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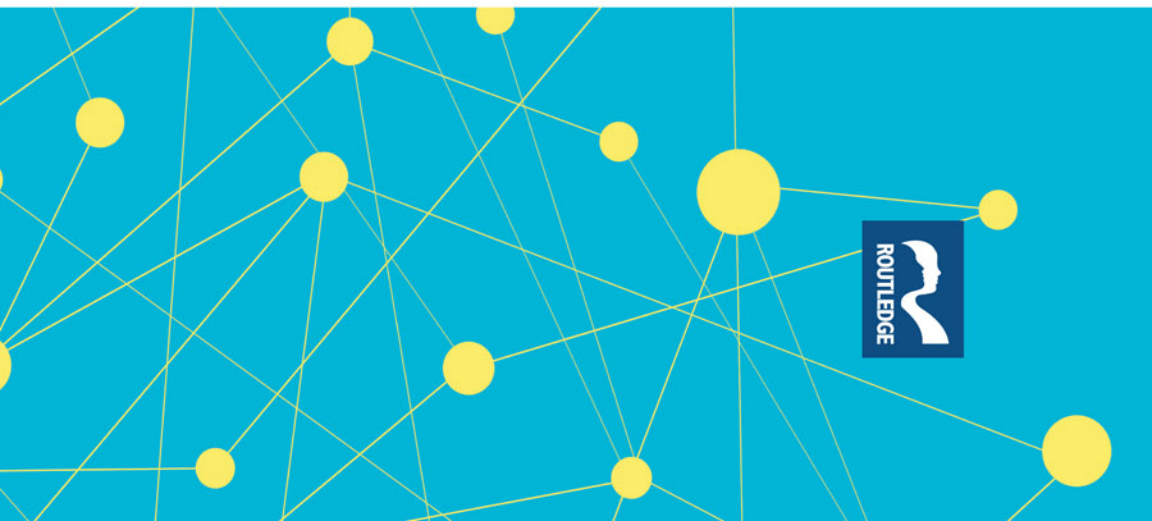
RESEARCHING AND ENACTING CHANGE IN POSTSECONDARY EDUCATION

LEVERAGING INSTRUCTORS' SOCIAL NETWORKS

Edited by
Charles Henderson, Chris Rasmussen,
Alexis V. Knaub, Naneh Apkarian,
Kathleen Quardokus Fisher, and Alan J. Daly



Researching and Enacting Change in Postsecondary Education

Calls to improve undergraduate STEM education have resulted in initiatives that seek to bolster student learning outcomes by promoting changes in teaching practices. Written by participants in a series of groundbreaking social network analysis (SNA) workshops, *Researching and Enacting Change in Postsecondary Education* argues that the academic department is an important unit of change and that department-level social networks are a key departmental feature that must be understood. By clarifying methodological issues related to SNA data collection and articulating relevant theoretical approaches to the topic, this book leverages current knowledge about social network theory and SNA techniques for understanding instructional improvement in higher education.

Charles Henderson is a professor in the Physics Department and a professor and director of the Mallinson Institute for Science Education at Western Michigan University.

Chris Rasmussen is a professor in the Department of Mathematics and Statistics at San Diego State University.

Alexis V. Knaub is a postdoctoral research associate in the Physics Department at Western Michigan University.

Naneh Apkarian is a research assistant in the Center for Research in Mathematics and Science Education at San Diego State University.

Kathleen Quardokus Fisher is an assistant professor in the Department of Earth & Environment and the STEM Transformation Institute at Florida International University.

Alan J. Daly is a professor and chair of the Department of Education Studies at the University of California, San Diego.

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Foreword

Sandra L. Laursen

This volume resulted from a project to gather scholars interested in social network analysis (SNA) as a tool for studying instructional change in science, technology, engineering, and mathematics (STEM) departments. LERNUS—Linked Education Researchers of Networks in Undergraduate STEM—convened two workshops in 2016 to explore SNA methods and consider their applications to questions that interested us about how educational change proceeds in the social context of a college or university STEM department. While the project's acronym was created with tongues firmly in cheeks, it is apt in capturing the group's emphasis on collaborative learning as we bootstrapped our way to new understandings of the power and limitations of SNA concepts and methods. Expert colleagues were generous in sharing their knowledge and perspectives and open to challenge; everyone grappled with new ideas and engaged candidly in discussion.

The new understandings emerging from this collaborative sensemaking process are now shared with a wider audience in this volume. Particularly important is the focus on human connections within a changing environment such as a STEM department. To map these connections, the quantitative methods of SNA can be powerful for revealing complex, subterranean structures within a group—"the deeply unconscious and complicated 'infra' structure" that underlies and is entangled with more "overt and tangible" structures of human society (Moreno, 1953, p. 97). Such structures may influence the adoption or rejection of new instructional approaches promoted or proposed by a department head, dean, disciplinary organization, or other would-be change agent.

Academic units offer good contexts for studying social networks because unit members are identifiable, public, and hold specific roles, and networks are generally bounded and meet many of the main conditions to make SNA viable (Düring, 2015). SNA studies on K-12 education offer some models for how research questions related to the spread and success of reform within educational organizations may be framed; at the same time, they raise interesting questions about how social networks may operate in different or similar ways in higher education contexts. The four

perspectives offered here, on networks as representing structure, social capital, sensemaking, and identity, help to remind us that—while depicted with simple lines or arrows—the human relationships in networks are complex. Such ties may represent multiple, dynamic influences that can shape the spread, extent, and sustainability of change.

Academic departments are important for understanding change, too; many have argued that departments are key allies and barriers to widespread change in STEM instruction toward methods shown to benefit students' learning and persistence (Treisman, 1992; Fisher, Fairweather, & Amey, 2001; Austin, 2011; Wieman, 2017). For both scholars and change agents working with departments, this book offers concepts, metrics, practical advice, and examples of how SNA studies of STEM departments can benefit our understanding of change processes in departmental environments. Because such studies can be sensitive, with scholars embedded in the same networks they are studying, the authors' calls for customized and participant-guided approaches to SNA should be well heeded by those undertaking such studies, whether for research or to guide a change initiative.

However, this book should not be read solely by those interested in sociometric network studies. Equally powerful for those leading or studying change is the social network mindset, which prioritizes relationships among people and not just their characteristics as individuals. Here, these relationships are framed as part of the overall environment in which STEM instructors teach, and also learn from, debate with, and take cues from colleagues. Even when quantitative sociometric approaches are not well advised (Düring, 2015), it is often useful to consider the web of interpersonal relationships and how that web may shape or respond to formal institutional structures, to informal and societal power dynamics, and to departmental and broader cultures (Bolman & Deal, 1991).

The ideas offered here will likewise be useful to those thinking about instructional change in other settings, such as informal faculty networks that function as professional learning communities. When is a social network approach essential or uniquely enlightening? As the authors note, perhaps the most powerful studies use combined approaches, emphasizing not just the relationships between actors but the way these relationships connect to individuals' attributes, roles and behaviors, and to properties or structures of the system in which they are embedded. For non-departmental cases, the networks are less well-defined, and thus particularly careful thought about methods is required—yet a social network mindset may still be fruitful.

To put my money where my mouth is in making these claims, I share the story of a colleague, Chuck Hayward, who took part in a LERNUS workshop and was inspired to carry out a social network analysis of his own. He examined the email messages shared on a dedicated e-mail list by college mathematics educators who had participated together in

a summer workshop on inquiry-based learning, and treated their messages as network nodes tied together through email threads. By coding the messages' content by their communicative functions, he was able to show how list members provided each other with intellectual and emotional support as they implemented the new instructional methods (Hayward & Laursen, 2017, 2018). Positive reinforcement helped to cement these changes as part of their teaching practice. The analysis also showed how workshop facilitators deliberately used their messages to maintain participant engagement, bolster participant autonomy and ownership, and build community—all inherently social outcomes that in turn supported the instructional change goals of the workshop leaders.

This is but one more example to complement the argument presented in this book: SNA concepts and approaches may yield insights into the processes of instructional change. This volume will serve as an informative guide to those interested in carrying out or using social network methods in research and practice.

References

Austin, A. E. (2011). *Promoting evidence-based change in undergraduate science education*. Paper commissioned by the National Academies' Board on Science Education. Retrieved March 13, 2018, https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_072578.pdf

Bolman, L. G., & Deal, T. E. (1991). *Reframing organizations: Artistry, choice, and leadership*. San Francisco, CA: Jossey-Bass.

Düring, M. (2015, June 29). *Should I do social network analysis?* Retrieved June 8, 2017, from Digital Humanities Lab: http://cvcedhlab.hypotheses.org/125

Fisher, P. D., Fairweather, J. S., & Amey, M. (2001). Systemic reform in undergraduate engineering education: The role of collective responsibility. *International Journal of Engineering Education*, *19*(6), 768–776.

Hayward, C. N., & Laursen, S. L. (2018). Supporting instructional change in mathematics: Using social network analysis to understand online support processes following professional development workshop. *International Journal of STEM Education*.

Hayward, C. N., & Laursen, S. L. (2017). *Supporting instructional change in mathematics: The role of online and in-person communities*. 20th Annual Conference on Research in Undergraduate Mathematics Education, San Diego, CA, February 23–25.

Moreno, J. L. (1953). *Who shall survive?* (Rev. ed.). Beacon, NY: Beacon House.

Treisman, U. (1992). Studying students studying calculus: A look at the lives of minority mathematics students in college. *The College Mathematics Journal*, *23*(5), 362–372.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the science education initiative*. Cambridge, MA: Harvard University Press.

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Brian Carolan
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1 Introduction

Naneh Apkarian and Charles Henderson

There is no shortage of calls for change and improvement in postsecondary education. The broad purpose of this book is to understand both how to enact that change and how to study it. The authors come from a range of academic traditions, and the combined knowledge from our varied perspectives has led us here. While much of our independent work has focused on science, technology, engineering, and/or mathematics (STEM) education, we believe this text is relevant for change at the postsecondary department level in any discipline. The lessons learned from social network analysis can be applied to any system of people, and many aspects of department structure and pressures which we focus on in these chapters transcend disciplines.

The LERNUS Project

In 2016, the editors of this book organized two workshops for researchers interested in the use of social network analysis (SNA) to promote change in postsecondary education, funded by NSF (#1550990); this book grew out of that collaboration. The idea was to combine the knowledge and perspectives of individuals to advance research in this area, hence the title *Linked Education Researchers of Networks in Undergraduate STEM*, or LERNUS. All of the authors of chapters in this text participated in at least one of those workshops, and the entire LERNUS group contributed to the major ideas and themes herein. Chapters 2, 3, and 4 cover (more or less) the shared base LERNUS members brought to the first workshop. We were all concerned with the state of postsecondary education, understood change as a social process, had a basic understanding of the construct of a social network, and had seen K-12 and organizational science results which pointed to SNA as a promising approach in this area. Chapters 5, 6, and 7 represent some of the knowledge we developed through the LERNUS collaboration. A more comprehensive understanding of the relationship of SNA as methodology to theoretical underpinnings, the cataloging of varying instrumentation and methodology techniques, and the cross analysis of data from across studies have helped us all refine our

thinking about this work. We hope that others who read this book will come away with new ways of thinking about the process of change in postsecondary education.

The Need for Change

In the US, there has been a strong focus on improving undergraduate STEM education. One of the oft-repeated motivations for this is economics. There is great need for STEM graduates in the workforce, especially as the workplace becomes increasingly technical and technological, but there is a dearth of STEM majors graduating from American colleges and universities (PCAST, 2012). Investigations of the gap, and in particular why undergraduate students who originally intend to pursue STEM degrees change their degree aims, have indicated that poor experiences in introductory STEM courses rather than poor performance are the main culprit (PCAST, 2012; Seymour, 2006; Seymour & Hewitt, 1997). Furthermore, these same investigations have revealed that students from historically underrepresented groups leave the sciences disproportionately more than those from groups already well represented in STEM fields. Thus, there is a need to improve students' educational experiences in order to retain high-performing and interested students, especially from diverse backgrounds, who can then fill existing opportunities in STEM careers.

For decades, researchers in STEM education fields have explored the ways in which students learn particular content areas and pedagogical approaches that support deeper conceptual understanding and affinity for STEM fields (National Research Council, 2012). Across both STEM and non-STEM disciplines, there has also been a push to explore pedagogy that supports students with a wider range of identities than have traditionally persisted in postsecondary education. One general theme has emerged: active learning[1] or student-centered instructional strategies are better than lecture-based instructional strategies for a wide variety of desirable outcomes. Perhaps the most convincing evidence of this is Freeman et al.'s (2014) meta-analysis of 225 studies comparing pedagogy in science classrooms. Across multiple disciplines, student attrition decreased while, at the same time, student learning increased. There have also been studies which indicate that active learning narrows achievement and retention gaps for students from underrepresented groups (e.g., Kogan & Laursen, 2014). Despite the extensive evidence in support of student-centered or active learning approaches to education, these methods have not become widespread (Apkarian & Kirin, 2017; Brainard, 2007; NRC, 2012; Pollock & Finkelstein, 2008), and their use by instructors without support does not produce as positive results (Andrews, Leonard, Colgrove, & Kalinowski, 2011; Larsen, Glover, & Melhuish, 2015). Work must be done to better understand how and why pedagogical change is or is not

taken up, and how best to support sustainable and productive adoption of improved pedagogy in postsecondary education.

Why Social Networks?

Historically, many change initiatives designed to improve undergraduate education focused on individual instructors; telling these instructors about new instructional strategies and encouraging them to use these strategies (e.g., Pollock & Finkelstein, 2008; Henderson, Dancy, & Niewiadomska-Bugaj, 2012). However, many now consider the academic department to be the core unit for creating change because of the social nature of knowledge construction (e.g., Austin, 2011; Wieman, Perkins, & Gilbert, 2010). There have been calls to use social networks in the planning and study of institutional change in postsecondary education, both implicitly through declarations of the importance of camaraderie and explicitly by those with exposure to its use in other fields. In particular, Kezar (2014) published a review of literature that makes convincing arguments for increased attention to the social structure of groups undergoing planned changes. In this book, we show how the tools and theories of SNA can be productively used in tandem with theories of learning and change to determine the current state of academic departments, uncover hidden social structures, target participants for involvement in change initiatives, and inform postsecondary education reform efforts to support quality teaching.

In Chapter 2, Henderson, Quardokus Fisher, and Beach discuss in more detail the current literature regarding change in postsecondary education settings. Their review indicates that creating sustainable change is a social process, requiring trust, camaraderie, and support. It has been shown that social ties influence the beliefs and behaviors of individuals. The value of good communication among multiple trusted parties is important for groups to function productively. Well-functioning groups consistently lead to desirable results in a wide variety of contexts. Simply put, social groups and their intricacies matter.

We do not expect readers to already be well-versed in social network theory. Therefore, Knaub and Henderson's Chapter 3 provides a brief overview of some major features of social networks and network analysis. This is certainly not intended as a substitute for the many texts on networks and analysis, but rather as a primer. Many more comprehensive texts exist for those interested in conducting SNA (e.g., Kadushin, 2012; Scott, 2012; Wasserman & Faust, 1994). The goal of this chapter is more modest: to enable the reader to grasp the basics of social networks in sufficient detail to follow the discussions in the remaining chapters.

In Chapter 4, Mamas and Daly review K-12 SNA literature and identify some major themes among those works that can and should inform studies in postsecondary education. They identify the importance of both formal and informal social networks (and the extent to which these overlap), the

quality as well as quantity of relationships among actors, collaboration among those in a community under study, and taking a *systems perspective* that considers individuals as part of a larger community and organization with contextual factors. The authors provide concrete examples of studies and results related to these themes in their chapter, which can serve as inspirational models for postsecondary education network researchers.

How Can We Use SNA in Higher Education?

Having seen what components and features make up a social network, and a review of prior results in the K-12 education context, Knaub, Henderson, Rasmussen, and Lo present four perspectives through which social networks can be viewed in Chapter 5. These theoretical perspectives are what give the constellations of actors and relationships real meaning. As with other types of research, theoretical perspectives inform the entirety of an empirical study, from the initial questions to design to methodology. This is also true of those with more practical matters: understanding the social network of a department and its impact on a change process is also dependent on theoretical assumptions about relationships and the development of practice. The *structuralist* perspective assumes that individual practices, behaviors, and beliefs are deterministic and based on those of the people they interact with. *Social capitalism* conceptualizes social ties as avenues through which resources of many different kinds are shared and accessed. The *sensemaking* perspective posits that information and ideas exist between people and are constructed through interactions. Using an *identity* perspective puts the focus on how individuals are perceived and why they might be more or less connected to others in their group.

Following the discussion of theories that can be leveraged alongside social networks, Skvoretz, Risien, and Goldberg in Chapter 6 describe methodological options for studying social networks in departments at postsecondary education institutions. This includes considerations for overall study design to ensure that appropriate data is collected for the researcher's purposes. The authors of this chapter suggest that researchers consider mixed methods and the inclusion of qualitative data. Details of how to identify social ties are also discussed, highlighting the various benefits and constraints of different approaches for different contexts. Given the main thrust of this book, the majority of this discussion focuses on instrumentation for network data collection, which nowadays is often primarily done via electronic surveys.

The final substantive chapter of this book, Chapter 7, presents analyses of instructor discussion network data from real departments. These data come from multiple ongoing studies by authors of this book, but the comparisons presented in this chapter are original. In presenting their findings, Quardokus Fisher and Apkarian build on the previous chapters to discuss disparities between the studies and how the data were made comparable. This is intended to show how the information in this book can combine to

produce results, and what those results can mean. The analysis across 22 STEM departments at multiple universities allows for some discussion of trends in both *connectedness* (or how much interaction is happening) and the *distribution of ties* (or who is participating in that interaction). Discrepancies in data collection methods and the non-representative nature of the samples mean that we cannot present this as "typical"; however, it is a collection of data which others may compare to their own results.

Goals for the Reader

This book is aimed at those who wish to study and/or enact change in postsecondary education departments, couched in the context of a nationwide push for pedagogical improvement. We hope that the utility and value of SNA in these endeavors will rapidly become clear and compelling to the reader. We also hope that we are able to present the basics of carrying out network-informed research in postsecondary education settings, in order to demystify the process and grow the ranks of those doing this work.

For those primarily interested in *researching* change in postsecondary education, we situate SNA in the broader change and education literature and present details of methodology. Our intention is to provide you with the basics of SNA and how it can be used in this research context, so that you can determine whether or not it is an appropriate tool for your particular research purpose.

For those primarily interested in *enacting* change in postsecondary education, we present lessons from a spectrum of contexts. Our intention is to provide you with more ways to think about the context in which change is to occur and what factors may affect the implementation and sustainability of that change. Knowledge of typically hidden social ties can be a valuable tool for change agents.

Note

1. Here we are referring broadly to "active learning" as pedagogical strategies that promote student inquiry into content. These strategies go by a variety of names, such as inquiry-oriented learning, process-oriented guided inquiry learning, inquiry-based learning, student-centered active learning environment with upside-down pedagogies, and others.

References

Andrews, T. M., Leonard, M. J., Colgrove, C. A., & Kalinowski, S. T. (2011). Active learning not associated with student learning in a random sample of college biology courses. *Cell Biology Education*, *10*(4), 394–405. https://doi.org/10.1187/cbe.11-07-0061

Apkarian, N., & Kirin, D. (2017). *Progress through calculus: Census survey technical report*. Mathematical Association of America. Retrieved from http://bit.ly/PtC_Reporting

Austin, A. 2011. *Promoting evidence-based change in undergraduate science education*. A white paper commissioned by the National Academies National Research Council Board on Science Education. https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_072578.pdf

Brainard, J. (2007). The tough road to better science teaching. *Chronicle of Higher Education*, *53*(48), A16.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Henderson, C., Dancy, M., & Niewiadomska-Bugaj, M. (2012). Use of research-based instructional strategies in introductory physics: Where do faculty leave the innovation-decision process? *Physical Review Special Topics—Physics Education Research*, *8*(2), 2014. http://doi.org/10.1103/PhysRevSTPER.8.020104

Kadushin, C. (2012). *Understanding social networks: Theories, concepts, and findings*. Oxford: Oxford University Press.

Kezar, A. (2014). Higher education change and social networks: A review of research. *The Journal of Higher Education*, *85*(1), 91–125. https://doi.org/10.1353/jhe.2014.0003

Kogan, M., & Laursen, S. L. (2014). Assessing long-term effects of inquiry-based learning: A case study from college mathematics. *Innovative Higher Education*, *39*(3), 183–199. https://doi.org/10.1007/s10755-013-9269-9

Larsen, S., Glover, E., & Melhuish, K. (2015). Beyond good teaching: The benefits and challenges of implementing ambitious teaching. In D. Bressoud, V. Mesa, & C. Rasmussen (Eds.), *Insights and recommendations from the MAA national study of college calculus* (pp. 93–106). Washington, DC: MAA Press.

National Research Council. (2012). *Discipline-based education research: Understanding and improving learning in undergraduate science and engineering* (S. R. Singer, N. R. Nielsen, & H. A. Schweingruber, Eds.). Washington, DC: The National Academies Press. Retrieved from www.nap.edu/catalog.php?record_id=13362

PCAST: President's Council of Advisors on Science and Technology. (2012). *Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics*. Washington, DC: Executive Office of the President. https://eric.ed.gov/?id=ED541511

Pollock, S., & Finkelstein, N. (2008). Sustaining educational reforms in introductory physics. *Physical Review Special Topics—Physics Education Research*, *4*(1), 010110.

Scott, J. (2012). *Social network analysis* (3rd ed.). Los Angeles, CA: Sage.

Seymour, E. (2006). *Testimony offered to the research subcommittee of the committee on science of the U.S. House of Representatives hearing on undergraduate science, mathematics, and engineering education: What's working?* Retrieved from http://commdocs.house.gov/committees/science/hsy26481.000/hsy26481_0f.htm

Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge: Cambridge University Press.

Wieman, C. E., Perkins, K. K., & Gilbert, S. (2010). Transforming science education at large research universities: A case study in progress. *Change*, *42*(2), 6–14.