Evaluating Team Science through Social Network Analysis

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Background

Team science is needed to perform transformative and innovation research.

In the past decade, there has been a growing emphasis on building collaborative, transdisciplinary scientific teams to advance knowledge creation and dissemination; so much so that the National Institutes of Health (NIH) supported the development of the Science of Team Science, a field of research dedicated to understanding the multi-level influences on the success of scientific collaboration.

The goals of the Science of Team Science efforts are to investigate, evaluate, and foster team science, including institutional policies that may promote or hinder collaborative interdisciplinary research and the resources and infrastructure needed to promote team science within and across institutions.

In mapping a research agenda for the Science of Team Science, stakeholders have identified social network analysis (SNA) as an important methodological tool to understand and evaluate the complex dynamics of scientific collaboration.

Methods

A case study using SNA was conducted of co-authored scientific papers to evaluate team science at an NCI-designated Cancer Center, the Markey Cancer Center (MCC) at the University of Kentucky.

Change in network descriptives was evaluated over time and separable temporal exponential-family random graph models (STERGM) were used to estimate the effect of author and network variables on the tendency to form co-authorship ties.

The diversity of articles published over time was measured to understand whether the changes in co-authorship network are reflected in the diversity of articles published by authors.

Trends were followed to determine the impact of policy changes that were set to encourage team science.

Results

Characteristics of MCC Member Co-Authorship Networks

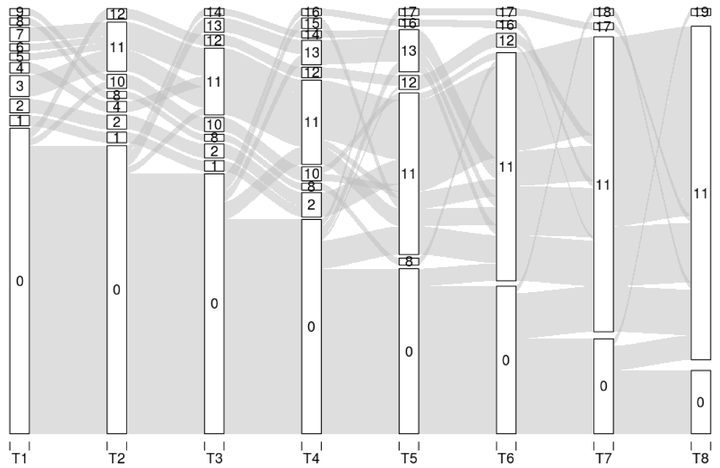
Year	# Articles	# Authors	Number of Components	Mean Degree	Centralization	Modularity
2007	103	46	27	1.79	0.062	0.93
2008	193	54	28	1.96	0.069	0.92
2009	305	62	29	2.13	0.060	0.92
2010	412	74	29	2.26	0.072	0.91
2011	546	83	21	2.41	0.074	0.90
2012	676	90	21	2.55	0.074	0.88
2013	857	98	13	2.59	0.065	0.87
2014	1047	106	11	2.66	0.057	0.86

Mean degree of the network: Average number of authors an author collaborates with.

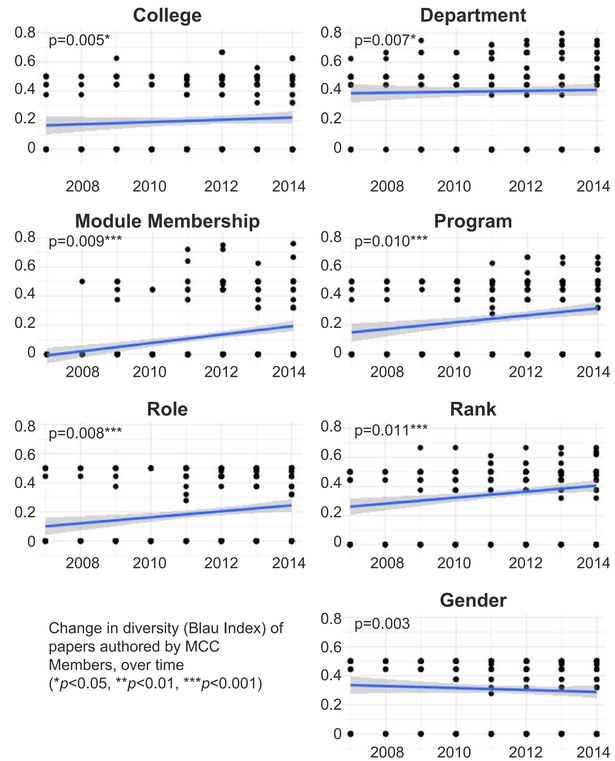
Degree centralization: How much of the co-authorship in this network is concentrated in just a few members.

Modularity: Degree to which researchers co-author with other researchers in their "dense group" versus people outside of their dense group.

MCC Co-Authorship Community Changes Over Time

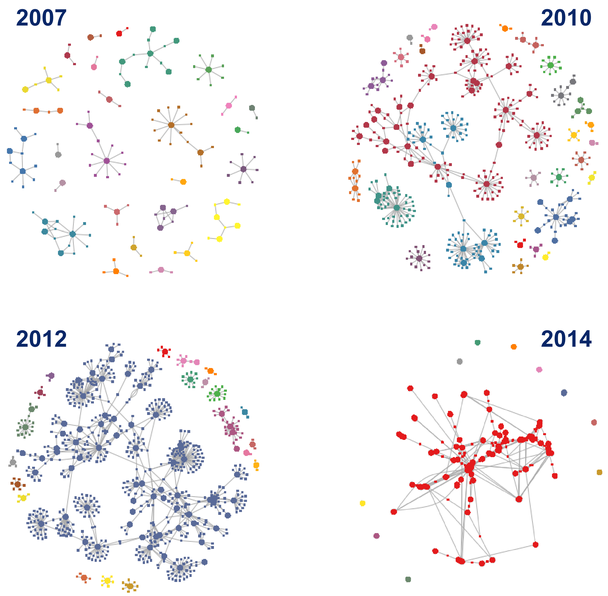


Change in Diversity of MCC Co-Authorships



Change in diversity (Blau Index) of papers authored by MCC Members, over time (*p<0.05, **p<0.01, ***p<0.001)

MCC Member Co-Authorship Network Clusters



Co-Authorship Comparisons

	First half		Second half	
	Formation	***Dissolution***	***Formation***	***Dissolution***
Structural controls	**est. (s.e.)**	**est. (s.e.)**	**est. (s.e.)**	**est. (s.e.)**
Edges	-7.99 (0.46)***	2.05 (0.87)*	1.09 (0.36)**	1.13 (0.52)*
Degree	-0.54 (0.14)***	0.16 (0.25)	0.37 (0.18)*	0.19 (0.25)
Triadic closure	1.53 (0.15)***	0.78 (0.25)**	0.89 (0.18)***	0.70 (0.23)**
Author character.	**est. (s.e.)**	**est. (s.e.)**	**est. (s.e.)**	**est. (s.e.)**
Assoc. Professor	-0.65 (0.27)*	0.05 (0.43)	-0.39 (0.17)*	0.09 (0.33)
Professor	-0.05 (0.20)	0.31 (0.36)	-0.09 (0.13)	-0.18 (0.28)
Male	0.52 (0.29)	-0.59 (0.51)	0.12 (0.18)	0.38 (0.21)
Same Rank	0.12 (0.27)	-0.26 (0.42)	0.05 (0.19)	0.20 (0.36)
Same Gender	-0.31 (0.34)	0.10 (0.60)	-0.09 (0.23)	-0.41 (0.29)
Same Department	1.37 (0.29)***	-0.10 (0.50)	1.20 (0.23)***	0.28 (0.39)
Same College	-0.10 (0.29)	0.56 (0.44)	-0.18 (0.19)	0.14 (0.31)
Same Program	1.25 (0.25)***	-0.28 (0.40)	0.60 (0.17)***	-0.09 (0.28)
AIC	944.6	238.2	2835	421.2
BIC	972.4	283.1	2863	470.1

Discussion and Conclusion

Over the 8-year period, this analysis shows increased inter-programmatic collaboration among MCC Members as evidenced by co-authorship of published scientific papers. MCC Members collaborated more with others outside of their research program and outside their initial dense co-authorship groups. Co-authorship was better dispersed through the network over time, with fewer authors dominating co-authorship ties. Papers increased in diversity over time on all measures with the exception of author gender. This increase in inter-programmatic research was fostered by policy changes from MCC administration encouraging interdisciplinary research through both informal (e.g., annual retreats, seminar series) and formal (e.g., requiring investigators from more than two research programs on applications for pilot funding) means.

Ultimately, SNA serves as a powerful means of conducting program evaluation in general and for identifying strengths and weaknesses of institutional policies/procedures that drive team science.

N.L.V. is supported by the University of Kentucky's Cancer Center Support Grant (NCI P30CA177558) and the Center for Cancer and Metabolism (NIGMS P20GM121327).