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Can they Relate? Teaching Undergraduate Students about Agricultural and Natural Resource Issues

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Abstract

Undergraduate students should be able to identify relationships between agricultural and natural resources (ANR) issues to be prepared for ANR sector jobs. The purpose of this study was to determine if communication courses focused on teaching about ANR issues influenced students' understanding of the relational nature of these issues. A pre/posttest research design was given to undergraduate students enrolled in communication courses at three universities that addressed communicating about nine ANR issues. After descriptive analysis, the data was visualized and density was calculated using social network analysis software. Prior to the course, the strongest perceived relationship was between food safety and food security, followed by water and animal health. After the course, the strongest perceived relationship was between water and food security, followed closely by water and conservation. Visually, water was central to the network of issues, followed by food security, and conservation. The density of the perceived interconnectedness of the issues indicated the respondents did perceive the nine ANR issues were more closely related after taking the course than before. In this case, courses focused on communicating about ANR issues assisted students in being able to convey how these issues are interdependent, preparing them for the workforce.

Keywords: agricultural and natural resource issues; relationships; undergraduate students; communication; social network analysis

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Introduction

Undergraduate students in colleges of agriculture are the future of the agricultural and natural resources (ANR) workforce and must be prepared to handle the many and varied issues – both individually and collectively (DiBenedetto, Lamm, Lamm, & Myers, 2016) – facing the agricultural industry today (United States Department of Agriculture – National Institute of Food and Agriculture, n.d.). Some of the issues include food insecurity (DiBenedetto et al., 2016), natural resource management, energy consumption, climate change, and agricultural production (Andenoro, Baker, Stedman, & Pennington Weeks, 2016).

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These issues are not independent of one another, but rather, they are all connected. For example, food security and the use of biotechnology, including genetic modification (which can be seen as contentious), are intertwined. Biotechnology is viewed by many as a solution to the food demands of an ever-growing population through the use of genetic modification (GM) (Godfray et al., 2010; LaJeunesse, 2015). Using biotechnology also impacts marketing and trade because GM crops increase yields and decrease inputs (Godfray et al., 2010; LaJeunesse, 2015), thereby increasing the potential for additional export availability that could assist in alleviating poverty in hard-to-reach parts of the world. Not only is biotechnology intertwined with food security, but also it is often discussed regarding food safety. Only 37% of Americans trust that GM food is safe to eat (Funk & Rainie, 2015) despite the scientific community repeatedly finding GM food safe to consume (National Academy of Sciences, 2016; Nicolia, Manzo, Veronesi, & Rosellini, 2014).

Food safety, food security, and animal health are also connected. Concerns have risen related to animal antibiotics affecting human health because of possible antibiotic residue (Lee, Lee, & Ryu, 200l; National Research Council, 1999). In a study of consumers in Florida, over half of the respondents expressed concerns about antibiotic residue in meat products (Anderson, Ruth, & Rumble, 2014), even though the use of antibiotics has improved animal health and productivity to increase meat production over the last few decades (McDermott et al., 2002).

Animal health issues have also been impacted by invasive species, which leads to food security issues. In 2016, screwworm flies from South America and the Caribbean (Nordile, 2016a) caused alarm because this invasive species can be detrimental to livestock producers' herds (Nordile, 2016b). Thus, the invasive species had the potential to impact food security if the outbreak had not been handled cautiously. According to Huang, Rumble, and Lamm (2014), land misuse can be a result of the "introduction of non-native species" (p. 26). Huang and Lamm (2016) found Floridians expressed concerns about invasive species affecting ecosystem conservation. Not only do invasive species affect the conservation of land and water resources, but water issues impact conservation of the land. Huang, Lamm, and Rumble (2016) found respondents expressed concerns about animal waste and water run-off/quality as factors impacting conservation of the land. If the land was not conserved properly, it could impact food security should the land become unsuitable for farming.

Another factor making food production more difficult is climate change and variability. As the climate continues to change, agriculture has to adapt (United Nations, 2015). Using biotechnology, researchers have begun to combat the effects of climate change. For example, GM drought-tolerant sorghum with genetics resistant to stalk rot is being produced (Tesso, Claflin, & Tuinstra, 2005) to alleviate the losses associated with extreme weather events and lack of water availability.

Food security is also connected to water (Andenoro et al., 2016). Simply put, both crops and livestock require water. Mismanagement and scarcity of water resources impact the quality and sustainability of food, which impacts food security. The connections above are not the only connections between ANR issues. These examples serve as evidence as to why it is imperative to educate undergraduate students on ANR issues and help them develop an appreciation for the connectedness of the issues they will wrestle with as they become the leaders the ANR industry needs to advance the field.

It is important students learn how these issues interconnect with one another. Communication courses are a good place to start; students learn about a variety of ANR issues and how to discuss them appropriately in one learning environment. Courses that foster learning about the connectedness of issues help students become better equipped to address these controversial and complex ANR issues. Currently, there is a lack of research identifying the potential benefits of a course that includes this type of learning. One of those benefits is students comprehending the connectedness of the many issues facing the industry. This research explored the benefits of communication courses that include lessons about ANR issues in regard to how students perceived the interconnectedness of ANR issues.

Conceptual Framework

The concept of contextual learning was used as the framework for this study, which was originally derived from experiential learning theory (Dewey, 1938) and brain-based theory (Caine & Caine, 1991). Contextual learning theory is often used to guide student-driven education because the educational materials are directly applied to students' lives. Communication courses focused on learning about ANR issues are student-centered with courses designed to help undergraduate students understand ANR issues and realize the issues do not stand alone. By focusing on contextual learning, students learn to think critically and actively apply knowledge to complex situations (Baker & Robinson, 2016).

In contextual learning, the experience of the classroom help students make connections between issues and how they play out in the real world because direct experience with an issue is expected to impact later experiences (Dewey, 1938). While students are not in a real-life situation when in the classroom, using techniques driven by contextual learning allows them to be presented with real issues the ANR industry faces and are able to gain knowledge (Roberts, 2006) they can apply later in their careers. Through contextual learning, students gain continuity, which promotes the growth of learning and the ability to better conceptualize connections between concepts (Dewey, 1938).

Knobloch, Ball, and Allen (2007) found high school and middle school student teachers believed "agriculture provided connections for their students" (p. 29). The teachers also believed teaching in the context of agriculture allowed students to be connected to the world around them. For example, the teachers expressed the importance of learning the water cycle and its connection to soil formation and the seasons (Knobloch et al., 2007). Along those same lines, Theimer and Ernst (2013) found students who spent more time outdoors with their teacher displayed "high levels of connectedness to nature" (p. 84-85).

Mueller, Knobloch, and Orvis (2015) conducted an experimental study examining differences in students' perceptions of biotechnology and genetics as integrated science topics related to food production sustainability and human health when actively engaged in experiential techniques versus traditional teaching methods. They discovered students who were in the active learning treatment group, based on experiential learning theory, were more likely to contextualize, think critically, and understand the topics of biotechnology and genetics. Students in the treatment group also scored significantly higher in the application of biotechnology and genetics than the control group (Mueller et al., 2015). Balschweid (2001) also concluded experiential learning provided a connection between content and context to address complex problems. In this study, students who took a biology class using animal agriculture as the context understood the role science played in production agriculture better than those in a traditional biology class (Balschweid, 2001).

In addition to the foundation of experiential learning, the brain-based theory provides additional context. According to Caine and Caine (1991), "a subject is always related to many other issues and subjects" (p. 7). Brain-based learning is the process of connecting information being taught and students' previous experiences (Caine & Caine, 1991). Every person is touched by the

ANR industry so a connection to the industry can be easily made. Communications courses can serve as a learning tool to assist students in completing the connection between ANR issues they have already been exposed to daily. Past research has looked at the connections middle school, and high school students make while in the classroom with limited research addressing how undergraduate students assess the connectedness of larger issues in an agricultural context.

Purpose and Objectives

The purpose of this study was to determine if communication courses that include content about ANR issues influenced undergraduate students' understanding of the relational nature of ANR issues. The purpose was fulfilled through the following objectives:

1. Identify undergraduate students' perceived relationships between ANR issues before and after taking a communications course focused on ANR issues.
2. Visualize undergraduate students' perceived relationships between ANR issues before and after taking a communications course focused on ANR issues.
3. Determine the strength of the perceived interconnectedness of ANR issues before and after taking a communications course focused on ANR issues.

Methods

A pre/posttest research design was used to address the objectives of the study. Perceived relationships between a series of ANR issues were measured on the pretest and posttest using a researcher-developed scale, which required respondents to indicate the level to which they believed each of the nine issues were connected to one another on a five-point semantic differential scale ranging from zero to four (0 = *not at all connected*, 4 = *completely connected*). In total, respondents were asked to respond to 36 relational questions. The nine-issue areas were animal health, biotechnology, climate variability and change, conservation, food safety, food security, invasive species, marketing and trade, and water.

Content and face validity of the pretest and posttest were determined by a panel of experts that included an assistant professor at Colorado State University who specializes in instrument development, an associate professor at Texas Tech University specializing in issues education and agricultural communication, and the director of the Center or Public Issues Education at the University of Florida (Ary, Jacobs, Sorensen & Razavieh, 2010). The instruments were pilot-tested with a group of graduate students to ensure understanding and clarity (Ary et al., 2010). Cognitive interviews were conducted to build a strong understanding of any misconceptions related to question wording. Minor adjustments to wording in the stem of the questions were made, and examples within each of the nine issue areas were added as a result of the pilot test.

Undergraduate students enrolled in a communications course focused on ANR issues were the population of interest for this study. Fifty-nine students enrolled in communication courses at the University of Florida, Texas Tech University, and Colorado State University were selected purposively as the sample since the courses were being offered at all three during the spring semester in 2016. Enrollment was consistently open to students from a diverse array of colleges at all three universities.

Students were provided with a pretest on the first day of class and a posttest on the last day of class. A 44% response rate was obtained with 26 complete pre/posttests collected that were able to be matched. The low response rate was due to students enrolling in the course after the semester began therefore not receiving the pretest, students who dropped the class before the posttest was administered, and those who chose to not participate in the study. The low response rate is a limitation, making the results only generalizable to those who completed both the pretest and posttest. However, non-response bias was addressed using Chi-squared tests, comparing respondents' gender and college rank to non-respondents (Ary et al., 2010). No significant differences were found; therefore, the sample was determined to be representative of the students enrolled in all three courses. Eight of the respondents were from the University of Florida, nine from Texas Tech University, and ten from Colorado State University.

Demographics were collected on the pretest. This included race, gender, college rank, and college major. All of the participants were White and Non-Hispanic, and their age ranged from 20 to 24 years old. Most of the respondents were female (80.8%) and represented all four college classes: freshman (7.7%), sophomores (15.4%), juniors (38.5%), and seniors (38.5%). Most of the respondents reported an Agricultural Education, Leadership, and/or Communication major (65.4%). Several reported a Journalism and Media Communication major (18.5%) and Agricultural Literacy major (7.7%). One of the respondents reported having an Environmental communications major and one reported a Natural Resource Recreation and Tourism major.

Means were calculated for each of the perceived relationships on the pretest and the posttest individually. A post hoc analysis was conducted and the scale deemed reliable (α = .97) Change in the overall mean for each of the perceived relationships from pretest to posttest was also calculated. Paired *t*-tests were then used to determine if there were statistically significant differences in perceptions before and after the course. A significance level of .05 was established *a priori*. The mean scores were then imported into Ucinet 6 (Borgatti, Everett, & Freeman, 2002), a social network analysis software, to visualize the respondents' perceived relationships between the nine issues as individual connections, as well as a broader network of issues that were interconnected. The analysis allowed the data to be viewed visually to see which issues were more central within the broader group of issues from the respondent's perspective, the density of relationships between multiple issues, and the intensity of the perceived relationships. The placement of the nodes (each of the nine ANR issues) within the broader network of nodes (group of ANR issues) was visually examined, and the width of the ties between the nodes were used to indicate the strength of the perceived relationships (Borgatti, Everett, & Johnson, 2011). Ucinet 6 (Borgatti et al., 2002) was also used to calculate the density of the perceived interconnectedness of the ANR issues overall on the pretest and posttest (Borgatti et al., 2011). Density is the proportion of direct ties in a network relative to the total number possible (Xu, 2010) and, in this case, is an identifier of how related respondents perceived the issues to be with one another as a network. A higher density statistic indicates a higher level of density within a network.

Results

Perceived Relationships Between ANR Issues

The respondents' perceived relationships between ANR issues were examined before and after taking the communications course (see Table 1). Prior to taking the course, the strongest perceived relationship was between food safety and food security (*M* = 3.23), followed by water and animal health (*M* = 3.19). After taking the course, the strongest perceived relationship was between water and food security (*M* = 3.28), closely followed by water and conservation (*M* = 3.24), and water and animal health (*M* = 3.23).

Prior to taking the course, the weakest perceived relationship was between conservation and marketing and trade (*M* = 1.81). It was followed by conservation and food safety (*M* = 1.88).

After taking the course, the only perceived relationships with a mean score lower than two on the scale ranging from zero to four was between conservation and food safety (*M* = 1.92).

The relationships with the largest reported differences in mean score from the pretest to the posttest were between conservation and biotechnology (+.62) and conservation and marketing and trade (+.58). Although they were the largest changes, they were not significantly different when a paired *t*-test was conducted. However, the differences in perceived relationships between conservation and invasive species (+.34), climate change and water (+.31), food safety and water (+.27) food security and water (+.12), and invasive species and water (+.04) all had positive, statistically significant changes.

Several relationships had a negative change with the largest occurring between animal health and food safety (-.38), indicating the respondents felt these two issues were less related after the course than before. However, the change in response to this item was not statistically significant. The only statistically significant negative change was between food safety and invasive species (-.08).

Table 1

Perceived Relationships Between ANR Issues Before and After Taking the Course

Issue 1	Issue 2	*N*	Pretest *M (SD)*	Posttest *M (SD)*	Mean Difference
Conservation	Biotechnology	26	2.00 (0.98)	2.62 (1.02)	0.62
Conservation	Marketing & Trade	26	1.81 (0.94)	2.38 (1.02)	0.58
Climate Change	Marketing & Trade	26	1.92 (1.09)	2.46 (1.10)	0.54
Food Security	Invasive Species	26	2.19 (1.13)	2.62 (0.94)	0.42
Biotechnology	Water	25	2.40 (1.12)	2.80 (1.04)	0.40
Climate Change	Food Safety	26	2.00 (1.09)	2.38 (1.24)	0.38
Conservation	Invasive Species	26	2.81 (1.30)	3.15 (0.88)	0.34*
Biotechnology	Climate Change	26	2.11 (1.24)	2.46 (0.90)	0.35
Biotechnology	Food Security	25	2.84 (1.14)	3.16 (1.11)	0.32
Climate Change	Water	26	2.96 (1.15)	3.27 (0.87)	0.31*
Climate Change	Food Security	26	2.23 (1.21)	2.54 (1.17)	0.31
Climate Change	Invasive Species	26	2.46 (1.14)	2.77 (0.99)	0.31
Animal Health	Marketing & Trade	26	2.23 (1.21)	2.54 (1.10)	0.31
Food Safety	Water	26	3.11 (1.03)	2.85 (1.16)	0.27*
Climate Change	Conservation	26	2.77 (1.14)	3.00 (0.89)	0.23
Invasive Species	Marketing & Trade	26	2.15 (1.05)	2.35 (1.16)	0.19
Water	Marketing & Trade	26	2.54 (0.86)	2.69 (1.09)	0.15
Animal Health	Conservation	26	2.81 (1.06)	2.96 (0.91)	0.15
Food Security	Water	25	3.16 (0.85)	3.28 (0.79)	0.12**
Food Security	Marketing & Trade	26	2.96 (1.15)	3.08 (0.93)	0.12

Table 1 (Continued)

Perceived Relationships Between ANR Issues Before and After Taking the Course

Issue 1	Issue 2	*N*	Pretest *M (SD)*	Posttest *M (SD)*	Mean Difference
Food Security	Food Safety	26	3.23 (1.18)	3.35 (0.94)	0.12
Conservation	Water	25	3.12 (1.20)	3.24 (0.93)	0.12
Animal Health	Biotechnology	26	2.27 (1.15)	2.38 (0.80)	0.11
Animal Health	Invasive Species	26	2.46 (1.24)	2.54 (0.99)	0.08
Biotechnology	Food Safety	25	2.60 (1.15)	2.68 (1.22)	0.08
Invasive Species	Water	25	2.77 (0.82)	2.73 (0.96)	0.04*
Animal Health	Water	26	3.19 (1.23)	3.23 (0.95)	0.04
Biotechnology	Invasive Species	25	2.32 (1.14)	2.36 (0.91)	0.04
Conservation	Food Safety	26	1.88 (1.03)	1.92 (1.09)	0.04
Animal Health	Climate Change	26	2.58 (1.10)	2.58 (0.99)	0.00
Animal Health	Food Security	26	2.77 (1.24)	2.73 (1.15)	-0.04
Food Safety	Invasive Species	25	2.36 (1.04)	2.28 (1.06)	-0.08*
Conservation	Food Security	26	2.46 (1.21)	2.35 (1.26)	-0.11
Food Safety	Marketing & Trade	26	3.00 (1.13)	2.81 (0.94)	-0.19
Biotechnology	Marketing & Trade	25	2.76 (1.05)	2.56 (1.04)	-0.20
Animal Health	Food Safety	26	2.88 (1.21)	2.50 (1.14)	-0.38

Note. 0 = *Not at all related*; 4 = *Completely related;* $*p < 0.05$; $**p < 0.01$; Animal Health (animal welfare, animal disease); Food Safety (foodborne illnesses); Marketing & Trade (imports/exports); Conservation (endangered species, land use); Biotechnology (GMOs); Invasive Species (not native to specific location); Food security (food availability, access and use); Water (water quality, water quantity, agricultural water use); Climate Change (carbon sequestration, greenhouse gas emissions, sea level rise).

Visualization of the Perceived Relationships Between ANR Issues

The perceived relationships between the ANR issues were visualized using social network analysis software. The pretest results can be viewed in Figure 1. The darker lines indicate a stronger tie, and the lighter lines indicate weaker ties. Visually, water and food safety had the strongest ties to the eight other issues with darker lines indicating the strength of their relationships. Marketing and trade and climate change were the two issues with weaker ties.

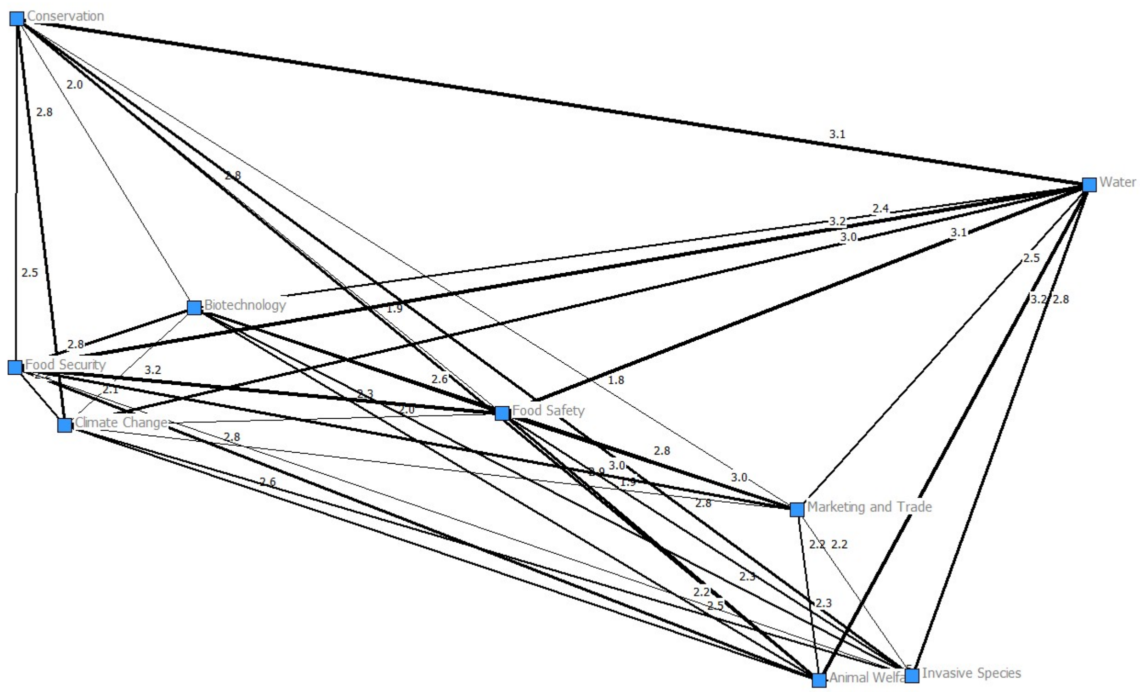

Figure 1. Perceived relationships between ANR issues before taking the course.

The perceived relationships between the ANR issues were then visualized using the results from the posttest and can be viewed in Figure 2. Visually, water was central to the network of issues with dark ties, and food security moved into a central position with dark ties to almost all of the other eight issues. Conservation also exhibited darker ties to the other issues. Biotechnology was placed at the far left with weaker ties to the other eight issues expressed.

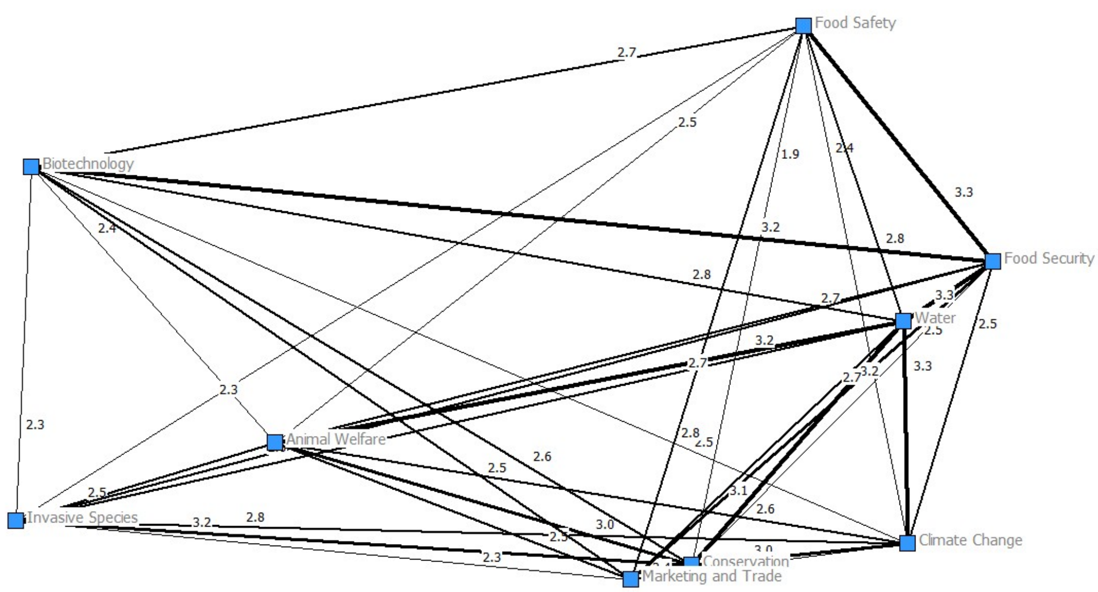

Figure 2. Perceived relationships between ANR issues after taking the course.

Density of the Perceived Interconnectedness of ANR Issues

The density of the perceived interconnectedness of ANR issues was measured using density value (see Table 2). The density value increased from pretest to posttest (+5.51). This result indicated the respondents did perceive the nine ANR issues were more closely related after taking the course than before.

Table 2

Density of the Perceived Overall Interconnectedness of ANR issues Before and After Taking an Agricultural Issues Course

	M	*SD*	Total Density Value
Pretest	2.56	.40	92.07
Posttest	2.71	.34	97.58

Note. 0 = *Not at all related*; 4 = *Completely related.*

Conclusions and Implications

As the undergraduate students of today become the workforce of tomorrow, they need to be equipped to address the many diverse issues facing the ANR industry (DiBenedetto et al., 2016; USDA-NIFA, n.d.). These issues vary from food insecurity to climate change, energy consumption to agricultural production (Andenoro et al., 2016; DiBenedetto et al. 2016) and are so intertwined that addressing one issue requires an understanding of how it will impact others. The purpose of this study was to determine if communication courses that include content about ANR issues influenced undergraduate students' understanding of the relational nature of ANR issues. In response to research objective one, the results indicated students did recognize the interconnectedness of ANR issues before the communication courses, but these relationships were more evident after completing the course. Providing educational opportunities for students to learn about ANR issues through experiential learning has proven effective at encouraging critical thinking and understanding of these issues (Mueller et al., 2015). In addition, using agriculture as the context for learning has had positive learning outcomes for subjects as varied as biology (Balschweid, 2001) and the water cycle (Knobloch et al., 2007). The results of the current study indicated providing opportunities for students to learn about ANR issues seemed to clarify how the issues were more related than previously thought. With the emphasis on communication in these courses, students may now be better able to convey how the issues are interdependent when they enter the ANR workforce.

Although many factors may influence how students perceive the connectedness of ANR issues (e.g., educational background, personal upbringing), it appears these courses did provide an opportunity to help students make those connections more evident. This is supported by the finding that only one relationship had a low mean score. The results of the paired samples *t*-tests revealed gains in the perception of interconnectedness for 29 of the 36 pairs of relationships (one pair was consistent from the pretest to posttest). As students in the communications courses learned more about these issues, they began to better realize the connections between them as Dewey (1938) described would happen through contextual learning.

Several of the relationships that increased in strength have been noted by previous researchers such as the connection between food security and biotechnology (Godfray et al., 2010; LaJeunesse, 2015); food security and water (Andenoro et al., 2016); and invasive species and food security (Huang et al., 2014; Nordile, 2016a, 2016b). Additionally, all the relationships with climate change had gains except one, which did not change at all from pretest to posttest. The United Nations (2015) noted that agriculture will have to adapt to address the impacts of climate change and variability. Perhaps students hear more about climate change, and the data reflect the students' awareness of the reverberating impacts climate change could have on the ANR industry.

Research objectives two and three were addressed through additional exploration of the data. The results of the social network analysis visually depicted the relationships between the ANR issues. A comparison of the two figures draws attention to the number of connection lines that grow in strength between the two data collection points. The findings further illustrated how students conceptualized the relationships between the nine ANR issues addressed in this study, and the density value demonstrated the extent to which students viewed these issues as interconnected.

Recommendations

As previously noted, the results of this study are limited in generalizability. Additional data collection with more students in similar courses could provide a better description of how post-secondary students view ANR issues and how courses impact perceived interconnectedness of ANR issues. While this study explored relationships between pairs of issues, this does not fully describe the interconnectedness of the ANR industry. The social network analysis gets closer to providing this picture, but it would be intriguing to see how additional ANR issues would fit. The nine issues identified for the current study represented a wide variety of issues, but it was not an exhaustive list. Future research should incorporate additional topics or simply ask students what other aspects of ANR are related to a specific issue. This would further demonstrate students' ability to recognize the complex and multi-faceted nature of the ANR industry.

It would also be insightful to collect this interconnectedness data from other groups and within different contexts. Collecting this data from undergraduate students studying agriculture and life sciences at the beginning and end of their degree program could provide insight on how complete degree programs are having an impact. Students completing bench science degrees could then be compared to those completing social science degrees to see if there are differences in their perceptions. It would also be interesting to see if the students' enrollment in courses, such as the ones studied in this research, have an effect despite declared major.

Graduate students should also be studied. Not only are undergraduate students going out into the ANR industry, but graduate students will be serving as leaders within the industry and as future faculty and should be thinking about ANR issues holistically rather than as independent issues. How graduate education in agricultural education and communication is impacting graduate students' ability to see the interconnectedness of ANR issues is unexplored.

It would also be interesting to study industry leaders to see how their conceptualization of the relationships between ANR issues compares to what undergraduate students recognized in this study. Perhaps those working within specific areas of the ANR industry have a perspective that could add to the educational content shared in these courses. These perspectives could be used to build case studies that could be integrated into agricultural education courses, further advancing the contextualization of agricultural education and communication courses.

Additional research should explore additional cognitive gains such as knowledge about the ANR issues and the ability to communicate about them effectively. This data could be collected using qualitative methodology to provide richer descriptions of what students gain from courses such as the ones in this study. Future research could also explore specific pedagogical strategies that might influence students' understanding of the interconnectedness of these issues. Previous scholars have advocated for experiential learning, so perhaps the integration of case studies, undergraduate research projects, or service learning might further improve the education outcomes. As Caine and Caine (1991) stated, the process of connecting the information presented in the classroom to previous experiences reflects brain-based learning. As instructors strive to help students draw connections and gain a deeper understanding of the connectedness of ANR issues, they should seek opportunities to help students connect the concepts to prior knowledge.

As others have recognized, it is important that students be aware of and knowledgeable about a variety of ANR issues and how they are interconnected. Having this understanding would help students recognize how changes in one area (e.g., policy, markets, weather) might influence decisions for another sector of the industry. As the future decision-makers and leaders of the ANR industry, undergraduate students need to be adequately prepared to develop solutions that are feasible within constraints on resources. While many classes these students might complete during their degree plan are limited to a particular agricultural science discipline (e.g., animal science, plant science, natural resources), perhaps there is a need to provide an opportunity for students to gain exposure to the interconnected nature of ANR issues and propose potential solutions to challenges facing the industry.

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