

Interdisciplinary Connections: Evaluating Collaboration between AFNR and Leadership, Mathematics, and Science Educators

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ABSTRACT

Agriculture, food, and/or natural resources (AFNR) content offers a tremendous context for interdisciplinary teaching and learning. Collaboration between AFNR and core content area educators has been recommended to increase interdisciplinarity in school-based AFNR Education; however, existing research lacks an empirical investigation of the relationship between interdisciplinary collaboration and outcomes associated with interdisciplinary teaching in school-based AFNR Education. Therefore, the current study explores the scope of collaboration between AFNR, leadership, mathematics, and science educators and the relationship between collaboration and interdisciplinary teaching in school-based AFNR Education. Findings indicate opportunities to initiate and strengthen interdisciplinary communities of practice through purposeful interactions, especially regarding length of interactions between AFNR and core content area educators. Recommendations for practitioners, teacher educators, and researchers are provided.

Keywords: collaboration; interdisciplinary teaching and learning; school-based Agriculture Food and Natural Resources Education

The Context: School-Based AFNR Education

Under the umbrella of Career and Technical Education (CTE) exists school-based Agriculture, Food, and Natural Resources (AFNR) Education. AFNR Education includes intermediate and secondary-level coursework in agribusiness; animal sciences; environmental service systems; food products and processing; leadership; natural resource systems; plant sciences; and power, structure, and technical systems. In addition, AFNR Education includes two intra-curricular pillars which extend student learning, (a) supervised agricultural experiences – out-of-class, student-directed experiences designed to engage learners in the application of AFNR content (e.g., working for a local farm store, starting a lawn mowing business, conducting research on the yields of multiple corn hybrids) and (b) the National FFA Organization – a career and technical student organization (CTSO) designed for the development of leadership skills and application of AFNR and leadership knowledge through various contests, conferences, workshops, and student leadership positions (Phipps, Osborne, Dyer, & Ball, 2008).

To address the increasingly complex problems (e.g., climate change and food insecurity) plaguing society, future generations must be prepared to enter the workforce with an interdisciplinary understanding of the complex systems which comprise the world (Chettiparamb, 2007; Newell, 2007). Therefore, CTE, including school-based AFNR Education, must be strengthened through curriculum which crosses multiple disciplinary bounds (Handy & Braley, 2012). In a review of existing literature, researchers identified five additional justifications for creating these interdisciplinary learning spaces within AFNR Education; specifically referencing science, technology, engineering, and mathematics (STEM) content integration (Scherer, McKim, Wang, DiBenedetto, & Robinson, 2017). Justifications for including STEM content included (a) increasing core academic learning via the context provided within AFNR curriculum, (b) increasing student interest in STEM and AFNR careers, (c) empowering students with the interdisciplinary perspective needed for emerging careers, (d) preparing problem solvers with the requisite interdisciplinary perspective, and (e) establishing interdisciplinary connections which adhere to the interrelated nature of AFNR and STEM systems of knowledge. In combination, identified justifications provide the rationale for approaching AFNR Education in an interdisciplinary manner.

Scherer et al. are not alone in articulating the importance of interdisciplinary teaching and learning within AFNR Education. In fact,

many suggest the inherent interdisciplinary nature of AFNR systems make AFNR Education the ideal environment for interdisciplinary education in secondary school settings (National Research Council, 2009; Stubbs & Myers, 2015). Within AFNR Education literature, commonly cited interdisciplinary connections are between AFNR, science, mathematics, and leadership. In fact, researchers have explored connections between AFNR and core content areas for over 25 years, illuminating both the importance of, and the opportunities available for, interdisciplinary connections in AFNR Education (Balschweid, 2002; Connors & Elliott, 1994; McKim, Velez, Lambert, & Balschweid, 2017; Morgan, Fuhrman, King, Flanders, & Rudd, 2013; Myers & Osborne, 2005; Newman & Johnson, 1993).

Future growth of interdisciplinary teaching and learning in school-based AFNR Education relies on an understanding of the status of AFNR and core content area connections. Therefore, the current national study explores the scope of collaboration between AFNR, leadership, mathematics, and science educators and the relationship between collaboration and intentions to teach leadership, mathematics, and science in AFNR Education curriculum.

LITERATURE REVIEW

Research suggests school-based AFNR Educators have responded to the calls for interdisciplinary connections with core content areas. Data indicate teachers have increased the amount of science, mathematics, and leadership, among other core content areas, within their curriculum (Haynes, Robinson, Edwards, & Key, 2012; Morgan et al., 2013; Myers & Thompson, 2009; Pauley, McKim, Curry Jr., McKendree, & Sorensen, 2019; Wang & Knobloch, 2018). Currently, research indicates AFNR educators report intentions to teach mathematics in nearly 25% of curriculum (McKim, Velez, Everett, & Sorensen, 2017), leadership in nearly 29% of curriculum (McKim, Pauley, Velez, & Sorensen, 2017), and science in nearly 40% of curriculum (McKim, Pauley, Velez, & Sorensen, 2018). Findings suggest AFNR educators are making connections between school-based AFNR Education and core content areas; however, there exists potential to increase the amount, and rigor, of interdisciplinary teaching and learning within the discipline.

One method for increasing the interdisciplinary teaching and learning within AFNR Education has been leveraging curriculum designed to foster an interdisciplinary learning environment. For example, Pauley et al. (2019) found AFNR Educators teaching specific *Curriculum for*

Agricultural Science Education (CASE) courses (i.e., curriculum designed to increase science content coverage in AFNR Education) reported higher science teaching intentions than their peers who did not teach the CASE curriculum. While resources such as the pre-developed CASE curriculum have been found to increase interdisciplinary connections between AFNR and core content areas, the interdisciplinary learning environment is limited to the expertise of the individual AFNR educator. Once the educator has completed professional development associated with the curriculum, he or she must rely on the curriculum and his or her own understanding of the core science content and skills to facilitate the connections between AFNR and science, potentially resulting in limitations to interdisciplinary teaching and learning.

Alternatively, collaboration between AFNR and core content area educators is a strongly cited recommendation which can provide opportunities for combined expertise throughout the school year and can create a more robust environment for interdisciplinary teaching and learning (Morgan, Parr, & Fuhrman, 2011; Myers & Thompson, 2009; Osborne & Dyer, 1998; Stephenson, Warnick, & Tarpley, 2008; Warnick & Thompson, 2007). Previous studies focused on collaboration between AFNR and science teachers indicate growth in collaboration over the years from less than nine percent of science teachers reporting collaborative activity with AFNR teachers (Osborne & Dyer, 1998) to 29% of science teachers and 39% of AFNR teachers reporting collaborative efforts (Warnick & Thompson, 2007). However, a more recent empirical investigation of the extent of collaboration between AFNR and core content area educators was not found in the literature.

In addition to scant current research exploring the scale of interdisciplinary collaborations, the relationship between interdisciplinary educator collaboration and outcomes associated with interdisciplinary teaching in school-based AFNR Education has been largely unexplored. One study was identified which determined the likelihood of mathematics and career and technical education (CTE) educators to illuminate connections between mathematics and CTE through the *Math-in-CTE Model* (Morgan et al., 2011). The study found teachers valued the collaborative opportunities and interdisciplinary connections the model promoted and were “likely, but not highly likely, to incorporate the model into their teaching” (p. 82). The findings suggest the potential to increase interdisciplinary connections through collaboration; however, more research is needed to determine the relationships between collaboration and

interdisciplinary teaching and learning within the scope of AFNR Education.

THEORETICAL FRAMEWORK

If interdisciplinary teaching and learning is the goal, opportunities to engage with others, contribute to an interdisciplinary community, and refine interdisciplinary practices must be created (Wenger, 2009). Collaboration between AFNR and core content area educators provides opportunities to create a community of practice focused on interdisciplinary teaching and learning. However, not all collaborative efforts share equal success. The theory of collaborative advantage describes the balancing act required by collaborative efforts, which can result in “collaborative advantage” or “collaborative inertia” (Vangen & Huxham, 2005; 2014). Collaborative advantage is the positive, forward energy created by collective action among members, the ideal achievement of collaboration; whereas, collaborative inertia is the idle lack of energy created by conflict and exasperated by ineffective management (Vangen & Huxham, 2005; 2014).

To promote collaborative advantage among collaborations in practice, Vangen and Huxham (2005; 2014) described various factors which influence collaborative processes and outcomes. They group the factors into themes, such as efficiency, collaborative structures, accountability, and resources, among others. Each theme indicates a characteristic or phenomena which influences the collaborative practice toward collaborative inertia or collaborative advantage (Vangen & Huxham 2005; 2014). However, the themes do not act in isolation. Rather, they overlap to depict the integrated and complex nature of collaboration (Vangen & Huxham 2005; 2014). For example, the presence or lack of collaborative structures can support or detract from accountability among the parties involved. The segregated, yet overlapping, structure of the theory allows for exploration of specific themes (e.g., accountability or resources) in research or practical contexts, while illuminating the dynamics and complexities of collaborations (Hibbert, Huxham, & Smith Ring, 2008).

The theory of collaborative advantage is operationalized in the current study by examining three quantifiable characteristics of collaborative interactions, related to efficiency (i.e., frequency of interdisciplinary interactions, duration of interdisciplinary interactions, and duration per instance of interdisciplinary interaction). However, as interdisciplinary collaboration is promoted in AFNR Education, it is imperative success must not be measured solely by the number of

collaborations; rather, by the ability to foster collaborative advantage, operationalized as emergent communities of practice enhancing interdisciplinary teaching and learning through intentions to teach leadership, mathematics, and science in school-based AFNR Education. While the theory is designed to allow for exploration of specific themes (Hibbert et al., 2008), the authors note, a focus on the exploration of efficiency characteristics results in an incomplete view of collaborations as described by the theory, thus indicating a limitation of the current study. However, the study serves as a first step in exploring interdisciplinary outcomes associated with collaborations in AFNR Education.

PURPOSE AND OBJECTIVES

The purpose of the current study was to understand the characteristics of interaction between AFNR and leadership, mathematics, and science educators on a national scale, as well as the relationship between interaction and the intentions of AFNR educators to teach leadership, mathematics, and science in school-based AFNR Education. This study was guided by the following objectives.

1. Describe characteristics of interaction between AFNR and leadership, mathematics, and science educators.
2. Analyze the relationship between characteristics of interaction and intentions to teach leadership, mathematics, and science in school-based AFNR Education.

RESEARCH METHOD

Data utilized for this study were derived from a larger research project in which survey methodology was used to collect quantitative data.

Population, Sample, and Data Collection

The target population included all school-based AFNR educators in the United States during the 2015-2016 school year. A simple random sample of 950 school-based AFNR educators from the National FFA Organization frame was obtained. Due to frame error (i.e., incorrect email addresses), potential respondents were limited to 828. Dillman's (2007) tailored design method was used to collect data in November and December of 2015. Usable data were provided by 212 respondents ($n = 212$; response rate = 25.60%). Using methods described by Linder, Murphy, and Briers (2001), non-response bias was determined not to have occurred, as a

comparison of on-time respondents (i.e., those responding within the first three points of contact; $n = 168$) and late respondents (i.e., those responding within the last two points of contact; $n = 44$) resulted in no statistically significant differences.

Instrumentation

Three variables of interest for each core content area (i.e., leadership, mathematics, and science) were utilized from the larger dataset. The first two variables quantified interaction between AFNR and leadership, mathematics, and science educators. For the first measure, frequency of interaction, respondents were asked to indicate the “average *instances per week* [spent] talking with leadership, mathematics, or science teachers (i.e. middle school, high school, or post-secondary) about their discipline's content.” Similarly, for the second measure, duration of interaction, respondents were asked to report “average *hours per week* [spent] talking with leadership, mathematics, or science teachers (i.e. middle school, high school, or post-secondary) about their discipline's content.” Each variable was reported separately for interaction between AFNR and leadership, AFNR and mathematics, and AFNR and science educators.

The third variable of interest was intentions to teach leadership, mathematics, and science in school-based AFNR Education. Sought in this group of variables were intentions to teach leadership, mathematics, and science in courses AFNR educators had taught, were currently teaching, or planned to teach, indicating familiarity of the educator with the curriculum. For familiar courses, respondents reported the percentage of curriculum in which leadership, mathematics, and science content/practices were intended. Responses were summated across courses to determine average intentions to teach leadership, mathematics, and science across school-based AFNR Education curriculum.

It is important to note respondents were asked to self-report all “interaction” and “intention” variables. The authors recognize the limitations associated with self-reported data; however, resources (i.e., cost) prohibited other methods of data collection.

Face and content validity were evaluated by a panel of experts, which included four faculty in school-based AFNR Education. Reliability was established via a pilot test among 31 preservice teachers at Utah State University and Oregon State University. Each construct of interest, intentions to teach leadership (Chronbach's Alpha = .96), mathematics (Chronbach's Alpha = .93), and science (Chronbach's Alpha = .96), exceeded the threshold for reliability (Fraenkel & Wallen, 2000).

Data Analysis

The first research objective, describing the characteristics of interaction between AFNR and core content area educators, was analyzed using descriptive statistics. Two respondent variables (i.e., frequency per week and duration per week) were utilized. A third variable, duration per instance, was calculated by dividing average duration per week by average frequency per week. Objective two was accomplished by analyzing correlations between the three characteristics of interaction and intentions to teach leadership, mathematics, and science in school-based AFNR Education. Effects sizes for correlations were established at $.10 = \text{small}$, $.30 = \text{medium}$, and $.50 = \text{large}$ (Cohen, 1988).

RESULTS

Research objective one sought to describe the characteristics of interaction between AFNR and leadership, mathematics, and science educators (see Table 1). On average, AFNR educators reported interacting with science educators between three and four times per week ($M = 3.42$, $SD = 5.52$) resulting in nearly three hours of weekly interaction ($M = 2.90$, $SD = 5.43$); whereas interaction with leadership educators occurred about three times per week ($M = 2.97$, $SD = 5.53$) and approximately two hours and eight minutes per week ($M = 2.14$, $SD = 4.29$). Interaction between AFNR and mathematics educators occurred about twice per week ($M = 2.12$, $SD = 4.98$) for a total of about an hour and 20 minutes per week ($M = 1.36$, $SD = 3.55$). While the weekly frequency and duration varied, average time per interaction was similar across discipline areas, at about an hour per interaction (i.e., leadership $M = 1.04$, $SD = 3.48$; mathematics $M = 1.05$, $SD = 3.76$; and science $M = 1.10$, $SD = 3.26$).

Overall, interaction between AFNR and core content area educators varies; though, over half of AFNR educators reported at least weekly collaboration with core content area educators (i.e., mathematics, = 60.00%, leadership = 69.70%, and science = 82.50%). Conversely, 17.50% of AFNR educators reported no interaction with science educators, 30.30% reported no interaction with leadership educators, and 39.00% reported no interaction with mathematics educators, which suggests an opportunity to initiate new interdisciplinary communities of practice.

Research objective two sought to analyze the relationship between characteristics of interaction and intentions to teach leadership, mathematics, and science in school-based AFNR Education. Regarding interaction between AFNR and leadership educators, there existed a trivial

(Cohen, 1988) correlation between both frequency ($r = -.04, p = .587$) and duration ($r = -.04, p = .623$) of interaction and leadership teaching intentions, as well as a small (Cohen, 1988) negative correlation between duration per interaction and leadership teaching intentions ($r = -.14, p = .118$; see Table 2). However, no statistical significance was found among the correlations.

Table 1: AFNR Educator Interaction with Leadership, Mathematics, and Science Educators

	<i>F</i>	<i>M</i>	<i>SD</i>	Min.	Max.
Leadership					
Instances per Week	185	2.97	5.53	0	45
Duration per Week	182	2.14	4.29	0	40
Duration per Instance	130	1.04	3.48	0	40
Mathematics					
Instances per Week	177	2.12	4.98	0	50
Duration per Week	182	1.36	3.55	0	40
Duration per Instance	111	1.05	3.76	0	40
Science					
Instances per Week	177	3.42	5.52	0	50
Duration per Week	182	2.90	5.43	0	40
Duration per Instance	149	1.10	3.26	0	40

Note. *F* = Frequency, *M* = Mean, *SD* = Standard Deviation. Duration indicates “interaction time (hours).” Duration per instance indicates “average time (hours) per instance.”

Table 2: Relationship between Interaction with Leadership Educators and Intentions to Teach Leadership

Characteristics of Interaction	Dependent Variable: Intentions to Teach Leadership	
	Pearson Correlation (<i>r</i>)	<i>p</i> -value
Instances per Week	-.04	.587
Duration per Week	-.04	.623
Duration per Instance	-.14	.118

Analysis of the relationship between interaction with mathematics educators and intentions to teach mathematics identified duration per instance had a statistically significant, small (Cohen, 1988), negative correlation with intentions to teach mathematics ($r = -.21, p = .024$; see Table 3). Additionally, while insignificant, interaction frequency had a small (Cohen, 1988), positive correlation ($r = .15, p = .052$) and duration had a trivial (Cohen, 1988), negative correlation ($r = -.07, p = .319$) with mathematics teaching intentions.

Table 3: Relationship between Interaction with Mathematics Educators and Intentions to Teach Mathematics

Characteristics of Interaction	Dependent Variable: Intentions to Teach Mathematics	
	Pearson Correlation (r)	p -value
Instances per Week	.15	.052
Duration per Week	-.07	.319
Duration per Instance	-.21	.024

Interaction between AFNR and science educators revealed a similar relationship (see Table 4). There existed a statistically significant, small (Cohen, 1988), negative correlation between duration per instance and intentions to teach science ($r = -.24, p = .003$). Though insignificant, trivial (Cohen, 1988) correlations were also identified between weekly frequency ($r = .06, p = .417$) and duration ($r = -.06, p = .430$) of interaction and intentions to teach science.

Table 4: Relationship between Interaction with Science Educators and Intentions to Teach Science

Characteristics of Interaction	Dependent Variable: Intentions to Teach Science	
	Pearson Correlation (r)	p -value
Instances per Week	.06	.417
Duration per Week	-.06	.430
Duration per Instance	-.24	.003

DISCUSSION AND CONCLUSIONS

The current study sought to understand the characteristics of interaction between AFNR and leadership, mathematics, and science educators as well as the relationship between interaction and the intentions of AFNR educators to teach leadership, mathematics, and science within school-based AFNR Education. Results suggest AFNR and core content area educators do collaborate, with at least 60 percent of AFNR educators reporting interactions with core content area educators at least once per week. The finding suggests continuous increases in collaboration from the late-1990s (Osborne & Dyer, 1998) and mid-2000s (Warnick & Thompson, 2007). However, the focus of collaborations should not be measured solely by amount of interaction, rather by outcomes.

Findings from research objective two suggest the amount of interaction during collaborative activities is related to interdisciplinary teaching intentions. However, what appears to matter is not the number of times educators interact per week or the length of time they engage per week, but the duration of each interaction. Regarding interactions between AFNR educators and science and mathematics educators, a statistically significant, negative correlation exists between the duration of each instance of interaction between AFNR educators and science or mathematics educators and AFNR educators' intentions to teach science or mathematics in their curriculum, indicating a positive relationship between shorter collaborative meetings and higher interdisciplinary teaching intentions.

Established conclusions are supported by the theory of collaborative advantage as the interactions characterized in interdisciplinary collaborations contribute to, or detract from, interdisciplinary teaching intentions. The shorter interaction of AFNR and mathematics and science educators contribute to collaborative advantage, where the increased interdisciplinary teaching intentions occur (Vangen & Huxham, 2005; 2014). However, longer interaction appears to contribute to collaborative inertia, where barriers prevent attainment of interdisciplinary outcomes (Vangen & Huxham, 2005; 2014).

While the current study explored the scope of interdisciplinary interaction, a wholistic view of the relationship between collaboration and interdisciplinary teaching and learning is limited. The current study did not explore the content nor context of interdisciplinary interaction; therefore, it is unclear what exhibited factors, beyond duration, frequency, and duration per frequency, contribute to, or detract from, collaborative advantage.

Research exploring the content and context of such interactions may provide insight into the relationship between shorter interactions between AFNR educators and science or mathematics educators and AFNR educator intentions to teach science or mathematics. For example, longer interactions may occur during mandated department meetings where little time is devoted to discussing interdisciplinary connections; whereas, shorter interactions may occur in a brief after-school meeting to ask for support with the next day's lesson.

RECOMMENDATIONS

Increased collaboration between AFNR and core content area educators has been recommended to promote further interdisciplinary teaching and learning within school-based AFNR Education (Stephenson et al., 2008; Warnick & Thompson, 2007). Implementing this recommendation has the potential to initiate new communities of practice centered around interdisciplinary teaching and learning (Wenger, 2009); however, practitioners should be intentional about engaging in short conversations with core content area educators. Additionally, to support the development of communities of practice, teacher educators should provide guidance and opportunities to practice interdisciplinary interactions among pre-service teachers in AFNR, mathematics, science, and leadership, as well as other core content areas.

While shorter interdisciplinary interaction was found to be correlated with higher mathematics and science teaching intentions, the content of these interactions is unknown. A limitation identified in the current study is the absence of data describing the content and context of interdisciplinary collaborative interaction; therefore, a qualitative study exploring such interaction is recommended.

Further, the current study analyzed the relationships between collaborative interactions and interdisciplinary teaching intentions in school-based AFNR Education. Recognizing collaborations have potential to promote interdisciplinary connections among all individuals involved, future research should explore interdisciplinary teaching intentions of other core content area educators participating in interdisciplinary communities of practice.

The current study identified practical strategies and opportunities for future research and practice to continue the growth of interdisciplinary teaching and learning within school-based AFNR Education. With focused efforts, school-based AFNR Education and core content area practitioners,

teacher educators, and researchers can create interdisciplinary communities of practice to better the learning experience for all students.

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