Institution-Based Instructional Improvement: Establishing Relational Expertise through Disciplinary Unit Social Network Analysis

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Abstract. Instructional change initiatives at institutions of higher education often involve stakeholders with a variety of disciplinary expertise. These participants bring perspectives and knowledge rooted in disciplines and apply these when envisioning goals, making decisions, and engaging in activities. Relational experts enable the collaborative work of change initiatives by attending to participant needs through an understanding and leveraging of these diverse perspectives. In this study, we document use of social network analysis to establish relational expertise of project leadership regarding teaching and learning and to infer relational experts within participating disciplinary units. We used network Euclidean distance to identify the topics of teaching and learning that are most salient within participant discussions and betweenness centrality to identify potential localized relational experts. Discussions of general instructional activities (e.g., how to teach, what to teach) were more frequent than discussions about specific instructional issues (e.g., grading issues, student diversity issues). These results establish relational expertise that can help us to attend better to teaching and learning needs and interests situated in the perspectives and knowledge of participants. Furthermore, we identified local relational experts currently involved in our change initiative that might further aid in constructing shared vision towards instructional change.

Keywords: College Science Teaching, Change**,** Quantitative (Social Network Analysis)

Enhancing Collaboration Across Disciplinary Boundaries

Science, Technology, Engineering, and Mathematics (STEM) educators prepare students to participate in the STEM workforce and to make informed decisions as citizens. According to the National Science and Technology Council (2013), STEM practitioners will be responsible for improving health care, preserving the environment, and informing political decisions. Stakeholders promote environments and classrooms that prepare students to fulfill these needs. However, they must also attend to the realities of higher education institutions. The current state of higher education institutions (i.e., teaching climate, instructional practices, instructor perspectives) inhibits the realization of these goals (Kezar, 2005). For example, promotion and tenure guidelines often do not motivate educators to improve their teaching practice; instead, policies are designed to reward improvements in research and scholarship (Bouwma-Gearhart, 2012). Change agents enlist the help of diverse experts in order to address all of these challenges, including STEM instructors, education experts, and institutional leaders (e.g., Pharo, Davison, McGregor, Warr, & Brown, 2014).

The participation of stakeholders from diverse disciplines creates advantages and challenges for a change initiative. An advantage is the diversity of knowledge that each type of stakeholder can contribute from knowledge of classroom best practices to disciplinary content knowledge. However, different perspectives present an obstacle to developing the shared understanding needed to promote positive change due to the disciplinary boundary misalignment of the interests, knowledge, or frameworks of participants (Bouwma-Gearhart, Perry & Presley,

2012). For example, disciplinary content experts may value covering content quickly while education experts may value in-depth exploration of ideas. Change agents must develop the means to work across these boundaries. Relational expertise is the ability to work across boundaries through understanding the knowledge, frameworks, needs, and interests of participants, and aligning participants' motives in a shared vision (Edwards, 2012). Relational experts are able to recognize what others value with respect to their own needs and mediate cooperation across these needs-based boundaries. Thus, when judgments and choices are made within the change activities, they address the needs of all participants. Relational expertise needs to be identified and cultivated to promote change across multiple disciplines.

We discuss a change initiative's leadership's efforts to build relational expertise by identifying various participants' interests, knowledge and perspectives. The change initiative includes participants from seven STEM disciplines, discipline-based education experts, and institutional leadership. The goal of the change initiative is to improve instruction of large-enrollment STEM courses through Evidence-Based Instructional Practices (EBIPs). This work includes learning from others' implementation of EBIPs and utilizing the education expertise within the project team.

Social Network Analysis to Build Relational Expertise

Relational Expertise includes understanding the interests, knowledge and perspectives of others in order to work across boundaries of practice. For this study, we are interested in beginning to build expertise by first exploring the teaching and learning interests of participants from various departments across the university. The change initiative leadership has identified goals of enacting the EBIPs of interactive engagement with frequent formative feedback and cooperative learning in the classroom. However, these EBIPs may not be the primary teaching and learning interests of the STEM departments. First, to understand what is of importance to the STEM department members, we investigated which topics regarding teaching and learning are discussed within social connections. Social connections influence individual behavior (e.g., teaching practices), and researchers suggest an understanding of social connections can inform higher education change initiatives (Quardokus & Henderson, 2014). We use the method of Social Network Analysis (SNA) to map connections between participants given specific topics of interest (Wasserman & Faust, 1994) in order to inform relational expertise. Second, we wish to know if the individuals who are central to the social networks are also participants in the change initiative. We compare participant attendance records with the centrality of individuals in the networks to investigate if the needs of the department with respect to the important teaching and learning issues are represented within our change initiative. This study is guided by two research questions: (a) what are teaching and learning-related topics of interest and discussion within the units targeted by our change initiative? (2)Who are the individuals who are likely to hold relational expertise within their units with respect to these teaching and learning topics of interest?

The SNA data were collected via a survey. Table 1 shows the survey items upon which this study is based; 54% of instructors in the seven participating units responded to the survey. In the survey, respondents identified other department members with whom they discussed teaching and learning as well as the topics that they discussed. The provided topics included general topics regarding instructional activities (methods, materials, timing, etc.) and issues regarding teaching and learning (grading, student motivation, student diversity, etc.). These topics were

chosen to help identify the important teaching and learning topics within each department. Thirteen networks were created based on the responses. The analyses presented here include ten of these networks which are organized into the two categories of relationships: discussions of instructional activities (five networks), discussions of instructional issues (five networks). In addition, the network of connections regardless of discussion topic is also analyzed.

Table 1: Social network survey items

Please list one person with whom you communicate about teaching and learning. State your colleague's first and last name. If this colleague does not work at [this institution], please state his or her affiliation. You will be asked follow-up questions regarding this person, and will have the opportunity to list up to 10 individuals.
What issues of teaching and learning do you discuss with this person? (Check all that apply) Teaching methods - How to teach Teaching materials and technologies - How to teach with what Curriculum - What to teach Curriculum timing - When to teach what Assessment - How to measure impact of teaching Grading issues Student motivation issues Student diversity issues Policy or accreditation issues Teaching issues related to promotion and tenure *Making changes to curriculum or instruction (not analyzed)* *Research/scholarship on teaching and learning (not analyzed)*

To answer the first research question, we used Euclidean distance to compare the unspecified discussion networks (with respect to all teaching and learning topics) with each individual topic network. All calculations and visualizations were made with the SNA software called ORA™ from Carnegie Mellon University's CASOS. Euclidean distance is a measure of similarity of networks. It is calculated between two networks by determining how many ties are present in one network but not in the other, that is, the square root of the sum of the differences of tie strength (for calculation, see Wasserman & Faust, 1994). When comparing each specific topic network with the unspecified network, the most frequently discussed topic is the most similar to the overall discussion network and has the smallest Euclidean distance.

To address the second research question, we identified individuals who are conduits of knowledge and could potentially provide insight into the needs of the department regarding the specific topics. Conduits of knowledge were identified as individuals with high betweenness centrality (Prell, 2012). Betweenness centrality indicates an individual who connects otherwise disconnected individuals (for calculation, see Prell, 2012). An individual who spans the boundary between two subgroups within a department would have high betweenness centrality. This individual will likely have access to the norms and ideas in subgroups of the department. Thus, this person may be a relational expert within the specific topic and will likely be an important contact for our change initiative to align project goals with the needs of the disciplinary unit (Quardokus & Henderson, 2014).

Topics of Discussion and Departmental Participants

The Euclidean distance between discussion networks was used to answer the first research question: what are teaching and learning-related topics of interest and discussion within the units targeted by our change initiative? In the survey, respondents were asked with whom they discussed issues of teaching and learning. For each person the respondent chose the topics of teaching and learning that happened during these discussions by placing a checkmark next to each topic that they discuss. Thus, each topic, as well as the overall topic, could be used to define a network within the unit. Figure 1 illustrates an example of two networks in Unit A.

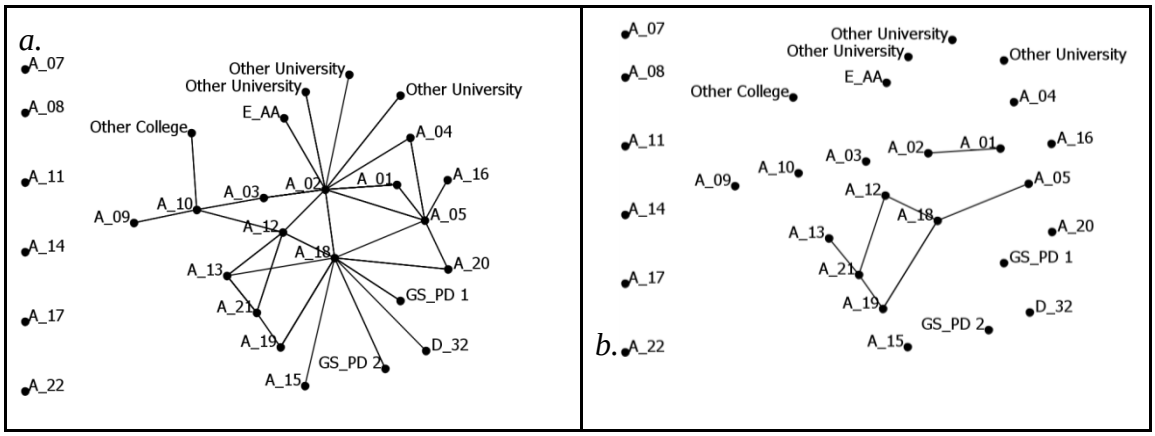

Figure 1: (*a*) Overall network of communications about teaching in Unit A. (*b*) Discussion network of teaching issues related to promotion and tenure in Unit A

Euclidean distance was calculated between the overall network for a unit and each topic network. Each topic network was then ranked from one (most similar) to ten (least similar) as compared to the overall network. A rank of one indicates the shortest distance, meaning that the specific topic is represented in most of the discussions in the unit. Figure 2 shows the ranking of each topic by each unit. In Unit A, for example, "General: Curriculum" was discussed most frequently.

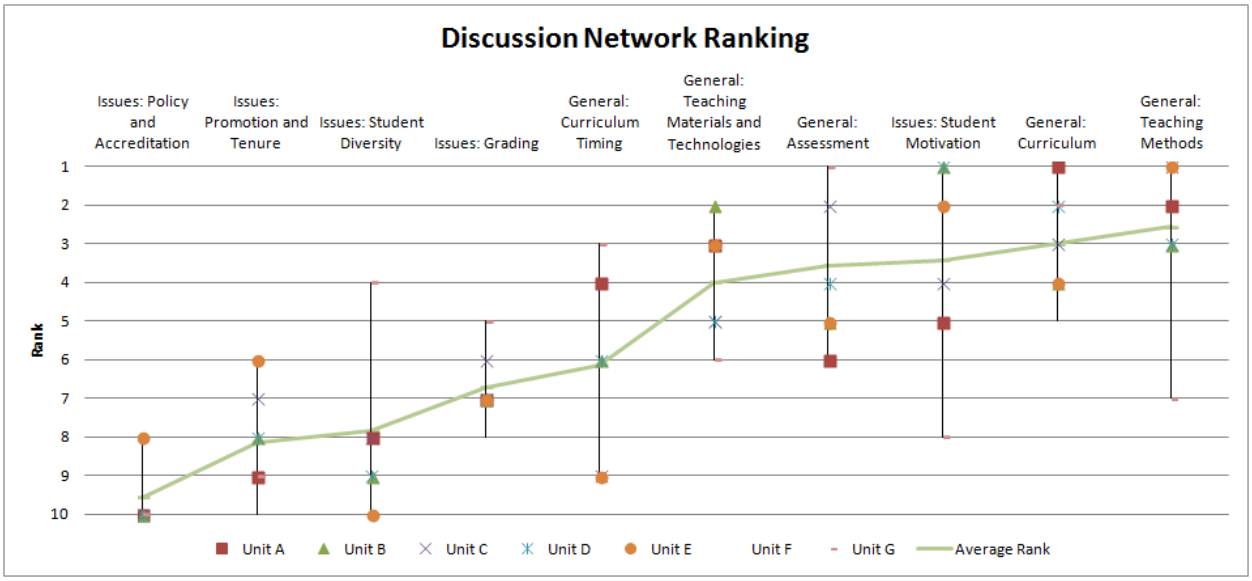

Figure 2. Ranking of Euclidean distances of specific topic networks with overall networks

Communication about teaching and learning in these seven units often include discussion on topics of teaching methods, curriculum, assessment, and teaching materials and technologies (topics from the category of instructional activities). In contrast, discussions about student diversity issues and grading issues are uncommon (topics from the category of instructional issues). An exception to these across-unit patterns are issues of student motivation. For Units B, D, and E, student motivation issues are often included in discussions; however, in Unit G they are not. This analysis builds the relational expertise of the change initiative leadership by identifying topics of interest across units (instructional activities), what may be neglected as topics (most instructional issues), as well as where interests vary. Thus, these needs must be addressed when the change initiative is planning for specific EBIPs to be implemented and adapted.

We identified betweenness centrality to answer the second research question, who are the individuals who are likely to hold relational expertise within their units with respect these teaching and learning topics of interest? Conduits of knowledge were identified as the individuals with the five highest betweenness centrality measures of a network. We identified individuals who often appeared in these rankings across all of the different networks (Figure 3). In Units A, B, C, D, and F the top two ranked individuals are change initiative participants. The change initiative leadership should capitalize on these individuals' presumed relational expertise to develop shared visions that attend to their unit's needs. Some top ranking individuals in Units E and G are not participants of the change initiative. It is likely that more outreach is needed to understand their needs.

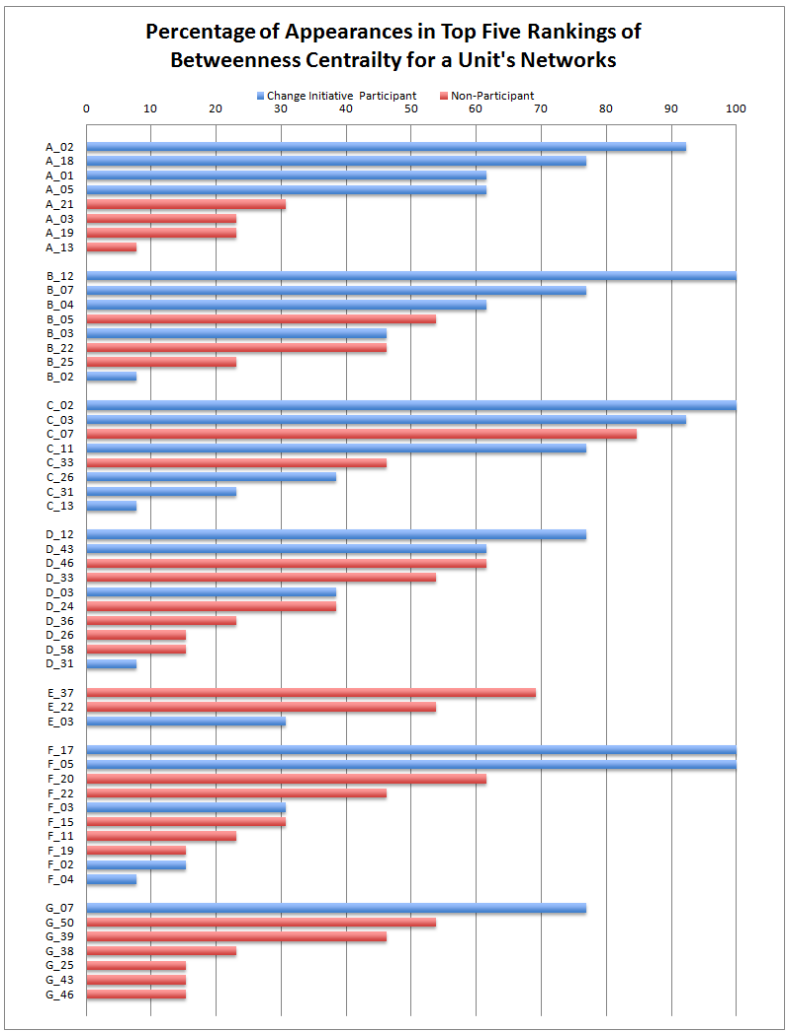

Figure 3. The percentage of an individual's appearance the top five rankings of betweenness centrality. Blue indicates a participant in the change initiative. Red indicates a non-participant

Implications Beyond Our Change Initiative

Instructional improvement initiatives are needed in STEM to achieve science literacy for all learners. These change initiatives work across disciplinary boundaries. They aim to fit the needs of diverse stakeholders and to benefit from disciplinary knowledge and perspectives. In our project, this boundary work is focused on the transfer of EBIPs across disciplinary units and cross-pollination of ideas regarding the use of EBIPs. We have shared a methodology and the outcomes of our attempt to build relational expertise. SNA was used to identify topics of discussion and to infer local relational experts. By completing this analysis early in a change initiative, we build upon knowledge that helps us develop a shared vision for the adoption and adaption of EBIPs that addresses the interests of our participants. Other change initiatives may benefit from a similar study and analysis.

In addition to this methodology affording improvement of instructional initiatives, the identification of topics of discussion, while not generalizable, provide insight into topics that are of interest to postsecondary STEM educators. Of particular note to general audiences may be the

lack of discussion around teaching issues related to accreditation and other policy seen as a linchpin for promoting certain pedagogical practices, reflection, and continuous improvement, as well as a lack of discussion concerning student diversity, a focus of many postsecondary change initiatives. Also notable is the lack of tenure and promotion discussion across the units, which is frequently cited as a challenge to instituting teaching and learning-related change. In our next round of activities and analysis, we will work to incorporate the needs of each department into the change initiative and explore why these patterns of interests have emerged. This will provide more insight into how a general audience may be able to use these findings.

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