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Coauthor Network Analysis of *Journal of Agricultural Education* Articles from 2008-2017

Quisto Settle[1], Kathryn L. Teixeira[2], Rachel Bechtold[3], Catherine W. Shoulders[4], and Audrey E. H. King[5]

Abstract

The social capital of collaboration is a critical part of the research process. While AAAE supports collaboration and inclusivity, analysis has not occurred for what collaborations are occurring. This study addressed collaboration between researchers via a social network analysis of coauthorship in the Journal of Agricultural Education *from 2008 to 2017. There were 587 articles published in that time frame with 593 unique authors. The number of articles published annually and number of authors per article increased during the 10-year period. The majority of authors only published one article in the time frame analyzed. After excluding authors who never collaborated on an article, a social network of 582 coauthors was analyzed. There was a general tendency for the most prolific authors to also be the most connected, though there were some outliers. Of note, the majority of the most connected authors received their terminal degrees from one of three institutions. The majority of the most prolific coauthor pairs were advisor-advisee pairings, and the remainder were individuals who had worked at the same institution during much of the study's time frame. A prolific coauthor pairing was not necessarily indicative of a connection that was important for bridging authors across the network.*

Keywords: coauthorship; social network; social capital

Introduction and Theoretical Framework

Collaboration has proven to be an essential skill as the complexity of new knowledge increasingly requires more interdisciplinary work; researchers share information, improve communication, and produce new data by working together on projects (De Stefano et al., 2011). A trend across disciplines illustrates that more coauthored pieces than sole-author works exist in scholarly journals (Victor et al., 2016). These coauthored pieces form and develop a structure that can be seen as a type of social capital in the publishing circuit (Bordons et al., 2015).

For a researcher to create a higher volume of published works, coauthoring aids in intellectual collaboration and individual performance (Ductor, 2015). Coauthoring with better-known scholars helps generate more citations for other lesser-known researchers: As Li et al. (2013) stated, "to cross the boundary, it is better for a scholar to conduct research in collaboration with other scholars" (p. 1515) to facilitate a flow of shared information, resources, and workloads. Avenues for initial collaborations

[1] Quisto Settle is an assistant professor of agricultural communications in the Department of Agricultural Education, Communications and Leadership at Oklahoma State University, 441 Agricultural Hall, Stillwater, OK 74078 (qsettle@okstate.edu)

[2] Kathryn L. Teixeira is a doctoral student in the Department of Agricultural Education, Communications and Leadership at Oklahoma State University, 459 Agricultural Hall, Stillwater, OK 74078 (kathryn.teixeira@okstate.edu)

[3] Rachel Bechtold is doctoral student in the Environmental Dynamics Program, Gearhart Hall 213, University of Arkansas, Fayetteville, AR, 72701 (rbechtol@uark.edu)

[4] Catherine W. Shoulders is an associate professor of agricultural education in the Department of Agricultural Education, Communications and Technology, 1120 West Maple, University of Arkansas (cshoulde@uark.edu)

[5] Audrey E. H. King is a doctoral student in the Department of Agricultural Education, Communications and Leadership at Oklahoma State University, 457 Agricultural Hall, Stillwater, OK 74078 (audrey.king@okstate.edu)

may be through geographic proximity; locality can play a major role in which institutions and their employees' network (Santos & Santos, 2016; Uddin et al., 2011). As productivity is increased in these collaborative networks as measured by the number of publications released, other benefits also emerge. Coauthors form a social network that consists of individuals who are known to at least one other individual in the group (Rodway, 2015; Santos & Santos, 2016; Uddin et al., 2011).

These patterns of collaboration (e.g., the number of papers, the number of collaborators, and the temporal and spatial movement of relationships) are questions of interest because understanding coauthorship networks leads to understanding how research can be outsourced, collaborated on, and made more efficient (Santos & Santos, 2016). Not only in education but across multiple disciplines, studies have examined how collaboration turns into coauthoring and how these projects promote transdisciplinary work.

Coauthorship networks have been analyzed extensively to explore researchers' behavioral patterns (Newman, 2001), but there is still much to learn from the structure of how the network exists; notably, the last two decades in particular, have shown an increase in interest for an analysis of these social networks (Yan & Ding, 2009). How these indicators affect authorship citations and productivity in the coauthorship network for specific journals is also of interest as different disciplines interact in unique ways (Henriksen, 2016; Li et al., 2013). There is a push to use statistical counts on coauthored works to understand how researchers collaborate; this heightened interest is possibly due to improved statistical technologies and the free access to authorship data (Uddin et al., 2011).

The *Journal of Agricultural Education* (*JAE*) is the premier journal for researchers of agricultural education in which many of the publications are coauthored. By publishing, scholars can earn promotion and tenure, as well as gain social interactions and find commonalities in research (Ductor, 2015). The impact of published work positively correlates with employment enhancement. In other words, the more research and publications a scholar undertakes, the greater the chance of promotions, tenure, and enhancement of a researcher's reputation; project motivation and increased grant funding may be an added benefit (Abbasi et al., 2011; Li et al., 2013; Yan & Ding, 2009).

Past work has assessed author productivity in *JAE*. Radhakrishna and Jackson (1995) assessed the most prolific authors of the 1980s. During that time period, there were 309 articles published overall, with almost half the articles featuring one of the most prolific authors. The most prolific author had 16 articles. They also assessed the terminal degree of prolific authors whom they were able to contact via telephone, finding six were graduates of Ohio State University, three from Texas A&M University, and two from Iowa State University. No other university was represented more than once among the most prolific authors. Of note are the factors the authors believed helped them be successful: After personal drive being listed by everyone, the majority also listed colleagues, graduate school training, advisors, and employers, which indicates the value of social capital for productivity.

Kelly and Warmbrod (1986) also assessed productivity within agricultural education, though their study was broader than journal publications. Their participants reported there were three categories aiding productivity: content enablers, context enablers, and collaborative factors. Among other aspects, content enablers included experience with research courses and projects, context enablers included work with other researchers and graduate students, and collaborative factors included "help from advisers or researchers" (p. 30). All of three categories have components grounded in the building and sharing of social capital. The majority of participants reported that having a competent advisor was the most important factor affecting their productivity and that advising graduate students also aided their productivity.

Further, Harder et al. (2008) examined research productivity and factors contributing to said productivity in *JAE* from 1996. Harder et al. assessed the most productive institutions as well as the most productive authors. Related to social capital, authors stated that the following aided their productivity: the opportunity to conduct research under the guidance of faculty members as doctoral

students, availability of research partners at their current institutions, and availability of doctoral students to assist with research. Motivation to publish was largely driven by promotion and tenure, along with some intrinsic factors. The authors reported a desire to succeed and help others succeed.

While research activity is important, there is disparity across the discipline in terms of research capacity (Greiman & Birkenholz, 2003). Collaboration could offer the opportunity to help narrow this disparity while also aiding scholarly output in the discipline (Myers & Osborne, 2006). Past research has addressed research productivity in *JAE* and agricultural education, but the past work did not directly assess collaboration. Radhakrishna and Jackson (1995) excluded coauthorship between prolific authors in their analysis, only giving credit to whoever was listed first, even though the majority of articles in the timeframe were coauthored.

While research on collaboration across the discipline is lacking, Hajdik et al. (2003) assessed collaboration within the graduate program of an agricultural education department. One of the issues they found was a lack of common ground between the faculty members' research agendas and students' research interests. The faculty members believed it was the onus of students to initiate research collaborations with faculty members. The researchers made recommendations to improve communication with and mentoring of graduate students in the program.

This paper explores the existing network of coauthorship by examining papers published in *JAE* over a 10-year period from 2008 to 2017. Because many authors publish in more than one journal, data on publications found in one journal will not give a complete picture of authorship patterns (Santos & Santos, 2016; Newman, 2004). However, this study was specifically undertaken to describe author collaboration and coauthorship patterns within *JAE*, which is the only national journal of the American Association for Agricultural Education (AAAE).

Social capital provided the framework for this study. Social capital consists of the social structure that allows individuals and organizations to share resources and knowledge (Yang et al., 2017). Like any resource, social capital benefits those who have it (Kriesi, 2007), but unlike other resources, social capital is inherently a shared resource that benefits both parties involved (Coleman, 1990). While gaining social capital is not typically the goal of collaborations such as those done in research (Hauberer, 2011), social capital is still gained in the process and becomes the property of both parties involved (Burt, 1992).

While the type of analysis in this study cannot assess the quality of interactions (Scott, 2017; White, 2011), there is still a need to provide a baseline understanding of what interactions are occurring in the agricultural education discipline. As the discipline seeks to promote collaboration and inclusivity (Roberts et al., 2016), there is a need to understand what collaborations are occurring. Without this baseline information, it will be difficult for the discipline to move forward in fostering more and higher quality collaborations.

Purpose and Objectives

Exploring data behind interactions found in social structures as a measure of social capital can have a strong research impact. By collaborating to share resources and expertise, the discipline as a whole can help promote efficient and effective agricultural education programs (Roberts et al., 2016). However, understanding how social capital can be fostered is difficult without understanding what collaborations are already occurring. Social network analysis is needed to provide these baseline data.

The purpose of this study was to evaluate how coauthorship can be seen as a form of social capital in the agricultural education field for researchers who publish. In doing so, it is possible to compare coauthor networks and determine the collaboration structure that has existed over the past decade.

The objectives of the paper were the following:

1) describe the authorship and frequency of *JAE* published papers,
2) describe the coauthor network found in *JAE* papers from 2008-2017, and
3) describe the relationship between social network characteristics and frequency of publications of *JAE* authors.

Methods

This study consisted of a social network analysis of coauthorship in *JAE*. Social network analysis explores the patterns of relationships between individuals and how groups form from these relationships (Scott, 2017). Analysis can include both numerical descriptions of the properties of social networks and visualizations of the relationships (Scott, 2017). While the network is developed through a quantitative analysis, an element of qualitative analysis is required to describe the network and its development (Scott, 2017).

JAE was selected as the target publication because it is the academic journal for AAAE, which seeks "to be the premier national society for social science scholarship in food, agriculture and natural resources" (AAAE, n.d.). *JAE* offers the best opportunity to understand coauthorship within the broadly defined world of agricultural education. Inclusion of related journals that agricultural education researchers publish in would increase the breadth of data that could be included but would also include researchers outside of the agricultural education community, which would potentially obscure relationships within the agricultural education community. AAAE conferences were excluded from analysis because many of those works become journal articles. For social network analysis that uses relational data like this study, analysis can quickly become unwieldy, so it is necessary for researchers to establish boundaries for what will and will not be included in analysis (Scott, 2017).

All articles published online in *JAE* were analyzed for authorship for volumes 49 to 58 (2008 to 2017), which was the most recent 10-year period available when the research occurred. For objective one, all 587 articles were analyzed. For objective two, articles with one author were excluded because they do not contribute to the coauthorship network (N = 555). Volume, issue, and authors were logged for each article in Excel. For the social network analysis, each unique author pair was logged. A two-author publication would have one unique interaction, a three author-publication would have three unique interactions, and so on. Names were cross-checked using a researcher-developed master list, and all spelling and surname discrepancies were addressed before placing the names into the final listing of authorship pairs.

Objective one described authorship and frequency of publication. This included the number of articles published each year, the number of authors per article, the number of unique authors, and how many articles each author published. Means were calculated for authors per article, including splitting results by volume.

Objective two addressed the social network of *JAE* coauthors, who are identified in this manuscript by their doctoral institutions. Social network analysis terms are defined in Table 1. Social network analysis can look at the full network and individuals' results within the network, which includes nodes (i.e., authors) and interactions between authors. For the full network, analysis included assessing the number of nodes, components, diameter, number and average of shortest paths calculated, average number of neighbors, network centralization, and network density. Reporting characteristics of nodes included degree, average shortest path between the node and other nodes, betweenness centrality, clustering coefficient, and eccentricity. Interactions between coauthor pairings are reported by number of interactions and edge betweenness. Cytoscape was used to conduct the social network analysis.

Table 1
Definitions of Social Network Terminology

Term	Definition
Node	An individual in the network. Authors in this study.
Connections	If two nodes have a relationship, they have a connection. In this study, a connection is if they coauthored a paper.
Interactions	The frequency two nodes have connected with each other in the network. If two authors published twice together, they would have two interactions.
Neighbor	Other nodes an individual has interactions with.
Network	All nodes and interactions.
Component	Set of nodes that are connected to each other but not the rest of the network.
Diameter	Longest of all shortest paths in the network.
Shortest Path	The fewest interactions between a node and any other node in its component.
Network Centralization	The extent to which there is a central hub of connections in the network.
Network Density	The extent to which nodes are connected to each other within the network.
Degrees	The number of nodes one node is connected to.
Betweenness Centrality	The extent a node connects otherwise unconnected nodes.
Clustering Coefficient	Extent the neighbors of a node are connected to each other.
Eccentricity	Furthest a node is from any other node in its component.
Edge Betweenness	The number of shortest paths that go through a connection.

For objective three, Pearson product-moment correlations were used to compare the relationship between authorship frequency and the social network characteristics of authors. Statistical significance for the relationship was determined by the $p < .05$ threshold. The effect size is described using Cohen's conventions (1988).

Results

Objective 1: Describe the Authorship and Frequency of *JAE* Published Papers

From volumes 49 to 58, there were 587 articles published, with a total of 1509 nonunique authors and 2148 coauthorship pairs. There were 593 unique authors and 1533 unique pairings of coauthors. More than half of authors had one article (Table 2). Ten authors had 20 or more articles in the 10-year period assessed. There were 300 unique first authors, with 183 (27.67%) who were first author on one publication. Twenty individuals were first author on six or more publications, with the highest being 12.

Table 2
Publication Frequency of Authors

Number of Articles	Author Frequency	Number of Articles	Author Frequency
1	337	15	1
2	88	16	2
3	46	17	3
4	23	18	1

Table 2
Publication Frequency of Authors, Continued…

5	16	20	1
6	16	22	2
7	15	23	1
8	13	25	2
9	6	28	1
10	5	33	1
11	3	38	1
12	2	44	1
13	6		

There were 58.7 articles published per volume, with a low of 43 for volume 50 and a high of 80 for volume 58 (Table 3). The mean for authors per article was 3.00, with a trend of increasing authorship during the timeframe assessed. The majority of publications (n = 555, 94.55%) were coauthored (Table 4). Solo authorship accounted for less than 6% (n = 32, 5.45%) of all articles published, including 10 that were in the distinguished lecture series. The most common number of authors per article was two (n = 207; 35.26%). There were 24 (4.09%) journal articles with more than five authors, including one publication with nine authors.

Table 3
Articles and Coauthorship by Volume

Volume	Number of Articles	Authors per article
49	45	2.53
50	43	2.79
51	49	2.78
52	59	2.83
53	53	3.17
54	67	2.96
55	71	3.30
56	60	3.08
57	60	3.12
58	80	3.18
Total	587	3.00

Table 4
Frequency of Articles by Number of Authors

Number of authors	Frequency of articles	%
1	32	5.45
2	207	35.26
3	183	31.18
4	90	15.33
5	51	8.69
6	17	2.90
7	6	1.02
9	1	0.17
Total	587	

Objective 2: Describe the Coauthor Network Found in *JAE* Papers

While there were 593 unique authors, 11 of the authors were only on solo-authored publications, so they were excluded from the social network analysis because they did not contribute to the coauthorship network. This led to 582 nodes in the network located across 26 components. The average number of neighbors per node was 5.27. There were 243,843 shortest paths between nodes calculated in the network, with an average shortest path length of 4.20. The diameter of the network was 9. The clustering coefficient for the network was .68. The network centralization score was .09. The network density was .01.

Table 5 shows the characteristics of the most-connected nodes in the network. University of Florida (UF) 1 (f = 55) was connected to the most other nodes in the network, followed by UF2 (f = 44), UF3 (f = 35), University of Missouri (MIZ) 1 (f = 32), and Texas A&M University (TAMU) 1 (f = 32). All of the most-connected nodes were connected to at least one of the other most-connected nodes. UF1 was connected to 12 of the other 24 nodes, while UF2 was connected to 11 of the other 24 nodes. MIZ1 and MIZ3 had the lowest eccentricity at 5 of the most-connected authors, while the other most-connected authors were 6 or 7 degrees removed from the node that was furthest away. UF1 had the lowest average shortest path (M = 2.68) and highest betweenness centrality (.20) among the most-connected authors. TAMU1, UF1, and MIZ6 (.11) had the lowest clustering coefficient scores among the most-connected authors, indicating their neighboring nodes are not that well connected to each other. Of note are the institutions that granted the terminal degrees of the most-connected nodes. Three institutions were responsible for 20 of the nodes: University of Florida (f = 9), University of Missouri (f = 6), and Texas A&M University (f = 5).

Table 6 shows interactions and edge betweenness for the most prolific coauthor pairs. The pairs with the most interactions were Oregon State University (ORST) 1-OHST1 (f = 14), UF3-UF1 (f = 11), ORST1-ORST2 (f = 10), MIZ1-TAMU4 (f = 10), UF2-UF10 (f = 10), and Virginia Tech (VTECH) 1-Iowa State University (IAST) 2 (f = 10). Of the 20 most-prolific coauthor pairings, 12 of them are advisor-advisee connections. The highest edge betweenness scores were for MIZ1-TAMU4 (4009.29) and TAMU2-UF1 (3959.68). Notably, neither of these coauthor pairs are an advisor-advisee connection.

Table 5
Characteristics of the 25 Most-Connected Nodes within Network

Author (pseudonym by doctoral institution)	Degrees	Number of Publications	Average Shortest Path	Betweenness Centrality	Clustering Coefficient	Eccentricity
UF1	55	44	2.68	.20	.11	6
UF2	44	38	2.94	.13	.12	6
UF3	35	25	3.09	.07	.15	7
MIZ1	32	28	2.99	.12	.12	5
TAMU1	32	16	3.12	.08	.11	7
TAMU2	28	18	3.19	.06	.12	7
IAST1	27	15	3.21	.06	.12	7
OHST1	26	25	3.28	.07	.17	6
TAMU3	25	8	3.01	.06	.16	6
MIZ2	24	13	3.50	.05	.15	7
TAMU4	23	22	3.31	.07	.13	6

Table 5
Characteristics of the 25 Most-Connected Nodes within Network, Continued…

MIZ3	23	17	2.87	.13	.15	5
Texas Tech University (TTU) 1	22	17	3.29	.05	.13	6
UF4	20	8	3.13	.05	.23	6
UF5	20	33	3.10	.05	.21	7
UF6	20	17	3.15	.05	.17	7
Oklahoma State University (OKST) 1	20	10	3.17	.07	.21	6
UF7	20	8	3.13	.03	.31	6
VTECH1	19	13	4.12	.06	.16	7
TAMU/TTU1	19	11	3.51	.02	.21	7
UF8	19	7	3.19	.01	.28	7
UF9	19	22	3.29	.03	.18	7
MIZ4	18	23	3.33	.04	.20	6
MIZ5	18	7	3.32	.03	.21	6
MIZ6	18	11	3.43	.09	.11	6

Table 6
Interactions and Edge Betweenness for the 20 Most Prolific Coauthor Pairs

Author Pair	Interactions	Edge Betweenness
ORST1-OHST1	14	102.57
UF3-UF1	11	2163.34
MIZ1-TAMU4	10	4009.29
VTECH1-IAST2	10	1967.24
UF2-UF10	10	675.10
ORST1- ORST2	10	629.58
IAST1-UF3	9	1327.91
OHST1-ORST2	8	1451.04
UF5-UF6	8	1090.96
UF2-UF11	8	697.01
UF9-UF5	8	624.49
TAMU2-UF1	7	3959.68
OKST2-MIZ1	7	720.93
UF2-TAMU/TTU1	6	1351.29
MIZ7-MIZ4	6	986.00
UF12-UF1	6	693.24
MIZ1-OKST3	6	514.27
UF9-UF13	6	411.22

Table 6
Interactions and Edge Betweenness for the 20 Most Prolific Coauthor Pairs, Continued…

MIZ8-MIZ4	6	155.82
UF14-UF10	6	23.58

Objective 3: Describe the relationship between social network characteristics and frequency of publications of *JAE* authors

The relationship between social network characteristics and frequency of publications of *JAE* authors was represented by the correlations summarized in Table 7. The number of degrees had the strongest correlation to the total number of publications (r = .886), meaning the more publications an author had, the more people they were connected to. Moreover, the clustering coefficient had a moderate relationship to the number of publications (r = -.437), which means the more an author published, the less likely their coauthors were to be connected to each other. There was a small correlation (r = .232) between betweenness centrality and number of publications, which indicates the more an author published, the more likely it was they were a part of the shortest path between other nodes.

Table 7
Relationship Between Social Network Characteristics and Frequency of Publications of JAE Authors

	Degrees	Average Shortest Path	Betweenness Centrality	Clustering Coefficient	Eccentricity
Total number of Publications	.886*	-.075	.232*	-.437*	.022

*p < .05

Conclusions

The results of objective one showed the majority of *JAE* authors only published once in the 10-year span addressed in this study, and three-fourths of all authors published three or fewer articles. On the other hand, out of 593 authors, 25 authors had at least 12 publications and 10 had at least 20 publications. While there is a larger number of prolific authors in this study than there were in the 1980s (Radhakrishna & Jackson, 1995), much of *JAE*'s content is still being produced by a relatively small portion of its author population. The potential reasons a majority of authors only published once include graduate students publishing from a thesis or external committee members on theses who are not in the agricultural education, but it is not possible to understand why so many authors are not more engaged in *JAE* without further exploration.

As a journal, *JAE* is publishing more articles each year, indicating increased scholarly activity in agricultural education. The 10-year period in this study resulted in almost twice as many research articles as occurred in the 1980s (Radhakrishna & Jackson, 1995). In addition to increased articles, there were also more authors per article as the 10-year period unfolded in this study. While the mode number of authors was two, the majority of articles had three or more authors.

Objectives two and three explored the social network of coauthorship in *JAE*. The overall analysis indicated a decentralized network with low connectivity, though an academic network is informally developed, which is a possible reason those results occurred. There was a very strong relationship between how connected authors were and how much they published. This is worth noting

because of past recommendations that promoted increasing and improving collaboration to increase productivity (Hajdik et al., 2003; Kelly & Warmbrod, 1986; Myers & Osborne, 2006; Radhakrishna & Jackson, 1995).

In looking at characteristics of the most-connected authors, it is noteworthy that 20 of the 25 most-connected authors had doctoral degrees from three universities: University of Florida, University of Missouri, and Texas A&M University, which were also three of the four most-distinguished programs recognized in the Birkenholz and Simonsen study (2011). This is a shift from past results. Harder et al. (2008) found that Ohio State University, Iowa State University, and University of Missouri were the most common terminal degree institutions of the most productive authors, while Radhakrishna and Jackson (1995) found Ohio State University, Texas A&M University, and Iowa State University to be the most represented terminal degree institutions. The common academic background could help explain why the most-connected authors in the network also tend to be connected to each other. Another characteristic to note is that the majority of the most-connected authors were faculty members the entire time period addressed, which would give them the ability to supervise graduate students that broadens their network of connections and aids their productivity (Harder et al., 2008; Kelly & Warmbrod, 1986).

For the most prolific author pairings, more than half included an author who was not among the most connected, despite relatively high research activity. Another trend to note is that more than half of the most prolific author pairings were between advisors and their advisees, which is in line with past research about graduate student advising aiding productivity (Harder et al., 2008; Kelly & Warmbrod, 1986). The advisor/advisee pairings were responsible for three-fourths of the pairs that included at least one individual who was not among the most-connected authors. Conversely, the edge betweenness results indicated that the MIZ1-TAMU4 and UF1-TAMU2 author pairs – both of which are faculty partners at the same respective institutions – were more important for linking authors across the entire network. While advisor/advisee pairings were the majority of the most productive pairings, that productivity did not necessarily translate to improving the connections within the overall *JAE* network.

In terms of how productivity relates to social network characteristics, this study indicated more connections were tied to more publications. Moreover, publishing more was also related to connecting otherwise unconnected authors. There is evidence that social connections aid productivity (Harder et al., 2008; Kelly & Warmbrod, 1986; Radhakrishna & Jackson, 1995), but none of the previous research directly addressed social capital and the value of those connections to productivity. This study sought to quantify those metrics, but future research is needed to look at causality and how these relationships change over time.

Recommendations

Recommendations for Research

While this research shed light on the author collaborations occurring in *JAE*, this study was descriptive and meant to provide baseline data about the academic community. Future research is needed to better understand these interactions, including how they possibly impact productivity via shared capital.

First, analysis is needed to assess the relationship various factors have with connectivity in *JAE*. For example, while the majority of the most-connected authors were graduates of three universities, it may be coincidental. Past research has assessed factors affecting productivity (Harder et al., 2008; Kelly & Warmbrod, 1986; Radhakrishna & Jackson, 1995), but understanding how similar factors affect connectivity can provide a fuller view of *JAE* from a social capital perspective.

Second, this study assessed which relationships existed, not how effective the relationships were. Why authors chose to collaborate and the effectiveness of those working relationships needs to

be further addressed with the aim of improving collaborations across the discipline. Qualitative research could help address this question. Understanding how to foster these different types of relationships is also needed. This includes understanding how advisors can work more effectively with their advisees, how faculty can more effectively partner within their respective departments, and how faculty can more effectively collaborate between institutions when no previous direct ties exist.

The third recommendation is to evaluate the citation social network in agricultural education. Past research has addressed use of citations in *JAE* (Estes et al., 2014; Radhakrishna et al., 1994), but the discipline would benefit from analysis of which works are being cited and by whom. The coauthorship network describes who is collaborating in the discipline, but citation networks can indicate which works are most influential on the discipline and which works are being cited together in the same articles (Yang et al., 2017).

Fourth, this study assessed productivity and connectivity within *JAE*, not the quality of the work. Assessing the quality of articles being published require different approaches. An example is the Warmbrod (2014) publication addressing the use and interpretation of Likert-type scales in *JAE*. Assessing *JAE*'s publications from a variety of angles is needed to fully understand AAAE's premier journal. This periodic assessment can help inform the decisions AAAE and its members make in trying to improve scholarly activity and impact. Addressing potential research quality issues discipline-wide is unlikely to occur if those issues are not first identified empirically, as opposed to anecdotally.

The last research recommendation is to repeat this study in 10 years. This paper provided an assessment of the past 10 years, but the only constant is change. The discipline of agricultural education is constantly changing and adapting, which necessitates reassessing the network of coauthorship in the discipline, among other research assessing the discipline. Assessing changes in the social network over time can help determine causality between productivity and connectivity. This study found they were related but not if one causes the other.

Recommendations for Practice

The first recommendation is to increase engagement from a wider variety of individuals and universities. The most prolific authors were graduates of three universities, which decreases the likelihood of alternative perspectives of research problems in the discipline. That said, the most prolific authors' current institutions were more widespread, which might lead to wider engagement in the future. AAAE should explore opportunities to widen participation in scholarly output.

The second recommendation is to increase interuniversity collaboration between authors without pre-existing connections. AAAE includes three regional meetings and one national meeting each year, yet the most prolific author pairings happened within universities or between advisors and their advisees. While this is logical from a convenience standpoint, research and subject matter expertise can easily travel beyond institutional boundaries. This is particularly important for faculty at smaller institutions who may lack peer agricultural education faculty or robust graduate programs to recruit graduate advisees. Connecting with faculty at other institutions could offer the opportunity to use and expand social capital in the discipline.

The last pair of recommendations relate to improving productivity and connectivity in the discipline. For authors trying to increase productivity, graduate advising appears to be aid productivity (Harder et al., 2008; Kelly & Warmbrod, 1986; Radhakrishna & Jackson, 1995). For authors trying to improve their connectivity in the discipline, interuniversity connections appear to be helpful. From the standpoint of improving individual success while also contributing to the social capital of the discipline, both are necessary. A productive pair of authors who are not well connected are likely to limit their potential impact in the discipline, while an individual who is well connected without being adequately productive could risk failing to achieve tenure and promotion. Agricultural education needs to find the right balance to ensure that individual success translates to discipline-wide success.

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