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Work In Progress - KEEN Faculty Impact Study

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Darby Riley is a student of engineering education at Rowan University. She has a special interest in issues of diversity and inclusion, especially as they relate to disability and accessibility of education. Her current research is focused on the adoption of pedagogy innovations by instructors, specifically the use of reflections and application of the entrepreneurial mindset. Her previous research experience includes examination of implicit bias in the classroom, and application of VR technologies to improve student engagement. Darby hopes to pursue a career in STEM education and educational research.

Cayla Ritz

Cayla, originally from Freeland, Maryland, has attended Rowan University for all undergraduate and graduate-level degrees. She graduated in Spring 2020 with her BS in Mechanical Engineering with a concentration in Honors Studies. She also has her MSc in Mechanical Engineering with a COGS in Holocaust and Genocide Studies, and is pursuing a PhD in Engineering with a concentration in Engineering Education. Specifically, her research interests are focused on combining the humanities and social sciences with STEM education to create a unique learning experience for students.

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Dr. Cheryl Bodnar is an Associate Professor in the Experiential Engineering Education Department at Rowan University and is currently serving as the Provost's Fellow for Student Success. Recently, the National Science Foundation (NSF) and the Kern Family Foundation have funded her research. Her research interests relate to the incorporation of active learning techniques such as game-based learning in undergraduate classes as well as integration of innovation and entrepreneurship into the engineering curriculum. In particular, she is interested in the impact that these tools can have on student perception of the classroom environment, motivation, and learning outcomes.

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Kaitlin Mallouk is an Assistant Professor and Undergraduate Program Coordinator in Experiential Engineering Education at Rowan University. Prior to beginning that role, she spent five years an Instructor in the Mechanical Engineering and Experiential Engineering Education Departments at Rowan. Kaitlin has a BS in Chemical Engineering from Cornell University and an MS and PhD in Environmental Engineering in Civil Engineering from the University of Illinois.

Work In Progress - Social and Practical Impacts of KEEN Professional Development

Introduction & Background

There exists a great variety of research communities which aim to improve engineering education through innovative, evidence-based practice. While many of these research communities work to develop new educational strategies with great success, there appears to be a missing link: that between the dissemination of evidence-based educational strategies and their use in an actual educational environment. Although new pedagogical methods continue to be developed, tested, and published, instructors can often struggle to fit them into their classrooms [1]-[3]. This gap is influenced by a few factors: resources available to faculty members [4]-[6], a faculty member's willingness to make changes to their pedagogy [7]-[8], and the social networks (or lack thereof) supporting faculty members through the implementation process [9]-[11]. While these factors have been studied on an individual basis, additional factors that may impact the implementation of pedagogy associated with some newer research and professional development communities may not be so easily categorized [12].

An example of one of these professional development communities is the Kern Entrepreneurial Engineering Network, or KEEN. KEEN not only funds and publishes research on best practices relevant to the integration of entrepreneurial mindset, but also hosts workshops and conferences, and provides an online space for faculty to network and share innovations [12]-[13]. The network's focus lies in the cultivation of an entrepreneurial mindset (EM), a set of skills and behaviors that help individuals identify and take advantage of opportunities to innovate [14]. Despite its prevalent use in the field of entrepreneurship education, there is no singular definition of EM; individual definitions depend upon field and perspective [15]. In engineering education, teaching habits and skills that foster EM development can shape students who are better at working within vague customer needs and constraints, identifying design problems, and pushing towards optimized solutions [16]. Similarly, the application of EM to an instructor's responsibilities could make them more effective as educators, and the faculty connections they develop while learning about EM may change the environment in which they work [17].

Over the last few years, there has been significant interest in incorporating EM into the curriculum for students and faculty alike [14], [16]. There are several groups and programs which focus primarily on educating faculty to use EM in their curriculum [16]; these resources include KEEN [13], the National Science Foundation's (NSF) Pathways to Innovation (Epicenter) [18], and the NSF I-Corps Program [16]. KEEN's approach to curriculum change and professional development has not yet been the subject of formal study, and therefore remains less understood, and perhaps unoptimized. The preliminary results of this study focus on how

EM professional development workshops (including ones offered by KEEN) affect the social networks of faculty members who attend them.

In order to effectively describe the connections that are made between faculty members, social network analysis is utilized. Social networks can be defined as "a social structure of nodes that represent individuals (or organizations) and the relationships between them within a certain domain" [19, pp.2]. These networks depict the connections that the university faculty make through attending workshops, among other types of interaction. The nodes, which represent individuals, are created and linked through edges, which represent the relationships that join them [19]-[20]. Social network analysis allows researchers to quantify some aspects of social interaction, and is particularly useful in identifying key actors in a social circle through a number of metrics collectively known as *centrality* [20]. In this study, *betweenness centrality* was used to identify actors who bridge the gap between otherwise disparate social groups within the network, and therefore have access to more perspectives and peer support within their professional network [21].This study seeks to answer the following research question: What types of social networks are developed through EM professional development within a single institution?

Methods

Faculty from a mid Atlantic university who have previously participated in EM-related professional development programs, both University- and foundation-sponsored, were invited to participate in this study. The faculty pool consisted of 44 faculty members, though only 38 were active at the university during the study. 11 faculty members participated. While community saturation is preferred for social network analysis, some measures are still appropriate for a network that is "incomplete" in this way. The survey itself is modeled after surveys from similar studies [22]-[23]; after identifying themselves from a pre-populated list, respondents select resources they use to develop their EM from a checklist [22], and then identify other faculty members from the 44 faculty members that they have collaborated with and notate the methods in with they collaborated (ex: talking about EM, attending workshops together, etc.) [23].

The collected data is organized into network visualizations, allowing us to examine the faculty-to-faculty relationships (known as a social network). This analysis allows us to examine the role of EM professional development programs in social networks by comparing the networks of those who attend such workshops against the networks of those who do not. After the survey was deployed and results were returned, the data was visualized in Ora, a dynamic network assessment and analysis tool developed by CASOS, to generate the social networks.

Results and Discussion

A social network was generated to examine the effect of professional development workshops on the social connections of faculty members, and how faculty members who utilize workshops may

impact the overall department's network. Of the 44 faculty members who had participated in EM-related professional development, only 3 are not represented in the social network (Fig. 1) that resulted from the 11 consenting participants. While this may indicate that these individuals are not as involved as others represented in this diagram, no conclusions about their involvement should be drawn beyond the fact that they were not socially connected to the 11 participants.

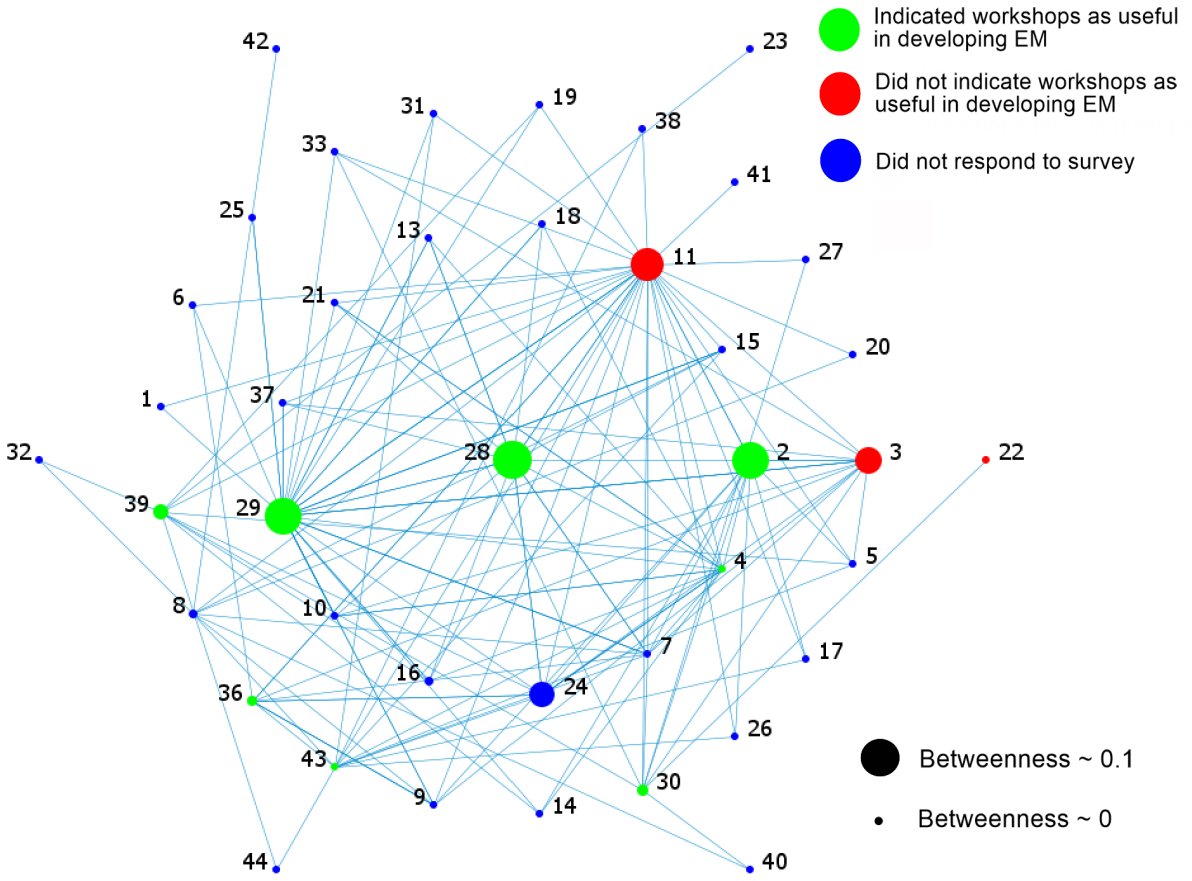

Fig. 1. Social network of faculty members at a large mid-Atlantic university

The above network features a set of 41 nodes sized by the *betweenness centrality* metric and colored based upon involvement in EM professional development workshops. Green nodes indicate those faculty members who listed EM faculty development workshops as a tool they use continually in building their EM, red nodes indicate faculty members who do not use EM faculty development workshops, and blue nodes are those who did not respond to the survey. A node of a larger size (ex: 2, 11, 28, and 29) indicates a higher betweenness; in other words, the large nodes in the network act as bridges between otherwise disparate parts of a community, are able to take in more perspectives from more faculty members, and have access to a greater support network through their direct connections [24], [2]. Betweenness is measured on a scale of 0 to 1, with nodes of betweenness 1 lying on the shortest path between all other nodes (for example, the

node at the center of a starburst shape), and nodes of betweenness 0 lying on none of the shortest paths (typically those on the outer edge of a network with few connections overall).

Based on these metrics, it is clear that nodes 2, 28, and 29 are of interest as they (a) display relatively high betweenness (all of approximately 0.1), and (b) indicate that they attend workshops as part of EM development. Members 2 and 28 also noted that they found workshops to be the single most influential resource in their development of EM. When connections made through workshops are removed from the network, the betweenness of nodes 2 and 28 drops dramatically; node 2 falls from 0.10 to 0.03, node 28 falls from 0.10 to <0.001. While node 29's betweenness increases (from 0.10 to 0.22), it is important to note that this is primarily due to a decrease in overall number of nodes represented (particularly those on the outer fringes of the network who have fewer connections), as those only connected through workshop attendance can no longer be used in this calculation. However, five of node 29's direct connections (a total of 21 other nodes) were made and maintained through workshops alone, and so node 29's network is still decreased when workshop connections are no longer considered.

Also of note are the two relatively large nodes who did not use workshops in developing their EM: 11 and 3. When connections made through workshops were removed from the network, the betweenness of node 3 dropped a small amount from 0.08 to 0.06. However, node 3 described their experience at KEEN conferences (their most influential resource) as motivating due to "seeing the diversity of ideas being pursued by colleagues everywhere and their successful outcomes". Node 11's betweenness increased (from 0.09 to 0.15, as noted above this is likely due to a decrease in the overall number of nodes), but similarly described their experience at KEEN conferences as being influential because of the opportunity to make "personal connections".

The results obtained seem to indicate that, while perhaps not central to all professional networks, many faculty members that are interested in EM integration in their coursework have networks that hinge upon EM professional development workshops and other structured networking opportunities.

Limitations and Future Work

This study was limited to a single institution, and may not be generalizable to other institutions. The sample size of faculty respondents was also very small, which can impact the quality of results obtained. Connections to faculty at other universities or through other events cannot be evaluated through the results of this study. Moving forward, the researchers will be conducting interviews with the survey respondents to more deeply understand the role of professional development workshops in building social networks.

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