activities were often different between courses which allowed for the students to have the opportunity to take the survey more than once. The survey was designed with the objective to obtain feedback from the undergraduate students on how useful they found each of the online interactive SoftChalk activities. Students were first asked if they participated in the SoftChalk activities. If the students answered that they did participate, they were then asked how useful and/or how much they used the various types of activities. This survey was considered an evaluation of a course tool by the University of Nebraska-Lincoln Institutional Review Board.

Students were asked to respond based on the five point Likert-type scale (5 = Very Useful/Used Extensively, 4 = Fairly useful, 3 = Moderately Useful/Moderately Used, 2 = Somewhat Useful, 1 = Minimally Useful/Minimally Used, 0 = Not Useful/Not Used) on how useful or how much they used the various type of SoftChalk activities. The survey also included general questions about the class to determine if students felt well prepared for the exams, if they understood the key concepts, if they were able to keep up with the course material, and if they felt that no additional study materials were needed for the course after completing the SoftChalk activities. The survey was provided to students during the last week of classes to serve as an evaluation of the activities.

### Statistical Analysis

The data was analyzed using the frequency procedure of SAS to determine the overall frequency of responses to each question by course. The survey was analyzed using the courses as the fixed variable. The data obtained from the survey was combined for all classes to provide a larger sample size that represented a larger population

## Results and Discussion

The four animal science courses involved in the study had a total of 159 students enrolled and 138 of the 159 students (86.8%) responded to the survey. The data from the surveys were combined as the frequency data was similar by course. Of those responding, 128 (92.8%) stated that they participated in the SoftChalk activities (Table 3).

Though not all of the activities were used in all courses, of the nine different types (labeling, sorting, DragNDrop, flash card, crossword puzzle, quiz groups, photo album, tabbed info., and hotspot), students reported three were most useful. The three activities used most extensively were sorting (86.6%; sorting a card containing information to the correct corresponding category card), labeling (87.9%; image which the student would need to match the corresponding label to the correct location on the image), and DragNDrop activities (81.75%; list of up to seven boxes of information and seven boxes of corresponding information that they would have to match up with the original seven boxes; Table 4).

The survey evaluated items such as how many times students completed each activity, student preference for the number of activities per module, and how much time it took them to complete an exercise. Most students indicated they completed an activity two to three times (66.9%; n=127). Over half of the students (55.2%; n=125) preferred to have four to six review activities per learning module. Students (70.9%; n=127) also reported activities took five to ten minutes to complete. Providing the students the opportunity to practice these lessons more than once can link the distance between learning the course concepts to actually applying the concepts in a setting outside of the classroom (Kumar and Lightner, 2007). This is a possible explanation for why students preferred to have four to six items per module instead of one to three per module. Additional resources allowed the students extra review of concepts presented and provided increased opportunities to apply the concepts, rather than just learning about them.

When asked if they felt the SoftChalk activities positively impacted their grade in the course, 83.6% (n=128) agreed it had (Table 5). Maiga and Bauer (2013) reported similar results in that the students felt interactive games helped improve exam scores. In the current

**Table 3: Student enrollment and SoftChalk usage for courses integrating SoftChalk into class material.**

| | Course | | | |
|---|---|---|---|---|
| Item | ASCI 240 | ASCI 251 | ASCI 252 | ASCI 450 |
| Total students enrolled in the course (n=159) | 59 | 51 | 29 | 20 |
| Respondents to survey (n=138) | 45 | 45 | 28 | 20 |
| Respondents that stated they used the SoftChalk activities provided (n=128) | 44 (97.8%) | 39 (86.7%) | 27 (96.4%) | 18 (90.0%) |

**Table 4: Student rankings of the usefulness of different types of interactive SoftChalk activities.**

| Activity[z] | Very Useful/ Extensively Used | Fairly Useful | Moderately Useful/ Moderately Used | Somewhat Useful | Minimally Useful/ Minimally Used | Not Useful/ Not Used |
|---|---|---|---|---|---|---|
| Labeling (n=116) | 74 (63.79%) | 28 (24.14%) | 7 (6.03%) | 2 (1.72%) | 0 (0%) | 5 (4.13%) |
| Sorting (n=127) | 72 (56.69%) | 38 (29.92%) | 7 (5.51%) | 6 (4.72%) | 1 (.79%) | 3 (2.36%) |
| DragNDrop (n=126) | 77 (61.11%) | 26 (20.63%) | 10 (7.94%) | 5 (3.97%) | 2 (1.59%) | 6 (4.76%) |
| Flash Card (n=125) | 51 (40.8%) | 35 (28.0%) | 24 (19.2%) | 7 (5.6%) | 3 (2.4%) | 5 (4.0%) |
| Crossword Puzzle (n=128) | 53 (41.41%) | 27 (21.09%) | 17 (13.28%) | 10 (7.81%) | 8 (6.25%) | 13 (10.16%) |
| Quiz Groups (n=112) | 42 (37.5%) | 25 (22.32%) | 16 (14.29%) | 3 (2.69%) | 3 (2.69%) | 23 (20.54%) |
| Photo Album (n=112) | 27 (24.11%) | 26 (23.21%) | 29 (25.89%) | 11 (9.82%) | 6 (5.36%) | 13 (11.61%) |
| Tabbed Info. (n=112) | 21 (18.75%) | 30 (26.79%) | 26 (23.21%) | 7 (6.25%) | 7 (6.25%) | 21 (18.75%) |
| Hot Spot (n=114) | 23 (20.18%) | 25 (21.93%) | 24 (21.05%) | 11 (9.65%) | 7 (6.14%) | 24 (21.05%) |

[z]n varies between items based on number of responses to each individual question.

**Table 5: Student perceptions of participation in the online interactive SoftChalk activities.**

| Item Statement[z] | Strongly Agree | Agree | Neither Agree or Disagree | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| I felt that the SoftChalk activities positively impacted my grade in the course. (n=128) | 49 (38.28%) | 58 (45.31%) | 18 (14.06%) | 2 (1.56%) | 1 (0.78%) |
| The SoftChalk activities were not helpful towards my learning and were just busy work. (n=128) | 1 (0.78%) | 7 (5.47%) | 7 (5.47%) | 67 (52.34%) | 46 (35.94%) |
| The SoftChalk activities helped me retain course material longer. (n=127) | 41 (32.28%) | 64 (50.39%) | 19 (14.96%) | 3 (2.36%) | 0 (0%) |
| The SoftChalk activities helped me feel more prepared for the exams and quizzes. (n=128) | 52 (40.63%) | 58 (45.31%) | 10 (7.81%) | 6 (4.69%) | 2 (1.56%) |
| I used the SoftChalk activities to help review for an exam/quiz. (n=128) | 64 (50.0%) | 48 (37.5%) | 12 (9.38%) | 4 (3.13%) | 0 (0%) |
| I was better prepared for the exam and lessons with SoftChalk activities than those without SoftChalk activities.(n=128) | 48 (37.5%) | 54 (42.91%) | 18 (14.06%) | 6 (4.69%) | 2 (1.56%) |
| Completing these activities improved my critical thinking skills. (n=128) | 26 (20.31%) | 53 (41.41%) | 33 (25.78%) | 13 (10.16%) | 3 (2.34%) |

[z]Ranked on a scale of 1-5: 1= Strongly Disagree, 2= Disagree, 3= Neither Agree or Disagree, 4= Agree, 5= Strongly Agree

study, the activities made the students feel more prepared for exams and quizzes (85.9%; n=128).

Almost 90% (n=128) of students strongly disagreed or disagreed when asked if they felt that the SoftChalk activities were not helpful towards their learning and were just busy work. A few of the comments made by the students included “it was a fun”, “interactive way to study and learn”, “it truly tested our knowledge rather than just reading the notes”, and “it was a valuable resource”. These statements indicate an apparent benefit of the activities to students’ learning experience.

Over 82% (n=127) of students claimed the online activities helped them retain the course material longer and this allowed students to better comprehend key concepts in the course. Our finding was similar to those of Randel et al. (1992). Since these types of games require active participation, the material has a greater chance of being integrated into the cognitive structures for the student and, therefore, more likely to be retained. Interactive games and activities have been shown to motivate people to learn, even those who might not have been interested in the material (Reigeluth and Squire, 1998; Lepper and Henderlong, 2006; Liberman and Linn, 1991). This explains why over 87% (n=128) of students indicated that they used the activities as a method to review material for upcoming quizzes and exams.

When asked what they liked most about the exercises, several students stated that the activities challenged their knowledge and allowed for increased comprehension of the concepts. The activities required thought, improved retention of information, required minimal time and helped summarize material in preparation for exams.

Student recommendations for improvement to the activities included providing clear instructions initially on how to use the activities, making all of the activities mandatory and point earning, having all activities engaging and not just informational, correcting some of the technical issues such as making it more mobile-friendly, and developing more of the activities for the entire course. Students suggested the instructor should provide a printed key and include the expectations for the use of the activities in the syllabus and within each activity.

A few possible explanations for some of the drawbacks in the findings of this study include the likely difference in instructor teaching styles and development of lessons. Each instructor chose the type of activity, quantity, and requirements to their own personal preference for their specific course. Bourgonjon et al. (2010) found that it is more beneficial to the students’ learning to explain to the students the specific advantages the particular activity or game has over other teaching tools rather than to present it as a fun way to learn. Therefore, by explaining the advantages of the SoftChalk lessons and creating a more unified environment across courses, this study may have been able to achieve a more valuable set of results. The study was also only completed over a length of sixteen weeks. Therefore, additional studies would be beneficial to support findings.

Because a variety of Animal Science courses were involved in the study (three sophomore/junior level courses and a senior level course), a variety of knowledge and degree of difficulty was incorporated into the activities. Students were provided with a unique online interactive learning resource for Animal Science courses. Furthermore, using new and different types of technology will help prepare students for future careers where familiarity with current technology will become even more important (Rhoades et al. 2008).

## Summary

Numerous activities were developed in SoftChalk, made available online to students in four Animal Science courses and evaluated through a student survey. The online activities allowed for students to engage in a non-traditional study method. The students found that the exercises helped them better understand the course material and feel prepared for quizzes and exams. In addition, students indicated the activities played a beneficial role in their grade and to their learning experience. In conclusion, online SoftChalk interactive review tools included in the courses provided students with additional learning resources and students confirmed that the activities enhanced learning of course content. The use of online interactive review activities can be beneficial in preparing students and helping them to learn and retain the course information.

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Ruben, B.D. 1999. Simulations, games, and experience-based learning: The quest for a new paradigm for teaching and learning. Simulation & Gaming 30 (4): 498-505. activity example.

# Plant Science Instructors' Perceptions of Learning Experiences in Online and Face-to-face Courses


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## Abstract

Introductory plant science instructors have several options for course setting; lectures and laboratories can both be held via a face-to-face course, online course, or a hybrid of the two. While online laboratories boast many benefits over their face-to-face counterparts, instructors' preferences for teaching in these settings is unknown. This study utilized a survey approach to describe introductory plant science instructors' perceptions of learning experiences in the three course environments. Findings indicate that instructors offer instruction via face-to-face lectures and laboratories, prefer class sizes under 40 students, and prefer face-to-face learning environments. Instructors also felt that learning could be maximized by offering students a lecture before a follow-up laboratory experience. They primarily offered students abstract conceptualizations through their lectures and concrete experiences through their laboratories. These findings yielded several recommendations, among them being the need for instructors to explore online learning settings to overcome challenges common to face-to-face lecture and laboratory environments.


## Introduction

In education, laboratory activities have numerous purposes. Primarily, laboratory work provides students with the conceptual and theoretical knowledge necessary to fully understand scientific concepts and understand the nature of science (Dikmenli, 2009). Additionally, students engaging in laboratory activities apply procedures used by scientists in the field (Dikmenli, 2009). Laboratory activities have also been found to increase students' interest in academic subjects (Tüysüz, 2010). Instructors and educational researchers acknowledge that laboratory work has the potential to foster higher order thinking skills (Ottander and Grelsson, 2006). Dale (1969) posited that learners engaging in hands-on experiences, such as laboratory activities, remember approximately 90% of what they do, compared to 10% of what they read.

Kolb (1984) identified four experiential learning stages in which a student must engage in order for learning to occur, each of which is possible in a laboratory setting. Information grasping activities, through either 1) concrete experiences or 2) abstract conceptualizations, enable the learner to take in new information. Information transforming activities, through either 3) reflective observation or 4) active experimentation, allow the learner to take that new information and use it in a manner that integrates it into the knowledge schema of the learner. Learning can occur regardless of the starting point and order of these stages, provided the learner engages in all four. Laboratory activities have the potential to include all four stages of experiential learning, thereby enhancing the knowledge gained by the student.

However, practitioners have identified several barriers that reduce the use or effectiveness of classroom-based laboratory activities, including the costs of equipment and consumables required for laboratory work, the time required to plan and conduct laboratory activities, the management of large numbers of students in confined laboratory spaces, and a lack of materials or facilities to carry out specific laboratory activities (Tüysüz, 2010). The rise of online education programs has offered laboratory instructors a potential avenue to overcome these barriers; virtual laboratory activities hosted on the internet reduce equipment costs and time requirements, enhance safety by reducing student access to hazardous materials and eliminating crowded laboratory rooms, and reduce the time required by instructors to prepare the laboratories (Kiyici and Yumusak, 2005). Online laboratory experiences also have the ability to maintain standards of educational quality set by face-to-face classroom laboratories; Demirci (2003) found that virtual laboratories allowed students to understand difficult concepts more easily, and Tüysüz (2010) reported that students experiencing virtual laboratories had significantly higher knowledge gains and interest growth than students experiencing a


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traditional laboratory. In Plant Science, the use of virtual laboratories may assist in reversing the widespread challenge of stimulating interest in plants among undergraduates (Vougioukalou et al., 2014).

The quality of the laboratory experience, regardless of delivery format, depends on the views and subsequent actions of the instructor responsible for the laboratory. While laboratory experiences can be utilized for knowledge production through all four stages of the experiential learning cycle (Kolb, 1984), research has shown that instructors "*fail to understand that laboratory activities may provide opportunities for students to produce new knowledge through scientific investigations*" (Dikmenli, 2009, para 3, line 5-7) and view laboratory activities as an opportunity for students to apply what they have already learned (Kang and Wallace, 2005; Shoulders and Myers, 2013). Shoulders and Myers (2013) found that high school agriculture teachers typically omitted at least one stage of the experiential learning cycle when working with students in laboratory settings, and that active experimentation was the stage most frequently omitted from laboratory-based learning activities. Further, there is a gap between undergraduates' and instructors' perceptions of the use of technology in the classroom. While current undergraduates "expect [technology] to support their learning" (International Advisory Board, n.d., p. 4), their instructors have been found to be resistant to new technologies (Pvtel, 2006). Currently, there is a gap in the literature with regard to plant science instructors' perceptions regarding online laboratory environments and how they compare to face-to-face laboratory environments.

## Methods

The purpose of this study was to describe plant science instructors' perceptions of face-to-face and online education. In order to achieve this purpose, the following objectives were developed:

1. to describe introductory plant science courses' learning environments;
2. to describe introductory plant science instructors' preferences with regard to learning environment;
3. to describe introductory plant science instructors' preferences with regard to class size based on their courses' learning environments;
4. to describe introductory plant science instructors' expectations of student participation based on their courses' learning environments; and
5. to describe introductory plant science instructors' perceptions of their use of experiential learning stages based on their courses' learning environments.

This study used a survey design to achieve its purpose. The population consisted of all introductory plant science instructors teaching at land-grant institutions in the US, and a census was sought after. The University of [State] Institutional Review Board deemed this study exempt, as it surveyed adults over 18. Because no comprehensive database exists for this population, the researchers reviewed institutional websites and made contacts in order to identify at least one introductory plant science instructor at each institution (N = 120). The sampling frame presents a limitation of the study, as the researchers may not have identified all introductory plant science instructors. Instructors without available email addresses (n = 28) were removed from the study, leading to an accessible population of 92.

In the absence of a validated survey designed to meet the study's objectives, the researchers developed a survey consisting of 50 multiple choice and Likert-type items. Instructors were presented with items only pertaining to the lecture and laboratory settings to which they had access. A panel of experts in plant science and online education reviewed the survey for face and content validity; edits were made based on the panel's recommendations. Reliability was established using the test-retest method (Huck, 2008). Eight professors of agricultural education completed the survey two times at the beginning and end of a two-week period, yielding a reliability score of 0.805.

Dillman et al. (2009) recommend multiple contacts with potential respondents in order to maximize response rate. Members of the sample were contact once weekly for a four-week period. After the four weeks, 41 responses were collected. Of those respondents, 15 indicated that they were not responsible for teaching an introductory plant science course. They were removed from the sampling frame, leading to a final response rate of 33.8% (n = 26). Nonresponse error was addressed via double dipping (Miller and Smith, 1983). No significant differences were found on responses to any item between respondents and nonrespondents (p = 0.433 - 0.715). Therefore, findings were generalized to all members of the accessible population.

## Results and Discussion

### Description of Plant Science Courses' Learning Environments

The majority (n = 20) of respondents described their learning environments as being a face-to-face lecture setting (Table 1). No instructors reported delivering instruction via an online or hybrid face-to-face/online laboratory. Sixteen respondents said they taught in a face-to-face lab setting, four utilized a hybrid face-to-face/online lecture format, and one respondent used an online-only lecture format. Most (n = 14) instructors reported their face-to-face lecture was required to be taken with a lab course, while all 16 respondents reported a face-to-face lab is required when taking the lecture. More (n = 13) instructors reported their face-to-face laboratories reinforced information introduced in the lecture, as opposed to eight respondents stating their face-to-face lecture supplemented information from the laboratory. Eleven respondents (68.9%) indicated that the face-to-face lab grade is not separate from the lecture grade, indicating that in most settings, the lecture and lab are closely linked.

**Table 1. Plant Science Courses' Learning Environments**

| Learning Environment | *f* | % |
|---|---|---|
| Face-to-face lecture | 20 | 83 |
| Face-to-face lab | 16 | 67 |
| Online lecture | 1 | 4 |
| Online lab | 0 | 0 |
| Hybrid face-to-face/online lecture | 4 | 17 |
| Hybrid face-to-face/online lab | 0 | 0 |

**Table 1. Plant Science Courses' Learning Environments**

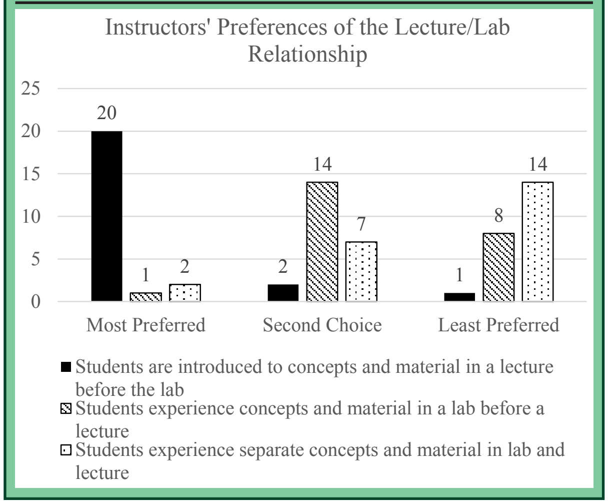



**Figure 2. Instructors' perceptions regarding student learning based on lecture/lab relationship.**

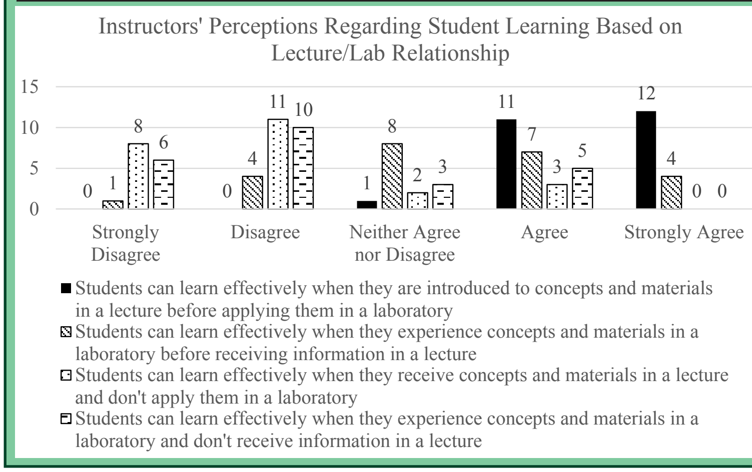
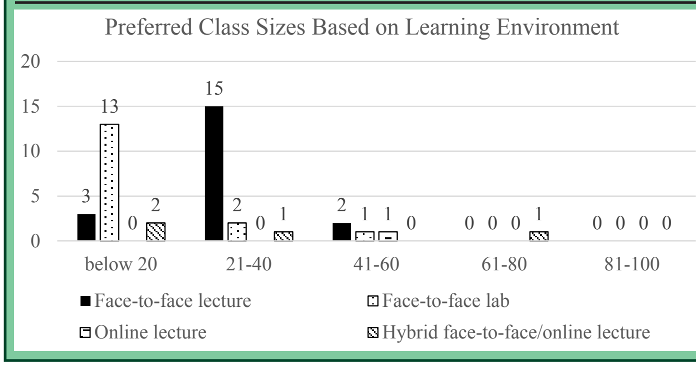


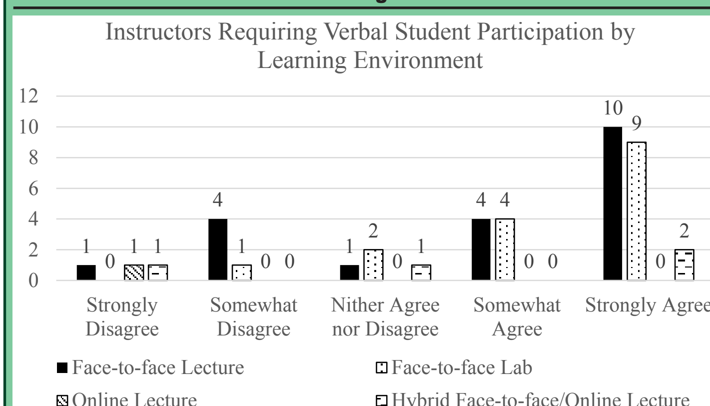

**Figure 3. Instructors' preferred class sizes based on learning environment.**




## Description of Plant Science Instructors' Preferences with Regard to Learning Environment

A majority (n = 20) of instructors ranked a face-to-face learning environment as their most preferred setting for lectures, and 19 listed an online environment as their least preferred for lectures. Similarly, most respondents (n = 22) indicated that a face-to-face lab environment is their most preferred for a lab and online as their least preferred laboratory environment (n = 20). Most instructors (n = 20) preferred to introduce concepts to students in a lecture setting before introducing those concepts in a lab and least preferred the lab and lecture focusing on separate concepts (n = 14) (Figure 1). The majority of respondents (n = 23) agreed or strongly agreed that students learn effectively when they are introduced to concepts and materials in a lecture before applying them in a laboratory. The majority of respondents disagreed that students can effectively learn when they engage in either the lecture or laboratory without the other (Figure 2).

**Figure 4. Instructors requiring verbal participation based on learning environment.**




## Description of Introductory Plant Science Instructors' Preferences with Regard to Class Size Based on Their Courses' Learning Environments

Most instructors (n = 15) preferred a class size of 21-40 in a face-to-face lecture setting, and fewer than 20 students in a face-to-face lab setting (n = 13) (Figure 3).

Instructors in a hybrid lecture format indicated that fewer than 20 students was also their preferred class size. No respondents indicated a preference for any type of class with more than 80 students.

**Figure 5. Instructors requiring hands-on participation by learning environment.**

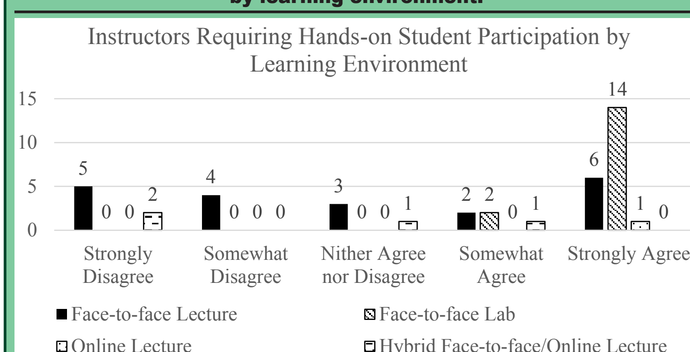


**Figure 6. Instructors' Perceptions of the Experiential Learning Stage Intended when they Instruct Students**

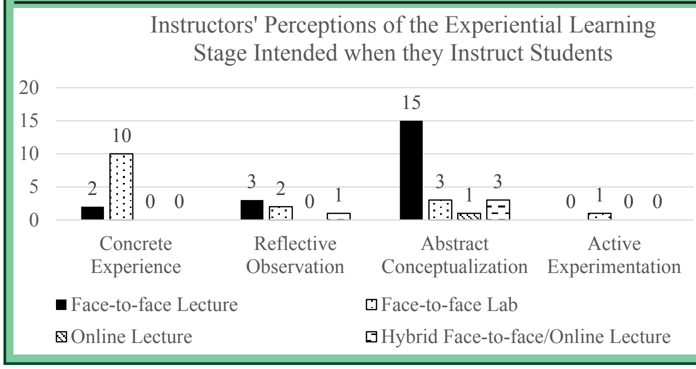



**Figure 7. Instructors' Perceptions of the Experiential Learning Stage they Intend when they Design the Purpose of their Class**

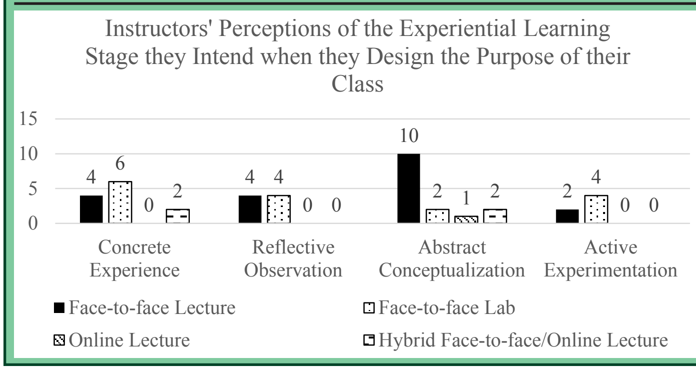



**Figure 8. Instructors' Perceptions of the Experiential Learning Stage they Intend when they Design Objectives for Students**

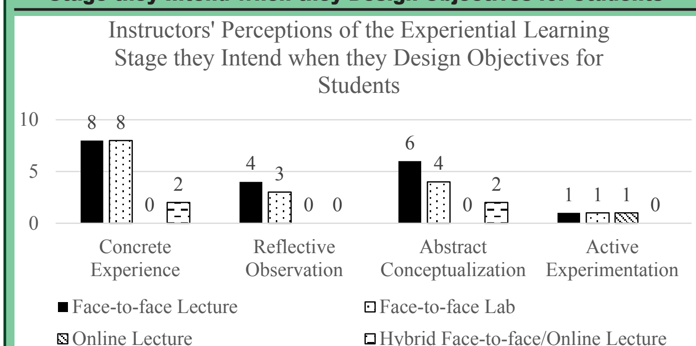
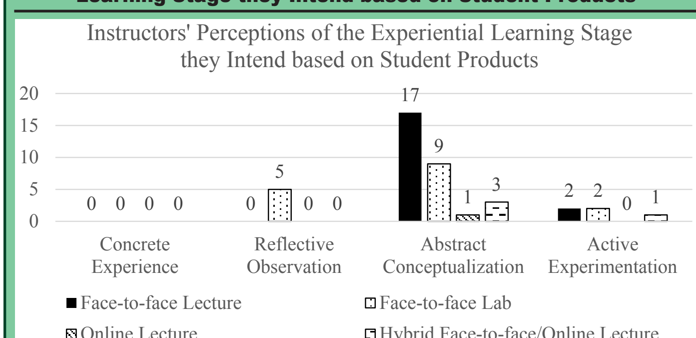



**Figure 9. Instructors' Perceptions of the Experiential Learning Stage they Intend based on Student Products**




## Description of Introductory Plant Science Instructors' Expectations of Student Participation Based on Their Courses' Learning Environments

A majority of instructors in face-to-face lecture, lab, and hybrid environments strongly agreed that students were required to participate verbally (Figure 4).

A single respondent strongly disagreed that such a requirement was present in an online lecture environment. Respondents displayed differing expectations with regard to whether hands-on student participation is required in a face-to-face lecture environment; nine respondents disagreed with the statement while eight agreed (Figure 5). Instructors in face-to-face labs placed high emphasis on hands-on student participation, as did the online lecture respondent. However, among those who taught a hybrid lecture model, hands-on participation was not a stringent requirement.

## Description of Introductory Plant Science Instructors' Perceptions of Their Use of Experiential Learning Stages Based on Their Courses' Learning Environments

Most instructors in any type of lecture setting, be it face-to-face (n = 15; 75%), online (n = 1; 100%), or a hybrid of the two (n = 3; 75%), intended for students to achieve abstract conceptualization, whereas the majority of instructors of face-to-face labs (n = 10; 63%) aimed to create a concrete experience for the student (Figure 6). The values were more widespread when examining the learning stage intended by the instructor when designing the purpose of the class (Figure 7). A majority of face-to-face lecture instructors (n = 10) still indicated that abstract conceptualization was their goal of instruction, but smaller factions also indicated that concrete experience (n = 4) and reflective observation (n = 4) were intended outcomes. The intentions of lab instructors were also spread across the range of choices, with concrete experience, reflective observation, and active experimentation receiving nearly equal responses. Respondents indicated the experiential learning stages in which they intended for students to engage when they design learning objectives (Figure 8). Instructors perceived student learning objectives for face-to-face lecture and lab as focused more on concrete experience, followed by abstract conceptualization and reflective observation. Hybrid learning environments were split evenly between experience and conceptualization, and three instructors in three different learning environments reported a focus on active experimentation. Instructors were more unanimous in their perceptions of learning stage displayed in student products (Figure 9). Most lecture and lab instructors reported abstract conceptualization as an intended goal, with a minority saying that active experimentation was the goal.

The majority of introductory plant science instructors taught in face-to-face lectures and laboratories. This follows national trends at land-grant institutions in that the majority of courses are held on campus via face-to-face means. However, the instructional needs and expectations of the technology-oriented millennial generation may benefit from an increase in online course offerings, especially in introductory courses with high enrollment numbers (International Advisory Board, n.d.). Most of the respondents reported the face-to-face environment as most preferred for both laboratories and lectures, and reported online lectures and labs as least preferred, aligning with Pvtel's (2006) position that instructors are resistant to new technologies and prefer to continue using familiar practices. Land-grant institutions should encourage instructors to engage in professional development that familiarizes them with the benefits and best practices of teaching online courses.

Instructors perceived that students can learn most effectively when engaging in both a lecture and a laboratory, but felt that learning was maximized when students experienced the lecture before the laboratory. These findings suggest that instructors' perceptions regarding learning align with the tenets of experiential learning theory, but they may not fully embrace the notion that learners can experience information grasping and transforming activities in any order (Kolb, 1984). Because students' schedules may not allow for a lecture to be experienced before a lab, instructors should become more adept at altering lecture experiences to accommodate students who have already experienced the lab.

All instructors preferred courses with fewer than 80 students, with the vast majority preferring lectures with fewer than 40 students and labs with fewer than 20 students. Universities generate funds through student tuition, making courses with high enrollments more lucrative. Online lectures and laboratories overcome enrollment-related barriers, such as room space and cost of consumables (Kiyici and Yumusak, 2005). Training instructors to feel comfortable in online lecture and lab environments may reduce the challenges they perceive with larger student numbers, enabling universities to bring in more tuition dollars via higher student enrollments in online plant science lectures and labs.

Instructors were similar in their requirements for verbal participation from students in face-to-face lectures, face-to-face laboratories, and hybrid lectures. However, their requirements for hands-on participation varied; only instructors of face-to-face laboratories unanimously required hands-on participation. Experiential learning theory states that students must engage in active experimentation and concrete experiences, both of which require hands-on participation (Kolb, 1984). Instructors should be encouraged to reconsider opportunities for hands-on learning experiences in all learning environments.

Instructors primarily utilized their face-to-face lectures for abstract conceptualization and their face-to-face labs for concrete experiences. Fewer than half of the instructors indicated they use their labs for active experimentation, which would enable students to develop higher order thinking skills (Ottander and Grelsson, 2006). This finding corroborates previous research which found that instructors utilize laboratories as a vehicle for application of knowledge previously learned (Kang and Wallace, 2005; Shoulders and Myers, 2013). Instructors should be encouraged to design laboratory activities that require active experimentation and theory development and testing in order to develop students' higher order thinking skills.

Because few instructors reported teaching lectures or labs in online settings, no comparisons can be made between the use of face-to-face and online lecture and lab settings. If the recommendations within this study are acted upon and instructors begin to offer more online introductory plant science lectures and laboratories, researchers should investigate the similarities and differences in the learning experiences offered to students in these different settings.

## Summary

The world of technology moves ever-forward; online learning is a component of students' educational expectations for the foreseeable future. Online laboratories have the potential to benefit introductory plant science students, but few opportunities exist for students to engage in online plant science courses. This study provides introductory plant science instructors a snapshot of the nation's introductory plant science courses, with results that encourage them to explore expanding online offerings and pursue professional development to increase their comfort in online educational methods.

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# A Description of Current National Horticulture Curriculum for Greenhouse Food Crop Production

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## Abstract

In order to determine whether horticulture programs within higher education are mirroring industry trends for greenhouse food crop production (GFCP) within their curricula, we set out to describe the presence of courses and topics within existing undergraduate horticulture programs devoted to GFCP currently offered at land-grant institutions within the United States. Our objectives were to describe: 1) the number of greenhouse food crop production courses offered by land-grant institutions; 2) the number of courses offered within land-grant institutions with objectives related to GFCP; 3) the number of objectives related to GFCP in courses offered by land-grant institutions; and 4) the amount of course time allocated to topics related to GFCP in courses offered by land-grant institutions. Forty-one institutions had a total of 84 courses with potential for GFCP while 69 institutions had no courses with potential for GFCP. From the 27 syllabi received, three courses were focused solely on GFCP, six courses contained a total of 8 GFCP-related objectives, and four courses contained a total of 59 GFCP-related topics in their timelines, which was calculated to total 51.5 hours devoted to GFCP. The authors recommend that land-grant institutions provide more courses and integrated course content in GFCP to better align curricula with industry needs and employment opportunities.

## Introduction

The U.S. greenhouse food crop production (GFCP) industry has experienced significant growth during the past decade (U.S. Department of Agriculture, 2014). The vast majority of GFCP in the U.S. is comprised of the production of tomatoes, peppers, cucumbers, fresh leafy greens and herbs in greenhouse structures of varying designs with a small amount of production being conducted in other types of controlled environments such as lighted warehouses and chambers. For the purposes of this study, we referred to production of food crops in any type of controlled environment as being in greenhouses.

Although less dependent on greenhouse food crop production than many other advanced countries, production of food crops in greenhouses has been growing rapidly in the U.S. Between 2007 and 2012, the number of farms producing greenhouse food crops more than doubled, increasing the square footage of GFCP from 61,765,935 to 97,999,731 (U.S. Department of Agriculture, 2014). In 2013, Rabobank reported the greenhouse food production industry had sales exceeding $3 billion and projected the industry to grow to more than $4 billion by 2020 (Rabobank, 2013). Inside Grower (2015) reported on findings from “Research and Markets” that the global hydroponics food crops production industry was expected to grow from $18.8 billion in 2014 to $27.29 billion by 2020. The U.S. production of greenhouse-grown food crops was expected to grow by 9.1% each year during the same period.

Numerous factors have contributed to the expansion of the greenhouse food crop production industry, including evolving consumer expectations (National Restaurant Association, 2013), advances in new technologies (Hottenstein, 2011), the need to feed a growing population with limited land and water resources (National Research Council, 2009), an increased interest having locally-grown food year-round, and unpredictable and

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often detrimental weather patterns (U.S. Global Change Research Program, 2009).

The Association of Public and Land-grant Universities (2009) reported a need for agriculture, food and natural resources curricula to adapt to meet the needs of the changing agriculture industry. They reported rapid growth in demand for graduates with "advanced academic preparation closely tied to advances in knowledge and technologies" within most agricultural, food, and natural resources industries (Association of Public and Land-grant Universities, 2009). The growing controlled environment and greenhouse food production industry also requires employees with the appropriate training and skills to support the industry, and students need to be properly trained in order to be able successfully pursue careers in this expanding area of agriculture.

As of 2005, the nation's land-grant institutions offered more than 84 courses related to general greenhouse production and management (Tignor et al., 2005). While greenhouse-related courses have the potential to prepare students to enter the GFCP industry, their inclusion of food production topics has not been assessed. In order to adequately adjust the content of greenhouse courses in a manner that will effectively prepare graduates to lead further innovation in GFCP, baseline data regarding the current inclusion of GFCP concepts in greenhouse-related courses was needed.

The overall purpose of this study was to evaluate the inclusion of general greenhouse management courses and specifically greenhouse food crop production courses in horticulture curricula within land-grant institutions. In order to achieve this purpose, the following specific objectives were developed: 1) to describe the number of GCFP courses offered by land-grant institutions; 2) to determine the number of courses that included objectives related to GCFP; 3) to describe the number of course objectives related to GCFP within greenhouse-related courses offered by land-grant institutions; and 4) to describe the amount of course time allocated to topics related to GCFP in greenhouse-related courses offered by land-grant institutions.

## Materials and Methods

This descriptive study used content analysis methods (Krippendorff, 1989) to identify the presence of courses, course objectives, course topics, and course time devoted to GFCP within land-grant institutions' course catalogues and related course syllabi. As content analysis does not involve human subjects but rather the analysis of written data, the study was deemed exempt by the University of [State]'s Institutional Review Board. Objectives, topics, and course time are each recommended components of comprehensive syllabi (Nilson, 2010); therefore, these syllabus components can accurately reflect a course's content.

Researchers attempted to collect a census of syllabi for greenhouse-related courses available to students between 2003 and 2013 from the 110 land-grant colleges and universities established in 1862, 1890, and 1994 (U.S. Department of Agriculture, 2014). A manual search of each institution's website led to the acquisition of course catalogues for the academic years 2005, 2008, and 2013. Catalogues for the remaining years were not available.

A total of 84 greenhouse-related courses were identified from 41 land-grant institutions. Sixty-nine institutions did not offer any courses related to greenhouse production or management. Requests for syllabi were made following an adapted tailored design method (Dillman et al., 2009). An email requesting either the identified course syllabus or contact information for the course instructor was sent to heads of departments with identified greenhouse-related courses. Non-respondents were sent a reminder email request after one week and another after two weeks. Twenty-seven syllabi were received for a total response rate of 32.1%. Due to the response rate in this study, we caution against generalizing the findings of this study beyond the included syllabi.

Two analytical constructs were chosen for this study (Krippendorff, 1989). The first construct was "greenhouse-related," which was used to identify courses with the potential to include GFCP content from course catalogues. Identification was performed using course titles and where needed, course descriptions. Courses initially identified as being related to greenhouse production and management were confirmed by a panel of experts in greenhouse production and management education in order to ensure reliability (Krippendorff, 1989). The second construct was "food crop", which was used to identify objectives and topics related to GFCP within the greenhouse-related courses. This stage of data analysis was confirmed by a panel of experts in syllabus evaluation, content analysis methods, and greenhouse crop production and management education. All data are reported using descriptive statistics, including frequencies and percentages.

## Results

The first objective was to describe the number of GFCP courses offered by land-grant institutions. Forty-one of the 110 institutions offered a total of 84 greenhouse-related courses. A majority (71.43%) of the courses contained a combination of the terms "greenhouse," "management," and/or "production". Most courses (35%) specifically contained "greenhouse man-

**Table 1. Number and percent of courses offered by land-grant universities associated with general greenhouse management and the production of food crops in greenhouses.**

| Identified construct in course title | Number of courses containing construct | Percent of courses containing construct[z] |
|---|---|---|
| Greenhouse management or operation | 29 | 35 |
| Greenhouse production | 19 | 23 |
| Greenhouse production and management | 12 | 14 |
| Food or greenhouse related miscellaneous | 21 | 25 |
| Food crops | 3 | 4 |
| Total courses | 84 | 100 |

[z] Percent of total of 84 courses.

agement or operations" in their titles. A total of three (4%) courses contained the term "food crops" in their titles (Table 1).

In objective two, the number of courses that included objectives related to greenhouse food crop production was determined. Six of the courses (7%) contained objectives related to food production. Seventy-three courses (87%) did not contain food-related objectives, while five courses (6%) did not state objectives within their syllabi.

In objective three, we sought to determine the number of course objectives related to GFCP within the 84 greenhouse-related courses identified in objective one. Eighty-three objectives were identified from the 79 course syllabi containing objectives. Eight of the objectives (10%) related to food crop production while 75 (90%) were not related to food.

In objective four, we sought to determine the amount of time allocated to topics related to GFCP in greenhouse-related courses. Thirty-one of the 84 courses (37%) listed topics on which course content focused. Of these 31 courses, four courses (13%) contained topics related to food production, while 27 courses (87%) did not contain food-related topics. Collectively, the 31 courses listed a total of 466 topics. Fifty-nine (13%) of the topics were related to food production, while 407 (87%) of the listed topics were not food-related.

Four of the syllabi included indications of the amount of time spent on each course topic during the course (Table 2). Percent time spent on a course topic was calculated according to the number of credit hours allocated to the course and the number of times the class met. The course with the highest food-related focus spent 69.5% of course time devoted to food-related topics. The courses with the lowest food-related focus spent 7.1% of course time devoted to food-related topics, although the two courses devoted different amounts of time to GFCP.

## Discussion

While the availability of greenhouse-related courses appeared to be stable since 2005 (Tignor et al., 2005), these courses may not be adapting content to reflect current industry trends. Within every area of description, focus on GFCP within greenhouse classes was in the minority. Ninety-six percent of identified courses focused primarily on greenhouse production, operations, or management and omitted food-related terms in their titles. Ninety-three percent of the courses omitted food-related learning objectives, and of those courses containing food-related objectives, only 13% of the listed objectives focused on food. Eighty-eight percent of the courses listing topics covered omitted food-related content. Finally, almost 90% of all topics listed were not related to food.

**Table 2. Hours and percent of class time in greenhouse courses including food production topics devoted to teaching greenhouse food crop production.**

| Course syllabus | Hours of class time devoted to food-related topics | Percent of class time spent on food related topics[z] |
|---|---|---|
| 1 | 4.0 | 7.1 |
| 2 | 41.0 | 69.5 |
| 3 | 4.5 | 9.4 |
| 4 | 2.0 | 7.1 |

[z] Percent of total class time as defined in course syllabus.

These findings imply that while the GFCP industry is growing, current higher-education offerings may not align with industry trends. This lack of alignment between industry and education suggests the call made by the Association of Public and Land-grant Universities to transform academics in agriculture to meet innovative industry technologies has not yet been fully answered by horticulture programs (Association of Public and Land-grant Universities, 2009). Leaders in horticulture education have an opportunity to address this gap by reviewing technologies and best practices within industry, examining existing courses and potential areas for course development, and evolving course content to accurately reflect industry trends.

Additional findings from this study imply that many greenhouse courses offer syllabi that do not contain "generally recommended components related to pedagogy and student learning" (Teaching and Faculty Support Center, n.d., para. 2). Learning objectives, topics to be covered, and time allocated to each topic are recommended components of a quality syllabus because they reduce misunderstandings about the scope and nature of the course and communicate expectations to students (Nilson, 2010). Many land-grant institutions provide opportunities for faculty to receive support in developing quality syllabi; the researchers recommend the use of syllabus development services and support, especially for faculty with degrees outside of the education field. Utilizing syllabus development services can assist faculty in accurately examining the content of their courses when aligning with industry trends, as well as enable students to access meaningful information regarding courses.

## Summary

The greenhouse food crops production industry has greatly increased over the past decade. Projections are that this area of agriculture will continue to expand. This industry will need highly trained graduates with special training in the production of food crops in greenhouses and other controlled environments. Likewise, the expansion of this industry will offer significant job opportunities for horticulture graduates. Programs within higher education should acknowledge this trend and adjust curricula to recognize these changing industry needs and employment opportunities.

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# The Effect of Undergraduate Extracurricular Involvement and Leadership Activities on Community Values of the Social Change Model

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## Abstract

The purpose of this study was to explore the effects that undergraduate extracurricular involvement and leadership activities had on the community values component of the Social Change Model of Leadership Development. Senior students in the College of Agriculture and Life Sciences at Iowa State University completed an online questionnaire about their extracurricular experiences. The Socially Responsible Leadership Scale (SRLS–R2) citizenship scale was used to assess leadership community values. Students who participated in more extracurricular clubs and organizations, students who reported spending more time per week involved in clubs and organizations, students who served as an officer, and females scored significantly higher on the SRLS–R2 citizenship scale. Students who participated in college–wide organizations, Greek organizations, university–wide organizations, and social/recreational organizations scored significantly higher on the SRSL–R2 citizenship scale than students who did not. Participation in major–related organizations, competitive/team based organizations, faith–based organizations, or community–based organizations did not provide significant results on the SRLS-R2 citizenship scale. These findings have implications for leadership development for all students, not just those in positional leadership roles. It is recommended that clubs and organizations revisit their purpose and associated activities to ensure they are aligned to meet espoused student leadership outcomes. It may be that not all clubs are focused on community values.

## Introduction

Ewing et al., (2009) suggested a new generation of leaders is needed to address changing issues facing local communities, build local partnerships, and assume leadership positions. Universities are uniquely positioned to facilitate leadership development and consider leadership development as part of their mission (Astin and Astin, 2000; Boatman, 1999). One way to conceptualize leadership development outcomes is by using the Social Change Model (SCM) developed by the Higher Education Research Institute of UCLA in 1996. The SCM was created specifically for use with college students and is widely cited in higher education literature (Haber and Komives, 2009). In addition, the SCM views leadership as a process, not a position, and encourages leadership development in all participants, including those who hold formal leadership positions and those who don't.

Community Values is one of the three components of the SCM and examines the importance of people coming together in their community to address their shared needs and problems (Komives et al., 2009). Community values defines leadership as active community participation as a result of a sense of responsibility to the communities in which people live. According to the SCM, the skills and knowledge that make community involvement more effective are: understanding social capital; awareness of the issues and the community history; empowerment; empathy; multicultural citizenship; an understanding of community development; and the ability to build coalitions (Komives and Wagner, 2009).

The collegiate leadership development model (Foreman and Retallick, 2012) provides a conceptual framework and consists of precollegiate characteristics and experiences, collegiate experiences, and leadership outcomes (Figure 1). The components of this model pertinent to this study include student demographic characteristics and out–of–class experiences related to extracurricular membership, amount of time spent on club activities, level of participation, and type of club or organization. The community values leadership development was the outcome variable for this study.

The precollegiate characteristic associated with this study was socio–demographic traits. Dugan and Komives (2007) found that demographics were a significant predictor of college outcomes. However, only 1–2% of the college outcomes studied was explained by demographics. Gender has been linked to leadership development (Dugan and Komives, 2007; Josselson,

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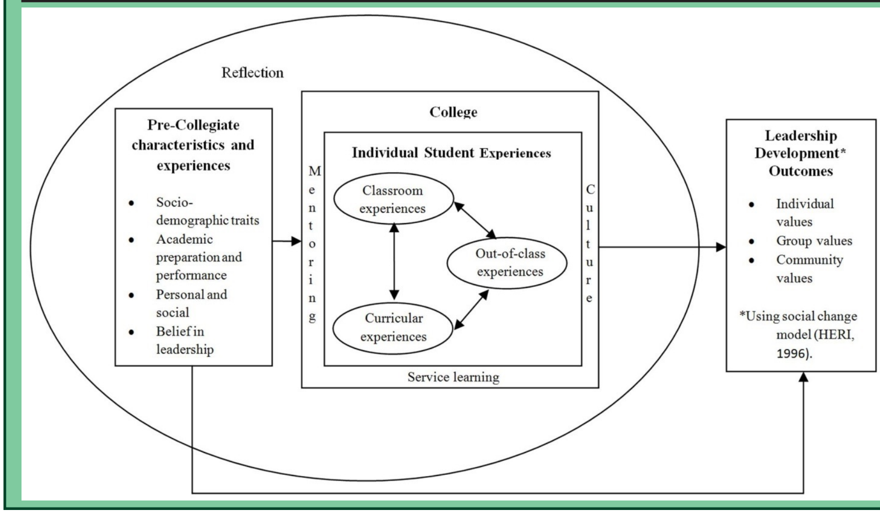
**Figure 1. Collegiate leadership development model. (Foreman and Retallick, 2012).**




1987; Kezar, 2002; Kezar and Moriarty, 2000). Dugan and Komives (2007) concluded that college women scored higher than males across all eight constructs of the Social Change model. Research indicated some influence of gender role norms in leadership. Females tended to agree more strongly with humanistic leadership abilities (Schumacher and Swan, 1993) than males and males perceived themselves as more dictorial (Schumacher and Swan, 1993) and hierarchical (Fisher et al., 2010) than females. However, other findings (Burton, 1981; Pugh, 2000) suggested that neither gender nor ethnicity influenced extracurricular participation.

The college experience construct, specifically extracurricular experiences, was the focus of the out–of–class experiences portion of this study. Experiential learning is instrumental in the development of leadership skills (Layfield et al., 2000) and a variety of out–of–classroom experiences provide concrete experiences to apply leadership theories (Kouzes and Posner, 2007). Layfield et al., (2000) suggested that without meaningful opportunities to practice leading a group, students would not gain skills.

Research about different categories (i.e., major–related, college–level, university level, competitive/team–based, Greek, social/recreational, faith–based, and community–based) of clubs or organizations is sparse in the literature. Moore et al., (2008) studied the relationship between university–wide student organizations and college–level student organizations and concluded that more students participated in college–level student organizations. However, students perceived university–wide organizations as more effective than college–level student organizations at developing leadership awareness, behaviors, skills, and abilities. The researchers suggested that this may be attributed to additional commitment required for university–wide organizations as well as more focused, long–term leadership education.

Research has supported Astin's (1999) theory of involvement, which suggests that both the amount of time involved in an activity and the quality of the student experience are important. The frequency and quality of students' participation in activities was associated with high educational aspirations, enhanced self–confidence, and increased interpersonal and leadership skills (Pascarella and Terrenzini, 1991). In addition, Rubin et al., (2002) used an extracurricular index that represented the number of clubs students were involved with, officer status, and hours spent and concluded that it was a significant predictor of interpersonal skills.

One aspect of involvement in extracurricular organizations that affects both the quality and quantity of involvement in extracurricular organizations is serving in a positional leadership role. Researchers have found serving as a club officer increased leadership development (Ewing et al., 2009), increased decision–making (Rubin et al., 2002), and resulted in higher levels of developing purpose, educational involvement, life management, and cultural participation (Cooper, et al., 1994). Positional leaders also scored higher on the Socially Responsible Leadership Scale (SRLS–R2) group values scale and the SRLS–R2 community values scale (Dugan, 2006).

Not all research supported the idea that serving as an officer of a club or organization was beneficial for students. Rubin, et al., (2002) found no difference on a student's initiative based on whether or not they served as a club officer. Foubert and Grainger (2006) reported similar findings when they examined the psychosocial development of students and found no increased benefit for students who served as officers.

Literature links undergraduate extracurricular participation and leadership outcomes (Birkenholz and Schumacher, 1994; Ewing et al., 2009; Layfield et al., 2000). However, there is a lack of literature that has defined leadership as active community participation. This research is needed in order to intentionally create leadership development experiences in colleges that are most likely to provide communities with the future generations of leaders. Therefore, there is a need to gain a better understanding of the extracurricular experiences and identify which of those experiences result in higher levels of community values of leadership.

The purpose of this study was to explore the effects that undergraduate extracurricular involvement and leadership activities had on the community values of College of Agriculture and Life Sciences seniors. Five research questions guided this study.

1. Does membership in extracurricular clubs and organizations influence community values of leadership development?
2. Does the amount of time a student spends participating in a club or organization influence community values of leadership development?
3. Does the level of participation in extracurricular clubs and organizations influence community values of leadership development?

4. Does gender influence community values of leadership development?
5. Does the category of the club or organization influence leadership development?

## Methods

This study was a part of a larger study designed to examine the role of undergraduate extracurricular participation in leadership development. Full–time, undergraduate college students classified as seniors in the College of Agriculture and Life Sciences at Iowa State University (N = 969) were surveyed.

The researchers designed an on–line questionnaire to answer the research questions. The instrument reflected the conceptual framework (Figure 1) and contained three sections: precollegiate characteristics and experiences, collegiate experiences, and SRLS–R2 citizenship scale. Precollegiate and collegiate characteristics and experiences were assessed using both university records (i.e., demographics) and the web–based survey instrument (i.e., collegiate extracurricular activities). Community Values of the Social Change Model was the dependent variable for this study and was measured using the citizenship scale of the Socially Responsible Leadership Scale (SRLS–R2) (National Clearinghouse for Leadership Programs, 2009).

The Multi–Institutional Study of Leadership (National Clearinghouse for Leadership Programs, 2009) has established the reliability of the SRLS–R2 citizenship scale, which was 0.77. Using Cronbach's alpha, the reliability coefficient for the SRLS–R2 citizenship scale for this study was 0.90.

Content validity for this study was established using a panel of experts including faculty and graduate students. This group used their expertise in undergraduate outcomes, extracurricular experiences, and leadership development to review and compare the purpose and research questions for the study to the content of the instrument. The panel's recommendations and suggestions were incorporated into the instrument.

A group of students (n = 24) similar to those in the sample population field tested the instrument. Using a focus group format to obtain feedback, students made suggestions regarding content, question format, and data collection procedures. Those recommendations were made to improve the face validity of the instrument.

Qualtrics (Qualtrics Labs, Inc., Provo, UT), a web–based survey program, was used to collect data because of the program's capabilities to improve the flow of the instrument. Qualtrics uses skip/display logic to customize the questions a subject receives. On the basis of initial responses, subjects were asked additional questions related to their experiences. Skip/display logic was used to customize the questions each subject received. Subjects were asked to indicate whether or not they participated in extracurricular organizations and based on the responses to these questions, subjects were asked additional questions to learn more about their experiences.

A five–step data collection process was developed based on the recommendations of Dillman (2007) and the students who served on the expert panel. Subjects were contacted via e–mail to participate in the study and were sent up to four e–mail reminders inviting them to participate in the study if they had not yet completed the questionnaire. Each correspondence contained a link to the survey instrument, the purpose of the study, and information regarding general consent. All students classified as seniors (N=969) were invited to participate in the study and their contact information was provided by the Office of the Registrar. The data collection process resulted in 270 responses (27%), 199 of which were fully completed for a usable response rate of 20.5%.

Non–response error was controlled by comparing early and late respondents, as suggested by (Lidner et al., 2001). Differences in extracurricular involvement did not exist between early and late respondents.

University records and student responses were matched using student email addresses. All identifying data were removed prior to data analysis to ensure confidentiality. Data were analyzed using SPSS (Version 17). The data analysis methods for each research question follows. The Iowa State University Institutional Review Board approved the study protocol and all participants were provided written informed consent prior to participation in the study.

Data analysis procedures were developed for each of the research questions. To analyze research question one, which focused on membership, a t–test was computed using the dichotomous variable of club membership as an independent variable and the SRLS–R2 citizenship scale as the dependent variable to determine if club membership influenced community values. The number of clubs and organizations a student participated in was calculated based on the clubs and organizations in which a student indicated they participated. This variable was recoded into four nearly–equal categories (i.e., 0 clubs, 1–2 clubs, 3–4 clubs, and 5–11 clubs). An ANOVA using the number of extracurricular clubs and organizations as the independent variable and leadership development (i.e., SRLS–R2 citizenship scale) as the dependent variable to determine if the number of extracurricular clubs in which a student participates influences community values.

Research question two focused on the amount of time spent on extracurricular activities. Average hours per week spent in extracurricular clubs and organizations was a categorical variable with 20 possible answers. This variable was recoded into four nearly–equal categories (i.e., 0–1 hours, 2–3 hours, 4–6 hours, and 7 or more hours). An ANOVA was computed using the recoded average hours per week as the independent variable and the SRLS–R2 citizenship scale as the dependent variable to determine if there was a significant relationship between the number of hours per week a student is involved in extracurricular activities and community values. To address research question three and determine levels of participation, a dichotomous variable (i.e., serving as an officer) was used as an independent variable and the SRLS-R2 was used as the dependent variable to determine if serving as an officer has an influence on community values.

Gender was the focus of research question four and a t-test was computed using gender as the dependent variable and the citizenship scale as the independent variable to determine if there were mean differences on citizenship based on gender. Finally, club categories were analyzed to address research question five. Students indicated whether or not they participated in 48 university or college recognized clubs or organizations. These were organized into eight different categories (i.e., major-related, college-level, university-level, competitive/team-based, Greek, social/recreational, faith-based, and community-based). A t-test was computed using membership in each category to determine if each category of club or organization influenced community values.

## Results and Discussion

Ninety-one (45.7%) males and 108 (54.3%) females participated in this study. All were full-time students and were classified as seniors; 151 subjects (75.9%) entered the university directly from high school, and 48 subjects (24.1%) entered as transfer students. Ninety-six percent of respondents indicated they were involved in an extracurricular activity, including 21% in the Greek system, 95% in extracurricular clubs and organizations, and 29% in competitive teams.

**Table 1. Analysis of Variance for the number of extracurricular clubs and organizations and Leadership Development (SRS–R2).**

| Dependent variable | Groups | *SS* | *df* | *MS* | *F* | *p* | *Cohen's f* |
|---|---|---|---|---|---|---|---|
| Citizenship scale | Between | 420.16 | 3 | 140.05 | 10.55 | 0.000* | 0.42 |
| | Within | 2376.24 | 179 | 13.28 | | | |
| | Total | 2796.40 | 182 | | | | |

*Note.* *p ≤ 0.05

**Table 2. Tukey HSD Post Hoc Results for Number of Clubs and Leadership Development (SRLS–R2)**

| Test | (I) Number of Clubs | (J) Number of Clubs | Mean differences (I–J) | *SE* | *p* | *Cohen's d* |
|---|---|---|---|---|---|---|
| Citizenship Scale | 0 | 1–2 | –0.51 | 1.02 | 0.959 | 0.12 |
| | | 3–4 | –3.03 | 0.99 | 0.015* | 0.73 |
| | | 5–11 | –3.88 | 1.01 | 0.001* | 0.94 |
| | 1–2 | 0 | 0.51 | 1.02 | 0.959 | 0.12 |
| | | 3–4 | –2.52 | 0.69 | 0.002* | 0.71 |
| | | 5–11 | –3.37 | 0.71 | 0.000* | 0.94 |
| | 3–4 | 0 | 3.03 | 0.99 | 0.015* | 0.73 |
| | | 1–2 | 2.52 | 0.69 | 0.002* | 0.71 |
| | | 5–11 | –0.85 | 0.68 | 0.597 | 0.25 |
| | 5–11 | 0 | 3.88 | 1.01 | 0.001* | 0.94 |
| | | 1–2 | 3.37 | 0.71 | 0.000* | 0.94 |
| | | 3–4 | 0.85 | 0.68 | 0.597 | 0.25 |

*Note.* *p ≤ 0.05

**Table 3. Analysis of Variance for the amount of time spent in clubs and organizations and Leadership Development (SRS–R2).**

| Dependent variable | Groups | *SS* | *df* | *MS* | *F* | *p* | *Cohen's f* |
|---|---|---|---|---|---|---|---|
| Citizenship scale | Between | 275.79 | 3 | 91.93 | 6.528 | 0.000* | 0.33 |
| | Within | 2520.61 | 179 | 14.08 | | | |
| | Total | 2796.40 | 182 | | | | |

*Note.* *p ≤ 0.05

### Membership

The results of a t-test indicate that students who were members of clubs (*M* = 33.22, *SD* = 3.71) scored significantly higher on the citizenship scale than those that were not (*M* = 31.73, *SD* = 4.29, *t* (75.83) = –2.15, *p* = 0.035). The number of extracurricular clubs and organizations that students reported being involved in ranged from 0 to 11 (*M* = 3.41, *SD* = 2.44) extracurricular clubs and organizations. Females (*M* = 3.91, *SD* = 2.29) were involved in significantly more clubs than males (*M* = 2.82, *SD* = 2.48, *t* (197) = –3.198, *p* = 0.002). An ANOVA using the number of extracurricular clubs and organizations as the independent variable and leadership development (SRLS–R2 – citizenship) as the dependent variable indicated a significant relationship between the number of clubs a student participates in and leadership development (*F*(3, 179) = 10.55, *p* 0.000) (Table 1).

Because the ANOVA provided significant results, post hoc testing was conducted to compare and contrast mean differences between groups. A Tukey post hoc test indicated that significant differences as occurred between the lowest two levels of involvement (i.e., 0 clubs and 1–2 clubs) and the highest two groups (i.e., 3–4 clubs and 5–11 clubs) (Table 2). Significant differences were found between respondents involved in two or fewer clubs than those who were involved in three or more clubs.

### Amount of time spent

The average amount of time students spent in extracurricular clubs and organizations ranged from 0 to 20 or more hours per week (*M* = 5.33). Gender differences were not found (*p* < 0.575). An ANOVA, using the recoded average hours per week as the independent variable indicated a significant relationship between the amount of hours per week a student is involved in extracurricular activities and community values (*F*, (3, 179) = 6.53, *p* = 0.000) (Table 3).

Because the ANOVA provided significant results, post hoc testing was conducted to compare and contrast mean differences between groups. A Tukey post hoc test indicated that significant differences occurred between the lowest two levels of involvement (i.e., 0–1 hours per week and 2–3 hours per week) and the highest two groups (i.e., 5–6 hours per week and 7 or more hours per week) (Table 4). Significant differences were found between respondents who spent the least amount of time (i.e., 0–1 hours per week) and respondents who spent four or more hours per week. In addition, respondents who spent seven or more hours per week scored higher on the citizenship scale than those that spent two to three hours per week.

### Level of participation

One hundred forty-two students (71.4%) reported serving as an officer; 57 students (28.6%) did not. Pearson Chi Square indicated no gender differences between students who served as an officer and those who did not ($\chi^2$ (1, $N$ = 199) = 1.076, $p$ = 0.30). Students who served as officers ($M$ = 7.02, $SD$ = 4.69) spent significantly more hours per week involved in extracurricular clubs and organizations than those who didn't serve as officers (($M$ = 3.55, $SD$ = 4.39), $t$(196.96) = 5.40, $p$ = 0.000). The results of a $t$–test show that students who served as an officer ($M$ = 33.80, $SD$ = 3.42) in a club or organization scored higher on the SRLS–R2 scale (($M$ = 31.80, $SD$ = 4.16), $t$(170.58) = –3.54, $p$ = 0.001) (Table 5).

One explanation of these differences might be the relationship between the mindset and training that officers receive and the definition of community values. Students in positional leadership roles are more likely to understand the group issues and community history, feel empowered to make changes, have a concern or empathy for group members, and the ability to build teams or coalitions. On the basis of these findings, increasing the amount of leadership training and opportunities for all students in extracurricular clubs and organizations is recommended.

A second explanation for these differences might be the increased amount of time officers spent participating in clubs and organizations than those who did not serve as officers. Shertzer and Schuh (2004) suggested that students who hold leadership positions are often given more leadership development opportunities when compared to those members who do not hold leadership positions. Therefore, the increased skills often attributed to serving as an officer may actually be associated with the additional training that officers receive as well as the increased time associated with serving as an officer.

**Table 4. Tukey HSD Post Hoc Results for Amount of Time Spent and Leadership Development (SRLS–R2)**

| Test | (I) Amount of Time | (J) Amount of Time | Mean differences (I–J) | *SE* | *p* | *Cohen's d* |
|---|---|---|---|---|---|---|
| Citizenship Scale Tukey HSD | 0–1 | 2–3 | –0.44 | 0.81 | 0.948 | 0.11 |
| | | 4–6 | –2.28 | 0.79 | 0.022* | 0.61 |
| | | 7 or more | –2.96 | 0.79 | 0.001* | 0.76 |
| | 2–3 | 0–1 | 0.44 | 0.81 | 0.948 | 0.11 |
| | | 4–6 | –1.84 | 0.78 | 0.089 | 0.51 |
| | | 7 or more | –2.52 | 0.78 | 0.008* | 0.67 |
| | 4–6 | 0–1 | 2.28 | 0.79 | 0.022* | 0.61 |
| | | 2–3 | 1.84 | 0.78 | 0.089 | 0.51 |
| | | 7 or more | –0.68 | 0.76 | 0.809 | 0.20 |
| | 7 or more | 0–1 | 2.96 | 0.79 | 0.001* | 0.76 |
| | | 2–3 | 2.52 | 0.78 | 0.008* | 0.67 |
| | | 3–4 | 0.68 | 0.76 | 0.809 | 0.20 |

*Note. *p* ≤ 0.05

**Table 5. t Test for serving as an Officer and Leadership Development (SRLS–R2)**

| Dependent variable | *t* | *df* | Sig | Mean difference | *SE* difference | *Cohen's d* |
|---|---|---|---|---|---|---|
| Citizenship scale | –3.54 | 170.58 | 0.001* | –2.00 | 0.57 | 0.54 |

*Note. *p* ≤ 0.05

**Table 6. t Test for Gender and Leadership Development (SRLS–R2)**

| Dependent variable | *t* | *df* | Sig | Mean difference | *SE* difference | *Cohen's d* |
|---|---|---|---|---|---|---|
| Citizenship scale | –3.11 | 164.88 | 0.002* | –1.78 | 0.57 | 0.48 |

*Note. *p* ≤ 0.05

**Table 7. t Test for Categories of Organizations and Leadership Development (SRLS–R2)**

| Independent variable | *t* | *df* | Sig | Mean difference | *SE* difference | *Cohen's d* |
|---|---|---|---|---|---|---|
| Major–related | –1.47 | 64.93 | 0.146 | –1.16 | 0.79 | 0.36 |
| College–level | –4.47 | 142.74 | 0.000* | –2.52 | 0.56 | 0.75 |
| University–level | –3.68 | 143.76 | 0.000* | –2.11 | 0.57 | 0.61 |
| Greek | –4.93 | 76.39 | 0.000* | –2.91 | 0.59 | 1.13 |
| Social/recreational | –2.81 | 178.33 | 0.005* | –1.58 | 0.56 | 0.42 |
| Competitive/teams | –0.08 | 47.49 | 0.934 | –0.06 | 0.73 | 0.02 |
| Faith–based | –0.89 | 56.56 | 0.379 | –0.60 | 0.68 | 0.24 |
| Community–based | –1.37 | 22.92 | 0.185 | –1.38 | 1.01 | 0.57 |

*Note. *p* ≤ 0.05

## Gender

The results of a t-test indicate that females ($M$ = 104, $SD$ = 3.77) scored significantly higher on the citizenship scale than males ($M$ = 79, $SD$ = 3.91), $t$(164.89) = –1.79, $p$ = 0.002 (Table 6), however spent no more time involved per week and were no more likely to serve as an officer. Similar to the findings of previous research (Dugan and Komives, 2007), females scored higher on the citizenship scale. Additional research should be conducted to learn more gender-related differences in regards to extracurricular participation and leadership development to help inform practice.

## Category of club

The results of t–test showed that college level organizations, university level organizations, Greek organizations, and social/recreational organizations significantly influenced community values. The following had large effect sizes: Greek (i.e., *Cohen's d* = 1.13), college level (i.e., *Cohen's d*= 0.75), and university level (i.e., *Cohen's d* = 0.61). While more students participated in major–related clubs and organizations than any other category of organization, those did not influence community values. Competitive/team–based, faith–based, and community–based were also not significant (Table 7). One possible explanation for these discrepancies is the differences in the mission statements of these organizations. Many of those organizations are more intentional in developing community values because of the focus on volunteerism and philanthropy. It is recommended that major–related organizations determine the extent to which community values is a part of their mission and implement additional strategies to develop these leadership outcomes. It may be that these organizations have a different focus and leadership development centered on community values isn't part of the organizational purpose. Additional research is recommended to identify specific characteristics or activities of extracurricular involvement that are most likely to increase leadership outcomes to assist educators as they work with student leaders to create meaningful experiences.

## Summary

Reforms in higher education have increased the attention on student learning outcomes as well as the need for graduates to have the skills necessary to be contributing members of their community. The results of this study indicate that involvement in extracurricular activities (i.e., membership, the number of clubs in which a student is involved, amount of time spent, and serving as an officer) had a strong relationship with community values. Therefore, as institutions create action plans to reach leadership outcomes related to community values, they should include the role of extracurricular activities in those plans as well as in assessment strategies.

A limitation of this study was that data were collected at one College of Agriculture and Life Science at a fairly homogeneous institution. In spite of this limitation, the analysis offers insights for other institutions that aspire to increase student leadership outcomes.

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# Course Evaluation Based On Course Objectives

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## Introduction

Evaluation of a course should not be limited to evaluation of the instructor, instructional method and content. Serious consideration needs to be given to course assignments and how closely aligned the assignments are to course goals and objectives (Popham & Baker, 1970). "Student learning assessments provide feedback to teachers about areas of instruction that need further emphasis. Student learning assessments help insure quality control of instruction over a period of time" (Wentling, 1979, p. 238). How closely course grades are associated with completion of the objectives should be an important question for all teachers.

The emphasis in student assessment should reflect the content determined by the objectives of the course. "The importance of clearly defined objectives for the evaluative process cannot be overstressed. It is axiomatic, of course, that evaluation can be done only with respect to the objectives that are to be achieved" (Morse & Wingo, 1969, p. 481). Course assignments, as well, should be tied to course objectives that are developed and identified before the inception of a course. After the course is conceived in terms of objectives or outcomes, two questions need to be considered. How can teachers access those objectives through the evaluation of students? How do teachers make sure the factors that contribute to a student's grade reflect the goals of instruction and not factors extraneous to these goals?

In an attempt to answer the above questions for Agricultural Education 290, Communication of Agricultural Concepts, at The Ohio State University, student assessment information on nearly 900 students was analyzed. The analysis included demographic data, individual assignment and test grades and their relationship to the student's final grade in the course and the importance of each assignment to the student's final grade.

## Background Information

Agricultural Education 290, Communication of Agricultural Concepts, is a service course for the College of Agriculture offered by the Department of Agricultural Education. AGR EDUC 290 is designed to teach procedures and practices in developing, interpreting and communicating concepts about agriculture and natural resources. The course emphasis is the use of visual materials and effective presentations.

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**Major Course Objectives**

1. Describing the importance and the applications of the communication process in agricultural business, industry and education.
2. Analyzing and interpreting agricultural concepts and research data.
3. Organizing effective presentations using audio and/or visual communication techniques as well as using the related equipment for various audiences.
4. Performing effective presentations with the appropriate communication techniques and hardware for specific audiences.
5. Evaluating the productivity and efficiency of presentations and of their related components.
6. Demonstrating greater proficiency in interpersonal and group communication techniques.

The final grade in AGR EDUC 290 is determined by the percent of total points on a straight scale.

**Course Assignments**

1. Communication Strategy Plan — 25 points related to objectives 1, 3 and 4.
2. Speech with Visual Aid — 50 points related to objectives 1, 2, 3 and 4.
3. Midterm Exam — 100 points related to all objectives.
4. Audio-Visual Labs — 30 points related to objectives 3 and 4.
5. Self-Evaluation — 10 points related to objec. 5.
6. One Major or Two Minor Projects — 150 points related to objectives 1, 2, 3, 4, 5 and 6. Major and minor assignments were selected by the students based on individual needs and interests. Assignments could include writing a news story or journal article, doing demonstrations, illustrated talks or persuasive speeches, photo practicum or developing slide-sound presentations.
7. In-Class Assignments — 40 points related to various objectives, depending on assignments. Assignments are completed during class time and cannot be made up if the student misses the class.
8. Final Exam — 100 points relating to all objectives.

A total of 505 points is possible in the course. While the course has been taught for over 12 years, the data included in this investigation were taken only from student records from Autumn Quarter 1981 through Spring Quarter 1984. A total of 893 students completed the course during that time and were included in the sample for this study. Demographic variables studied included student major, quarter enrolled in the course, class rank and whether the student was enrolled in the morning or afternoon section.

### Results of Demographic Variables

The results indicated that there was no significant relationship between most of the demographic factors and the student's grade in the course. Table 1 shows the relationships between selected factors and final grades in AGR EDUC 290. Of the factors studied, only quarter enrolled was significantly related to final grade at the .05 level, and then at a low level of relationship.

**Table 1. Relationship Between Demographic Variables and the Final Grade in AGR EDUC 290.**

| Variable | Correlation with Final Grade |
|---|---|
| Student Major | .10 |
| Quarter Enrolled in AGR EDUC 290 | .14a |
| Class Rank | -.03 |
| Class Section | .13 |

a Significant at the .05 level.

Table 2 shows the mean grade in AGR EDUC 290 by student major, indicating no significant difference in final grade between student major groups.

**Table 2. Table of Means: Grade in AGR EDUC 290 by Student Major.**

| Major | n | Mean | Standard Deviation |
|---|---|---|---|
| Agriculture | 714 | 2.80 | .77 |
| Natural Resources | 73 | 2.65 | .99 |
| Other | 99 | 2.73 | .81 |
| Agricultural Communications | 7 | 2.95 | .53 |
| **Total** | **893** | **2.78** | **.79** |

Analysis of Variance

| Source | df | SS | MS | F | F prob. |
|---|---|---|---|---|---|
| Between groups | 3 | 2.03 | .675 | 1.07 | .36 |
| Within groups | 889 | 559.59 | .630 | | |
| **Total** | **892** | **561.62** | | | |

**Table 3. Table of Means: Grade in AGR EDUC 290 by Quarter Enrolled**

| Quarter | n | Mean | Standard Deviation |
|---|---|---|---|
| Summer | 25 | 2.46 | .86 |
| Autumn | 287 | 2.79 | .74 |
| Winter | 331 | 2.90 | .74 |
| Spring | 251 | 2.62 | .88 |
| **Total** | **894** | **2.78** | **.79** |

Analysis of Variance

| Source | df | SS | MS | F | F prob. |
|---|---|---|---|---|---|
| Between groups | 3 | 11.55 | 3.85 | 6.22 | .0004 |
| Within groups | 890 | 551.24 | .62 | | |
| **Total** | **893** | **562.79** | | | |

Note: A significant difference existed in means between Winter Quarter and Spring Quarter using the Scheffe Post-hoc Analysis.

The table of means comparing grade in AGR EDUC 290 by quarter enrolled and the analysis of variance table (Table 3) indicate that a significant difference existed in mean grade between Winter Quarter students and Spring Quarter students with Winter Quarter students having higher mean grades. There was no significant difference in grade in AGR EDUC 290 between any other pairs of groups.

Although the ANOVA does not indicate a significant difference between class rank groups, it is interesting to note that seniors taking AGR EDUC 290 achieved a 2.66 average while all other classes were 2.80 or above (See Table 4). Students designated as Agr 7 are usually students enrolled in the honors program.

**Table 4. Table of Means: Grade in AGR EDUC 290 and Class Rank**

| Rank | n | Mean | Standard Deviation |
|---|---|---|---|
| Freshman | 155 | 2.80 | .80 |
| Sophomore | 306 | 2.85 | .69 |
| Junior | 206 | 2.80 | .75 |
| Senior | 213 | 2.66 | .96 |
| Agr 7 | 8 | 2.93 | .65 |
| **Total** | **888** | **2.78** | **.79** |

Analysis of Variance

| Source | df | SS | MS | F | F prob. |
|---|---|---|---|---|---|
| Between groups | 4 | 4.94 | 1.24 | 1.97 | .097 |
| Within groups | 883 | 554.11 | .63 | | |
| **Total** | **887** | **559.05** | | | |

A significant difference in final grade between the morning sections and afternoon sections is indicated in Table 5. Students enrolled in the afternoon sections of AGR EDUC 290 had significantly higher average mean grades than the morning sections at the .05 level.

**Table 5. Table of Means: Grade in AGR EDUC 290 and Class Section**

| Section | n | Mean | Standard Deviation |
|---|---|---|---|
| AM Section | 505 | 2.73 | .79 |
| PM Section | 389 | 2.85 | .81 |
| **Total** | **893** | **2.78** | **.79** |

Analysis of Variance

| Source | df | SS | MS | F | F prob. |
|---|---|---|---|---|---|
| Between groups | 1 | 3.44 | 3.44 | 5.48 | 0.195 |
| Within groups | 892 | 559.35 | .63 | | |
| **Total** | **893** | **562.78** | | | |

Multiple regression analysis of the student data indicates that the largest portion of the variance in the student's grade is attributed to the student's grade on the Major Project, accounting for .41 of the variance. In-Class Assignments accounted for the second highest portion of variance at .22 (see Table 6).

**Table 6. Regression of Grade in AGR EDUC 290 on Course Assignment Scores**

| Course Assignment Scores Entered Stepwise in Equation | R | $R^2$ | $R^2$ Change | F* |
|---|---|---|---|---|
| Major/Minor Projects | .6431 | .4136 | .4136 | 596.70 |
| In-Class Assignments | .7932 | .6292 | .2156 | 717.01 |
| Final Examination | .8734 | .7628 | .1336 | 904.58 |
| Midterm Examination | .9070 | .8227 | .0599 | 977.78 |
| Speech with Visual | .9292 | .8635 | .0408 | 1065.04 |
| Strategy Plan | .9365 | .8769 | .0134 | 998.88 |
| Audio-Visual Labs | .9144 | .8857 | .0088 | 929.70 |
| Self-Evaluation | .9419 | .8872 | .0015 | 824.58 |

*p►.001.

## Implications of the Study

The data indicate that the selected demographic variables of the student were not significantly related to the student's final grade in AGR EDUC 290. With the exception of quarter enrolled, none of the variables were significantly related to final grade at the .05 level. The explanation of why Spring Quarter grades are significantly lower than Winter may be that students, generally, achieve lower grades in all courses Spring Quarter, based upon information provided by the college office.

The multiple regression table indicates that the Major Project is the most important item in determining students' final grades. This is to be expected since the Major Project carries the most points toward the final score (150 of 505). The differences in point values of assignments may account for much of the differences in variance in final grade.

An interesting finding was that the 50 points of In-Class Assignments was the second most important factor in determining the student's course grade. This finding reinforces an old belief: students who attend class do better in the course. In-Class Assignments were developed to help meet course objectives; however, attendance was not an objective of the course. Therefore, it would be possible to criticize In-Class Assignments as a major factor in determining a student's final grade.

Assignments that address all the objectives (Major Project, Final Exam, Midterm Exam) contribute more to variance in the final grade than assignments that address only one or two objectives. However, an assignment that does not contribute much to the variance in final grade may still be important, especially if it is the only assignment that addresses a particular course objective.

The dilemma of whether or not to grade on attendance (measured by In-Class Assignments in this study) remains open to debate. If further analysis indicates a high correlation between In-Class Assignments and other assignments, then In-Class Assignments may not be needed. Such information may show that class attendance is associated with all assignments.

Assignments that contribute to the student's final grade which truly evaluate student mastery of the course objectives should be the goal of all teachers. An effort must be made to determine if the weight given the factors that determine the final course grade are closely aligned with content that is considered important by the teacher. This study provides an approach to such course evaluation.

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***PROJECT REPORT***

# Outdoor Laboratories In Juniper Studies

Bradley W. Pedersen

## Project Proposal

**Hypotheses**

"The environment for learning has changed dramatically in colleges of agriculture with an increase in students with a non-farm background and decreased practical experience. This requires instructors to better understand the processes and conditions of learning."[1]

Another synonym for "non-farm" might be "non-agriculture." Take the example of the introductory horticulture student. It is typical that these individuals, in majority, also do not come from backgrounds directly involved in the horticulture industry. However, the popularity of horticulture programs in secondary education, junior and senior high curricula has created this same disparity in entry level abilities between these students with some horticultural background and those with none as is most apparent between farm and non-farm background students. Also, it seems apparent that those students with farm backgrounds are more familiar with the culture of plants in general, so in that respect, do have a distinct advantage over the non-traditional farm student.

**General Rationale**

The problem arises: even though horticulture instructional materials may be introduced at an "intro" level, class membership becomes split almost instantly because some comprehend and others do not.

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**[1]From Harland Hasslen, University of Minnesota Technical College, Waseca, Grant Coordinator, The Fund for Improvement of Post Secondary Education (FIPSE).**

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## Student-Conducted Farmer Video Interviews

### Introduction

High school agricultural education teachers have expressed concern about the lack of easily accessible educational materials dealing with contemporary topics in sustainable agriculture. There are numerous textbooks and monographs available for farmers and students at the college level, including the highly practical resources available from the Sustainable Agriculture Research and Education (SARE) book series on soil fertility (Magdoff and van Es, 2010), cover crops (Bowman et al., 2007) and building a farm business (DiGiacomo et al., 2003), among others. Although these are full of color photos and easily accessible graphs and tables, they are still in the print media category. Many of today's students, accustomed to personal electronic devices and instant access to entertaining (and hopefully educational) video material are more apt to use information from newer formats. As one student said, perhaps in jest, "If it is not online, for me it does not exist." So we determined to meet high school students where they are.

The regional SARE grant committee agreed with our assessment and a modest proposal was approved to develop accessible sustainable agriculture teaching materials for high school students. With the help of experienced Nebraska high school teachers, we selected topics that would supplement their current modules in courses and raise interest by virtually 'bringing farmers into the classroom'. To add interest for the high school agriculture classes, students were selected to do the interviews. Questions were carefully edited by a member of the SARE grant team (Jenn Simons) and professionally produced by information technology experts at the University of Nebraska-Lincoln. Here are the methods used and results of the project.

### Methods

Ten important topics were chosen for development of videos to use in high school classrooms. Topics were determined by the project coordinators in cooperation with experienced high school agricultural education teachers. To make the material more engaging for classroom use, the teachers helped choose farmers who were willing to discuss their operations and what they were doing in a specific topic area and students were chosen to conduct the interviews.

Farmers were scheduled for video-taped interviews on their farms and UNL professionals were hired to do the filming of the interviews. Students prepared and practiced a list of questions before the interviews started, with the support of project coordinators and their teachers. Each interview lasted for 45 minutes to one hour and was edited down to five-minute segments by the team (Jenn Simons) with attention to system details that would be of greatest interest in the high school classroom. These ten videos are available at the Plant and Soil Science eLibrary (PASSEL) at University of Nebraska – Lincoln (passel.unl.edu/ and then search sustainable ag videos).

With so much additional interview material beyond the initial five-minute segments, it was determined that further editing could create ten additional cross-cutting topic modules by integrating and combining short sections from several farmer interviews. These topic-oriented cross-interview segments were also edited (by Jenn Simons) and produced by the IT department at UNL. When completed, the 20 videos, along with other references and teaching materials, were posted on the PASSEL web site as well as the Nebraska Agricultural Education educator site (www.neafed.org/curriculum.html). The edited videos as well as the ten original 45-60-minute interview videos are now available in public domain for high school and college teachers across the U.S. and wherever else they might be used. To assess the practical value of these modules in the classroom, a survey of agricultural educators in Nebraska was conducted in late 2014 to determine the usefulness of these videos in their teaching.

### Results

Quoting from the web site, "Sustainability … can be a messy concept, so why did we choose to use it in this project?" We visited ten farmers across Eastern Nebraska and paired with nearby high schools to interview these farmers about their operations. As a result, we ended up with ten different views of agriculture -- ten different examples of what 'sustainability' looks like in practice. The ten edited videos covering specific topics of interest to students in Nebraska and elsewhere are now available. These topics are:

- Vegetable production and cheese making
- Biodynamic farming system
- Diverse dairy operation
- Crop/animal integration
- Grass-fed beef
- Seed saving

- Future agricultural systems
- Shelterbelts
- Cheese making
- Grains processing

Then we combined short clips from these prior interviews into broad issue-based topics in another ten video lessons:

- Holistic thinking
- Niche marketing
- Macroeconomics
- Innovation and entrepreneurship
- Biodiversity
- Insects, weeds and diseases
- Soil health
- Community ties
- Passion
- Labor

All videos are enriched by a discussion document including background information on the featured farm, the farm's website, teaching objectives, discussion questions and an aerial image of the farm's exact location. The full interviews (30-45 minutes) from each farm are also available for longer, independent assignments. An outline of the full interview is included in the discussion document for easy reference to applicable sections.

From a survey conducted in December 2014, we assessed the value of the videos for teachers. More than 40 agricultural education teachers in Nebraska (30% of all vocational agriculture teachers) responded to the survey, representing more than 2500 students reached each year. Half of these educators had been teaching for more than 10 years; additionally, half of respondents were younger teachers (<35 years old). While 80% of these teachers felt sustainable agriculture was important, more than 40% agreed that there were not enough materials to teach sustainable agriculture or room in their curriculum to include more on sustainable agriculture. However, more than 80% of respondents agreed that the modules were a valuable way to introduce sustainable agriculture, engaging, easy to use and appropriate to be integrated into their future materials. There was general praise for the choice of topics and value of the interviews featured in the modules and a majority felt students were interested in and would adopt ideas from the modules in the future. More complete analysis will of these results will be prepared for publication.

## Conclusions

Based on the feedback from teachers, we deem this project a success. The farmers were highly interested in participating and the agricultural education teachers were enthusiastic about identifying students who were able to conduct the interviews. The students themselves were delighted to miss class for half a day and did a credible job of preparing questions and conducting the interviews. We sincerely appreciate the professional production capabilities of the information technology specialists and urge others who embark on such a project to take advantage of the relevant facilities and people in their organizations. We conclude that this is a valuable way to bring farmers into the classroom and build credibility in farming experiences among students in high school agricultural education classes.

## Acknowledgements

The authors recognize and thank the participating agricultural education teachers, the students who conducted interviews, the Nebraska farmers who offered their time and expertise and the professionals in information technology at UNL. Dr. Lloyd Bell and Ms. Shannon Moncure were involved with initial conceptualizing of the project. This work was financed by SARE Grant No. ENC10-116 on Sustainable Agriculture Modules for the Midwest.

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## Working with the Agricultural Diversity of College Students

An agriculture undergraduate student confided in me a comment she had heard from an agriculture instructor at my institution: "The West was not won by organics." The joke was not well received by the student, who favored organic and free-range agriculture. They felt marginalized from that point forward. This teaching-tips article will provide a basic overview of the issues involved in agricultural diversity along with some tips on how to work with diverse agriculture college students.

## Introduction

Diversity in agriculture can include a variety of ideas. Many think of diversity in education as involving issues of race, ethnicity, gender, sexuality, etc. as well as the field of multicultural education (i.e., Banks and Banks, 2010; Vang, 2010). These are important areas of diversity in agriculture; however, there is also diversity of ideas, which can include a variety of agriculture topics. Many in agriculture can recognize these ideas and the conflicting values attached to each: organic agriculture, chemical agriculture, free-range agriculture, community-supported agriculture, confinements, small-scale farming and family farms, to name a handful of them (i.e., Conway, 2012; Miller and Conko, 2004; Murphy, 2004; Rodale, 2010; Vallianatos, 2006). These issues are important in agriculture and shape how people talk about agriculture. I am not suggesting that an instructor needs to be an expert and advocate for positions within these various topics; rather, the tips listed below require an instructor to be more of a moderator than an expert. The goal is to create a classroom community of respect that will lead to learning between students beyond the walls of the classroom or lecture hall.

## Procedure

These tips are written in a list format to keep the ideas succinct.

1. Refrain from making derogatory jokes, remarks and slurs. This includes comments about agricultural beliefs and practices.
2. Take a few minutes at the start of the course to explain what your agricultural values are (for example, family farming or conventional). Explain to your class that your viewpoints come from this position and you do not mean to offend anyone who might have conflicting values.
3. Lay out discussion ground rules for everyone in class that emphasize individuality and respect. I say something to the effect of, "Everyone has an opinion and it should be respected. You can respectfully agree or disagree with it."
4. Encourage students to share their own viewpoints, even if they contradict yours.
5. When students begin to have a discussion that presents conflicting agricultural ideas, be sure to guide the discussion in a positive direction. Comments such as, "You both bring up interesting points…" can help keep the room civil. Do not take sides and stop any conversations which become disrespectful.
6. If you notice that only one side of an argument is being discussed, offer an argument agriculture from another viewpoint for discussion.
7. Do not call on students for their opinions on potentially controversial topics unless you know they are willing to share.
8. Always try to emphasize the difference between emotional arguments and factual arguments. These two concepts can be confused in a discussion. Remind students that the difference between the two is important.
9. Do not overvalue or undervalue emotional and factual arguments. It is often difficult for people to separate the two types of arguments. Honestly and respectfully demonstrate the difference between the two. Remember, emotional arguments can be sometimes irrational; yet, they also form the backbone of our identities in agriculture.
10. I prefer to spend the first day of class having students share their ideas and values about agriculture with their classmates. I think this is really important in an agricultural education class, because our field is completely socially-centered. I often bring food or take my students for chips and salsa for the discussion. I want them to feel comfortable with their classmates. I try to elicit their opinions on hot agricultural topics in a conversational style. For me, this particular activity is very important. This activity applies many of the tips from above. It also does not hide from the conflicts within agriculture. Students leave that first day of class feeling more at ease with the class and their classmates.

## Assessment

I have conducted both formal and informal assessments of my classes after having used the tips listed above. The course and instructor ratings are high, 4.29-5.00 out of 5.00. My research team has conducted focus groups and interviews with my students about their experiences in the class and virtually all comments have been positive. These generally high marks must be understood within the context of the course. I want to make the students feel uncomfortable and challenge their ideas. The high marks that students give the course after this experience testify to the usefulness of these tips.

I want to share two remarks from students which testify to the learning that occurs in the courses when we bring diversity of agricultural values to the center. A nonconventional agriculture student remarked how she had never heard of grain cooperatives. She found them amazing and quite progressive. She gained respect for this important segment of conventional agriculture. Likewise, a conventional agriculture student had entered my class convinced that using even one acre of ground for something other than food or commodity production was a waste. During the semester, he learned about a student's passion for growing lavender as well as the uses and profitability of the plant. At the end of the semester this conventional student told me that he would never grow lavender, but that he now sees the potential for cultivating for such crops. Both of these students, on either end of the agricultural value spectrum, gained an appreciation for the other side, which is all we can hope for in our modern and ever-changing agriculture systems.

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## Connecting Undergraduates to Dairy, Farm to Fork

### Introduction

It is no surprise that people have become disconnected from the origins of food as the number of farms in the United States has steadily declined for almost a century and significantly declined since 2007. As the number of farms decreased, options for food prepared outside of the home have dramatically increased including an abundance of fast-food restaurants, take-out options from restaurants, convenience foods and commercially prepared frozen meals. These options have consequently displaced home prepared meals using locally produced whole foods. As a result, we live in society lacking basic food literacy and some believe this change has contributed to the obesity epidemic. One of the learning outcomes of the undergraduate course Food Literacy at Utah State University is for students to define food systems and sustainability. The goal is to give students the opportunity to reconnect with the origins of the food they consume, while aiming to dispel myths about food from farm to fork.

### Procedure

Collaborations were made with a representative from the Dairy Council of Utah/Nevada to arrange a fieldtrip for undergraduates enrolled in Food Literacy. The fieldtrip includes a bus ride to tour one of the largest local dairy farms in Cache County, Utah, followed by a presentation and sampling of dairy products at the dairy processing plant Gossner Foods in Logan, Utah. The farm tour is scheduled as one of the weekly three-hour labs as part of the Food Literacy course.

On the bus ride to the dairy farm, the representative from the Dairy Council educates the students on the dairy farm's background, practices and owners. She then allows students to ask any questions they have about dairy farming and milk such as the benefits and drawbacks of pasteurized milk versus raw milk consumption and hormones in milk. At the dairy farm, students tour a carousel milk parlor, view milk tanks and cooling systems, interact with calves and take a hayride viewing different barns housing various age-groups and stages (pregnant and not milking) of dairy cows. Students learn about how the dairy cows are tracked digitally, which assists with peak nutrition from their nutritionist allowing for optimal milk production, prevention of antibiotics in the milk supply and monitoring of the health status of each individual dairy cow. Students are given time to ask any questions to the dairy farmers guiding the tour about the dairy farm and processing procedures.

Following the tour of the dairy farm students are bused to Gossner Foods' dairy processing plant, which is about 10 minutes' distance from the farm. They then are educated on how milk from local farms, including the one student visited, is processed at the plant. Students watch a video presentation highlighting the history of the plant and the many local farmers that supply the milk to produce their high-quality cheese, ultra-high temperature processed milk and delicious ice cream. Students are then given time to ask the Gossener presenter any questions they may have. If the cheese production line is running, the students are able to watch workers package and box the cheese. At the conclusion of the processing plant visit students enjoy sampling a variety of Gossner milk products.

### Assessment

The Food Literacy course has now participated in the dairy farm tour for four semesters. Each semester students are surveyed on whether they would recommend the tour for future students and nearly the entire class responds in agreement. One student said, "Being able to see the process of farm to fork is extremely eye opening" and another student, "I knew farming was a lot of work, but there is a lot I never thought of." The majority of students indicated that the dairy farm tour gave them a more positive perception of dairy foods and farming as shown by this students' comment of surprise by the "strict process to ensure safety and quality."


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## Cooked: A Natural History of Transformation

**By Michael Pollan. 2013. The Penguin Press, New York, NY. 403 pages, paper, $17.00, ISBN 978-0-14-312533-4.**

Anyone who has read previous books by masterful storyteller Michael Pollan will not be disappointed with *Cooked: A Natural History of Transformation.* Using the four elemental sections of Fire, Water, Air, and Earth, the author weaves a history of the human development of processing and transforming raw materials from nature into the edible foods that we enjoy every day. The book is carefully researched and referenced, yet unlike academic texts is personal, thoughtfully written, and flows more like a well-crafted novel than a non-fiction book about something as basic as cooking. Welcome to *Cooked*.

The act of cooking preserves the intricate relationship humans have with nature. Cooking detoxifies many food sources, enhances their nutrient value, and provides a space for humans to share, listen, and eat together. However, this intimate relationship with food has been altered in the past few decades as more U.S. consumers leave their kitchens and let food industry provide their meals. The author explores both the historical significance of our intimate relationship with food, as well as recent changes in human consumption habits that are driven by a barely-regulated food industry that puts profit ahead of human wellness, contributes to untold human costs in medical bills and unusually early deaths, and in a dismaying turn of events becomes a model for much of the developed world. We follow Pollan in his journey into the origins of food preparations through literature searches and thoughtful documentation, as well as into his kitchen where he learns first hand how we transform nature and her ingredients into digestible delicacies using the four basic elements.

This journey through the elements begins in Ayden, North Carolina where he learns the history and culture surrounding authentic barbeque, the kind that involves long hours cooking a pig in a pit room over a slow fire. It is no coincidence that as humans we enjoy the flavors and smells of barbeque. As he describes the process, "*It may well be that (some) animals are pre-adapted to prefer the smells, tastes, and textures of cooked food, having evolved various sensory apparatus to steer them toward the richest sources of energy*" (p 61). In addition to introducing us to the fabled competition among famed barbeque cooks and their curious idiosyncrasies, the author presents an unlikely myth about how the process was invented by tasting a roasted carcass pulled from a burned down barn. But rather than detract from the story, this enjoyable factoid adds to the mystique that surrounds a truly southern delicacy that has spread across this country and abroad.

Next Pollan moves to water and imagines the historical discovery of using fire and water to cook food, starting with heated stones in vessels made of animal skins before invention of pottery and metal cooking containers. He discusses the intricacies of blending vegetable and animal ingredients with proper spices to create new emergent properties of aroma and tastes in food. Integral to the story are the personalities associated with different cultural traditions and preparations, including a young friend from Iran who made weekly visits to the author's kitchen to introduce new ingredients and food preparations, along with the history of these in another country. Throughout the book we are introduced to special people who devote their lives to food and adding value to simple ingredients through cooking. The story of water and food is one part of the story of civilization.

One of the most intriguing sections of the book discusses the history of baking, with a suspected origin in the human search for a way to transform seed of grass species into something easily digestible. The author describes not only our growing capacity to process this vital food source into more edible products, but the accompanying co-evolution of enzymes in the human gut to catalyze the process. He goes on to describe the invention of white flour that began a societal norm of whole wheat bread for poor people versus white flour for those who were rich, to a flipped current behavior of white bread cheaply available to the poor while those with higher incomes and concern for nutrition now eat brown bread. Pollan documents how industry has changed wheat flour from something that was living (included the bran and germ), unpredictable, and perishable to white flour that is stable, has a longer shelf life, and is not living (bran and germ removed). This is not the only time that the food industry has transformed a beautiful natural substance into one that is easily digestible with low nutrient content. The story of flour portends the emergence of a food industry intent on profits, often using the guise of nutrition as a marketing tool.

Lastly, the section on fermentation and brewing brings alive the history of this fascinating process, as told through the stories of current brewers and their artisan-like trade. Pollan discusses the paradox of our quest to create germ-free environments in our food processing, yet rely on probiotics in mothers' milk to give infants a good start on life, on microbes that help us produce cheese, yoghurt, kimchi, and beer, and on penicillin from soil organisms to keep us healthy by killing the bad bugs that cause infection. It may in fact be bacteria-free food that is making us sick and cultured foods that keep our gut microbes as well as ourselves healthy and safe. Again, the story is told through visits with unique personalities who have dedicated their lives to one of these processes, providing a rich narrative of people, process, and place to illustrate this part of our food and cultural environment.

Throughout this book, the reader is challenged to answer several key questions. How has food changed us? More importantly, how have we changed food through industrialization and mechanization? What can the serious student of food do to improve personal nutrition and what can society do to reverse the general trends toward obesity, diabetes, and heart disease through taking back control of our diets? There are serious messages here to the food industry as well.

Such serious questions are addressed though many personal stories, always enhanced by Michael Pollan's personal involvement with the preparations and evaluation of each product. The book reads like a novel, yet contains so many practical tidbits about cooking that one is left with hundreds of small suggestions on how to relate more effectively with our food. *Cooked* offers both a scientific and cultural interpretation of the history of *Homo sapiens* and food. The depth of research and practicality found here is revolutionary for those who have yet to read a book by Pollan. *Cooked* provides an exciting perspective on our relationship with food throughout time as well as our current intimate relationship with this critical resource. It explores topics from the evolutionary implications of cooking, baking techniques, vegetable ferments, and the human microbiome. And of overall importance is the way we have changed our relationship with food when outsourcing much of the preparation to industry, much to our own disadvantage as we lose the power of food to nourish and sustain us, and transfer this power to the insensitive and even brutal commercial economy. This is a wake up call, and a stimulus to actually wake up to savor the real value of food in history and in our lives and how we can choose a healthier food future.

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## Agroecology: The Ecology of Sustainable Food Systems

**By Stephen R. Gliessman. 2015. CRC Press, Boca Raton, Florida. Hardcover, 371 pages, $79.95, ISBN 978-1-4398-9561-0.**

Holistic education and research in agroecology are growing in importance in the U.S., and increasingly endorsed by FAO and other influential organizations. Emphasis has also broadened to include the entire process of food production from natural resources and purchased inputs through processing and marketing to consumption and nutrition, and will soon embrace conversion of waste to valuable resources that can cycle back into the production process. Agroecology is a key textbook for undergraduate education in this important field, and the new Third Edition by professor emeritus Stephen Gliessman from U.C. Santa Cruz will certainly not disappoint those already familiar with prior versions.

Our growing recognition and concern about food production and access by all to solve current nutrition challenges on a global scale has moved many of us from focus on agricultural practices and more efficient use of increasingly scarce non-renewable resources to a thoughtful study of total food systems. As stated in the foreword by Ricardo Salvador, "life is about understanding the times in which you live and therefore what you should do with your life" (p. ix), a concise summary of what education is all about. Dr. Gliessman challenges us to move beyond production details and put them in context within whole systems, and questions our current singular paradigm of domination of the environment. The author further urges us to consider social issues such as the need for adequate wages for farm workers, safe working conditions, and rational distribution of food and other benefits of the agricultural enterprise. This changes the educational scene, and the new edition of Gliessman's text helps in the transition.

In the first two chapters there is adequate evidence for the need for 'fundamental change in agriculture' (Ch. 1), and visiting the agroecosystem concept (Ch. 2), both similar to previous editions. The rest of the book follows an appropriate hierarchical framework, with sections on plants, soil and environmental factors; the next on complexity of biological systems followed by a section that focuses on system-level issues and especially the important interactions that make study of agroecology unique from other reductionist fields; a short section on transition from present systems to those more sustainable under changing climate and unpredictable weather; and finally a section on broad topics that deal with society, community, culture, and transformation to a long-term sustainable approach to food systems. It is this last section that clearly distinguishes the third edition from the prior two. This review will emphasize what is innovative in the last three chapters.

Dr. Gliessman expands on the sequence of steps proposed by Rod MacRae and colleagues in Canada, who suggested improving systems through 1) greater efficiency; 2) substitution of alternative practices; 3) redesign of systems by adding two new dimensions: creating local food systems through connecting farmers with consumers, and then linking these local systems on a larger scale to "*build a new global food system, based on equity, participation, and justice, that is not only sustainable but also helps restore and protect earth's life support systems*" (p. 279). The challenge is to move researchers out of their disciplinary silos to consider broader issues in the food system, and to consider ethical issues such as distribution of benefits from our research and education.

There is a chapter on indicators, reporting on recent advances in "how to measure the unmeasurable" according to some critics, and now exploring soil health, crop productivity, ecological parameters and social dimensions of development. These are all important steps forward from the previous editions of the text. Lastly, the author tackles some of the seemingly intractable challenges facing any thoughtful and concerned student of farming and food systems: issues regarding long-term food security and food sovereignty, globalization and consolidation resulting in corporate control, political processes and power relations in policy determination, and general complacency of a population of consumers that seeks the cheapest food possible without attention to who grows it, how production is managed, and who benefits from the system. A series of steps is proposed for changing the food system, and here the book clearly takes a stance on advocacy and reflects the well-known quote from Nobel laureate René Dubos, who said that "Wherever humans are involved, trend is not destiny."

Readers of prior editions will recognize the comprehensive glossary, the impressive collection of references that complements each chapter, and an index to key terms found throughout the book. There are thought-provoking questions concluding each chapter, as well as current web sites to enable a student to access timely new information. Since the first edition of *Agroecology: Ecological Processes in Sustainable Agriculture*, this undergraduate textbook has been one of the most widely used resources in this field in U.S. universities. The third edition now titled *Agroecology: The Ecology of Sustainable Food Systems*, promises to keep that place among the many publications and web sites that are coming out in this burgeoning field.

We can observe the expanded chapter on animals and crop/animal integrated systems, an improved emphasis on agroforestry but lack of attention to permaculture and perennial systems in general including potentials of prairie polycultures (there is a pull-out box on the Sunshine Farm Project from The Land Institute in Salina, Kansas), and still a preponderance of examples from California and Central America. But of course that is where the author's competence is strongest. It is commendable that Dr. Gliessman continues to access current literature and provide our students with a comprehensive and accessible text on agroecology, a book that should be the first one to consider by anyone starting up an undergraduate course in this important and growing field.

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