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Fostering Institutional Change in Innovation and Entrepreneurship: A Social Network Analysis Approach

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ABSTRACT

Over the last decade, faculty champions across the country have made significant strides in integrating innovation and entrepreneurship (I&E) into engineering education. However, such efforts have not resulted in lasting and widespread change. This purpose of this study is to understand the degree to which a national network of faculty can promote sustained change in this domain. In so doing, this paper presents the results of a social network analysis (SNA) of the Pathways to Innovation Program (Pathways), and links network data to key programmatic inputs and institutional outcomes.

Pathways, the faculty-development arm of the National Center for Engineering Pathways to Innovation (Epicenter), is designed to help institutions infuse innovation and entrepreneurship (I&E) experiences into the undergraduate engineering experience. Pathways is a structured inter-organizational network of approximately 400 individuals at 50 institutions whose primary objective is to transform the undergraduate experience of engineering students by embedding I&E into undergraduate engineering[1]. Over the course of two years, Pathways teams turn their ideas into educational innovations aimed at improving the quality and quantity of I&E offerings on campus. To accomplish this goal, Pathways provides opportunities for teams to interact with each other, and subject matter experts, through a series of face-to-face gatherings and online activities.

The purpose of this study is to explore the relationship between the network structure of Pathways teams and shared outcomes in I&E offerings on campus that result from knowledge flows between the teams and other influencers in the Pathways community. To explore these relationships, the authors administered a novel SNA instrument to examine the extent to which network collaborations and communications relate to team outcomes, and understand how network differences both before and after joining Pathways contribute to successful change efforts. This research aligns with the extensive literature review that informed the design of Pathways, which emphasized the importance of a peer network in the design of an effective faculty development program[2]. Drawing upon research on community networks within a collective impact framework[3,4], the authors hypothesize that the Pathways initiative, which "…involv[es] a centralized infrastructure, a dedicated staff, and a structured process that leads to a common agenda, shared measurement, continuous communication, and mutually reinforcing activities among all participants" (p.1)[4] would positively impact the I&E ecosystem at participating institutions.

The program's sizeable network of institutions, collective impact design, and emphasis on fostering inter-organizational communication and collaboration towards a shared goal makes it an excellent source of study for other large-scale initiatives aimed at fostering change in the post-secondary educational context. Results of this study will contribute to our understanding of

inter-organizational and team-based collaboration networks to promote educational innovations in engineering education.

INTRODUCTION

Historically engineers were the drivers of innovation and a huge source of competitive advantage for the United States[5,6]. However, with the publication of the 1955 Grintner Report, the applied, practical approach to engineering education that nurtured young innovators was replaced by a more theoretical approach[6]. This theoretical approach was fitting for a time when engineering corporations were large and sought workers to simply execute their plans. However, society is now characterized by organizations that generate wealth from the innovations of their workers[7]. Indeed, employers seek graduates that can apply their knowledge, have the ability to innovate, can communicate effectively, work in teams and understand contexts and constraints[8,9], all skills typically addressed by entrepreneurship education. Such skills also prepare students to start their own companies based on their own innovations[10], which also serves to contribute to economic prosperity[11].

The integration of innovation and entrepreneurship (I&E) into undergraduate engineering is not a new phenomenon. Faculty champions across the U.S. have integrated I&E into engineering education in a number of ways[2] including through the development of extra-curricular offerings[12], the design of makerspaces[13], integration into existing courses[14], as well as through the design of specialized courses and programs[15]. However, although faculty have long worked on integrating I&E into engineering, these individualized efforts have not resulted in lasting and widespread change[1]. Thus, the goal of integrating I&E may be defined as an "adaptive challenge"[16], one that is too complex for a single individual or organization to solve. Therefore, in order to foster lasting and widespread integration of I&E into undergraduate engineering, it may be necessary for institutions interested in integrating I&E into engineering to work together, in the context of a community, to foster greater collective impact. This study utilizes social network analysis (SNA) to explore the relationship between the Pathways faculty community of practice networks and institutional changes in I&E. SNA examines the relationship (or ties) between nodes (individuals or organizations) in order to understand the social relationships between the nodes, the social capital or value the nodes attain from the network, and how the quality of those relationships translates into outcomes. [17–20]

The Pathways to Innovation Program (Pathways)

Pathways is the faculty-development arm of the National Center for Engineering Pathways to Innovation (Epicenter). Epicenter's mission is to help institutions infuse I&E experiences into undergraduate engineering. Drawing upon the collective impact framework, Pathways employs a "…centralized infrastructure, a dedicated staff, and a structured process that leads to a common agenda, shared measurement, continuous communication, and mutually reinforcing activities among all participants"[4]. Pathways is an inter-organizational, peer-based network currently comprising 394 individuals representing 50 institutions with the collective goal of transforming the undergraduate experience of engineering students through increased access to innovation and entrepreneurship opportunities. At the time of this writing, there have been three

cohorts of Pathways teams for a total of 50 institutions: 12 in the first cohort (Pathways 2014 or P'14), 24 in cohort 2 (Pathways 2015 or P'15) and 14 in cohort 3 (Pathways 2016 or P'16).

Over the course of one and a half to two years, Pathways provides opportunities for teams (consisting primarily of faculty and administrators) to establish communication networks whereby knowledge and ideas on I&E can flow readily between teams, and between teams and various "experts," who may serve the role of advisor, presenter and Epicenter Staff. Pathways facilitates networking opportunities through a series of face-to-face gatherings and online activities. We briefly review these team-based activities before describing how this research has been informed by the social network and communities of practice literatures.

Face-to-Face Gatherings
Teams are on-boarded to the Pathways process through two major in-person events, and are encouraged to attend hands-on workshops as well as the annual VentureWell OPEN conference.

- The *Team Leader Meeting* is a one and a half-day event that brings Pathways team leaders of an incoming cohort together for the first time. This convening (1) orients team leaders to the tools and activities that are part of the pathways model, (2) prepares them for their role as team leaders, particularly in the context of strategic doing, the agile strategic planning process they will use with their teams (3) starts to integrate them into the Pathways community through activities that break down social and professional barriers while forging connections with the other Pathways team leaders. All team leaders are required to attend this event. This is also when leaders are introduced to the landscape analysis tool. The landscape analysis tool is a spreadsheet designed to provide teams with a systematic way to collectively catalogue elements that contribute to their current campus I&E ecosystem and track changes in that ecosystem[21]. Through the process of cataloging their I&E ecosystems, teams determine both gaps to mitigate and strengths to leverage when designing their custom strategy for growing their ecosystem. Teams are required to complete the landscape analysis tool at the start of their involvement in Pathways and again 18 months later.
- The *All Team Meeting* is a two and a half day convening, designed for team leaders and team members. This event (1) orients teams to the tools and activities that are part of the Pathways model, (2) integrates them into the Pathways community through various activities. These activities are designed to forge connections with other teams and speakers, and demonstrate the value of the community through a process of sharing approaches and challenges to implementation, and (3) provide teams with an opportunity to work on their institution-specific strategic plans using the strategic doing process. Teams also form self-selected peer groups of 3-5 teams each using a set of suggested match-making criteria that include geographic location, level of experience, similar or different strategies being pursued, size and type of institution, mindset or venture creation focused, and same or complementary areas of expertise. These peer groups are then used to cultivate a greater sense of community (see description of peer group advising and strategic doing sessions below).
- The *OPEN Conference* is an annual conference sponsored by VentureWell. Through this conference Pathways teams join a broader community of approximately 500 educators, all attending to share and learn best practices for integrating I&E into post-secondary education.

- *Workshops:* These two day, hands-on workshops, are hosted on and by a Pathways campus and cover topics identified as critical to helping teams integrate I&E on their campuses. Team leaders and members are encouraged to attend these gatherings.

Online Activities

All online activities are hosted using BlueJeans videoconferencing. The activities are as follows:

- *Webinars* are monthly, 60 min long sessions in which 1-5 experts are asked to engage teams on a particular topic. Webinars provide teams with topical information from leading experts to help teams advance their goals (e.g., Assessment and Evaluation). Interactivity is highly encouraged to better prepare teams to apply their learning. These are voluntary activities; all team members and leaders receive an invitation to attend.
- *Peer Group Advising* sessions are monthly meetings that commence when teams join the program and continue for a total of 6 months. Advising meetings are attended by Pathways peer groups comprised of between 3 and 5 Pathways teams, and an expert advisor that has extensive experience starting and running an entrepreneurship program or center. These meetings are designed to (1) help teams realize their strategic goals by providing just-in-time support and advice and (2) to help teams start to form connections and cultivate a sense of community with their advisor and peer group through a process of sharing challenges and reciprocally tapping into the collective wisdom of the group. Team leaders are strongly encouraged to attend and invite team members that might find the meetings useful.
- *Strategic Doing* check-in calls take place monthly for the first 6 months and every four to six months thereafter. Check-in calls provide teams with an opportunity to update staff on the status of their project, and report on progress made toward their stated goals. Teams meet in peer groups of 3 to 5 schools with a Pathways representative, and review monthly strategic doing maps, used to track team plans and progress. Leaders are required to attend Strategic Doing check-in calls.
- *Topical Workgroups* are comprised of small groups of Pathways participants who wish to tackle a common challenge based on their school's specific needs. The groups meet for a short term (typically four online meetings spanning a total of four to six months), are action-focused and are led by expert content guides. Team leaders are invited to apply to join topical work groups of interest and are encouraged to invite team members that might benefit. Participation is voluntary.

These events (face-to-face and online) are designed to foster a sense of community among the teams, forge connections with Pathways "experts" recruited, and generate value by providing tools, strategies and support to realize the collective goal of integrating I&E into undergraduate engineering. This community of practice approach was borne out of the literature search that informed the design of Pathways and emphasized the importance of a community of practice in an effective faculty development program[2]. Additionally, it was also believed that this approach would enable Pathways institutions to collectively meet this "adaptive challenge"[16] of integrating I&E into engineering. However, while the aforementioned landscape tool is capable of demonstrating the impact that teams are having on their campus ecosystems, it is unclear the extent to which being part of a community of practice or social network[22,23] influences the degree to which institutions are successful at achieving desired outcomes.

Networks and Communities of Practice

The terms network and community of practice are often used interchangeably (Wenger et al, 2011) as their definitions share several areas of overlap. "Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly." (p.1)[22] Thus communities of practice are characterized as having a domain or shared interest that members care about, a community of actors that discuss and engage in activities related to this domain, and a practice they engage in of sharing resources and developing knowledge[22]. In a similar fashion the network literature indicates, "…networks are defined by the enduring exchange relations established between organizations, individuals, and groups" (p.1).[24] It is by virtue of these exchange relations that networks create value, by providing all members of that network with the capacity to reach a goal that individual or single organizations could not have achieved alone[25]. In spite of these overlapping definitions, communities of practice and networks represent two strands of practice and research, each discussing the formation, management, benefits and measurement of outcomes.

Networks are formed in two primary ways; they are either mandated/formal or emergent/informal[26]. Mandated networks require participation in order to foster a shared goal; emergent networks grow organically and participation is linked to the value members perceive in participating, the trust they have in the network[27] and their commitment to the network or community[28,29]. However, these polar definitions fail to capture how networks evolve over time. For example as value and the trust grows in a mandated network, this may result in a different level or type of participation. Similarly an informal network may later assume a more formalized structure. How a network is managed also varies, with governance often being influenced by the size of the network. For example, shared governance is typically found with fewer than ten participants; a network member may govern if the numbers are moderate; for larger networks, an administrative organization is often required[30]. This model of utilizing an administrative organization to manage network relations is a hallmark of the collective impact approach. The benefits of networks, and specifically inter-organizational networks, include learning, capacity building, a collective ability to exert pressure to foster change and support each other in that change[30]. These benefits can lead to a greater sense of commitment to shared goals.

In communities of practice, membership is always voluntary. Members elect to join because they believe they have something to contribute and to gain from the community. Other members are invited in because current members perceive them to be a good fit. For organizations looking to foster communities, potential communities can emerge from informal groups that have an area of interest or domain in common. Rather than being managed, communities of practice are fostered by providing the necessary infrastructure and recognition to ensure their success. Examples of infrastructure that might be provided include the necessary IT systems or personnel to coordinate the community's activities[23].

Clearly, there is significant overlap not only in the definition of networks and communities of practice, but also in the way researchers describe their membership criteria, modes of governance and potential benefits. One might argue that in many ways, communities of practice, particularly those fostered by administrative organizations, closely mirror informal collective impact networks with their focus on a common goal, a centralized agency to foster efforts and voluntary

membership. Interestingly, the most significant difference between a community of practice and a network may be in how researchers have traditionally evaluated the effectiveness of each.

The evaluation of networks has traditionally focused on analysis of the network structure, or connections across the network. According to social network analysts[31], networks are comprised of nodes (representing individuals or organizations) and edges (representing relationships between individuals or organizations) and can be analyzed at three general levels: micro-level (individual member of individual organization level), meso-level, which analyzes the structure of the network including relationships that form, and macro-level or outcomes of the network. Building upon Kirkpatrick's four-level model of professional training[32,33], the evaluation of communities of practice, by comparison, involves narratives that elucidate "cycles" of value creation. The term cycle is adopted in order to convey the fact that learning is not a linear process to be completed stage by stage; rather it is an evolving, continual process. Narratives include personal and collective narratives that tell the individual member or individual stakeholder stories, and the community's collective story[34]. The five cycles include (1) "immediate value" such as answers to a question posed, (2) "potential value" such as the support and legitimacy a community provides as well as ideas shared that are not put to immediate use, (3) "applied value" refers to the implementation of ideas shared, (4) "realized value" are the outcomes of any applied value and (5)"reframing value" is a reflective process whereby participants reevaluate their strategies and measures of success[34].

More recently however, network researchers indicate the need for a more sophisticated approach to analysis that takes into account the myriad factors outside of the network that impact results, including the evolving nature of networks. This indicates a need to analyze networks starting at their emergence and onwards. Effectiveness of any network and the definition of effectiveness are, in addition, context specific, and so too should be the approach for evaluating network effectiveness[30]. This more progressive approach, when combined with social network analysis can offer insights not only into network structures, but also how those network structures can be modified to optimize impact. This emerging approach to measuring networks again illustrates the similarities between networks and communities of practice. Therefore, rather than seeing networks and communities of practice as separate entities, they may be seen as overlapping complementary processes. Networks alone, focus narrowly on the social interactions without knowledge of or focus on a common goal, or the necessity of engaging over a sustained period of time. However, as the network develops, there may develop a sustained length of connectedness within a common domain and thus an emergent community[34].

The approach used to evaluate the efficacy of the Pathways community incorporates what is considered a more traditional analysis of network structure along with consideration of the lifecycle of the network and the value that is created by the network, both in terms of "realized value" or tangible outcomes, and those intangible outcomes that Wenger refers to as "potential value"[34].

Pathways' sizeable network of institutions, collective impact design, and emphasis on fostering an inter-organizational communication and collaboration towards a shared goal makes it an excellent source of study for other large-scale initiatives aimed at fostering change in the post-secondary educational context. Results of this study will contribute to our understanding of

inter-organizational and team-based collaboration networks to promote educational innovations in engineering education.

Research Questions

The purpose of this research is to 1) examine the extent to which the Pathways network has evolved, and 2) to explore the relationships between program participation (i.e., attendance at in-person events and online activities), network structure and institutional outcomes. According to social network analysts[31], a network is comprised of nodes (representing individuals or organizations) and edges (representing relationships between individuals or organizations) and can be analyzed at multiple levels (individual, structural and systemic). For this paper we are focused on the structural and systemic changes in Pathways team-based collaboration and influence networks as a result of program participation. Structural changes reveal the "architecture" of the network from before joining Pathways to now. Systemic changes identify connections between the network and participation levels and/or outcomes. The research questions below assess 1) the degree to which changes in networks or 2) changes in outcomes are related to one another and whether any of these changes have been influenced by levels of program participation.

- **RQ1:** How have team communication/collaboration and influence networks evolved from before joining Pathways to now?
- **RQ 2:** How have Pathways institutional landscapes (i.e., the quantity of I&E offerings) changed before joining Pathways to now?
- **RQ3:** How does the network relate to outcomes (e.g., quantity and change in I&E offerings)?
- **RQ4:** How does the network relate to levels of participation (e.g., attendance data)?

The following data sources were used to answer the research questions.

METHODS

Data Sources and Variable Operationalization

The Pathways Network

In October 2015, participants from the first cohort of twelve Pathways Teams (P'14) attended a Pathways to Innovation (Pathways) workshop. At least one pathways team leader from each P'14 institution attended this event. Following the workshop, team leaders (supported by members in some cases) were asked to complete a novel social network analysis (SNA) instrument (see Appendix A) on behalf of their team. The purpose of this instrument is to explore (1) the extent to which P'14 inter-team communication/collaborations have changed from before joining Pathways to now, and (2) the degree to which P'14 teams' influence network in I&E has changed from before joining Pathways to now (RQ1). In addition to providing a visual representation of both networks—inter-team communication/collaboration and influence networks—SNA, as an analytical tool, provides a set of basic network metrics that can be used to mathematically measure the structure or architecture of a network and inform the research questions above. Specifically, three metrics—*Network Density*, *Average Geodesic Distance* and *Degree Centrality*—were used to quantitatively assess the evolution of the networks across time.

- *Network density* is a measure of the connectedness in a network. Network density score is a number that varies between 0 and 1.0; when density is close to 1.0, all teams are connected within the network. As the network evolves, it is anticipated that network density will increase over time, indicating greater interconnectivity among teams.
- *Average geodesic distance* measures the average length of the shortest path between all nodes. If this metric is high (e.g., >1.0), many teams within the network do not directly know one another. If it is low (e.g., <1.0), most teams know one another either directly or indirectly through a mutual relation. Average geodesic distance provides a sense of how 'close" nodes are to one another. An effective intervention should yield a low average geodesic distance score, suggesting that knowledge can flow through the network more efficiently.
- *Degree Centrality* measures the number of nodes or teams to which a node is connected. This is used to identify influential members of the community. A node with a high degree centrality is often considered at the center of the network. A network comprised of only one or two members with a high degree centrality score is considered to be hierarchical whereby only one or two teams serve as the primary communication hub. In their absence, the network would be disconnected. By contrast, a network where all the nodes have an equal degree centrality score is considered non-hierarchical; all teams play an equal role in transferring communication and knowledge across the network.[35]

Network Variables: Communication/Collaboration & Influence

Team leaders rated the extent of their teams' interactions with their P'14 peers regarding I&E before joining, and now, after joining Pathways. Interactions were rated on a 5-point Likert scale (0, No one met or communicated to 4, We formally collaborated on at least one I&E related project). In addition to assessing the quality of collaborations across Pathways teams, the SNA instrument also asked each team to identify up to 10 individuals who most influenced their thinking about increasing opportunities for I&E in undergraduate engineering education on their campus. For each individual identified, influence was rated on a 5-point Likert scale (1, not at all influential to 5, extremely influential) both before joining Pathways and after joining Pathways.

Institutional Outcomes

Pathways teams are required to identify the I&E offerings available to engineering students at their institution at the start of their participation in the program and again 18 months later using the landscape analysis tool. This tool is a spreadsheet comprised of six worksheet tabs, each cataloging different dimensions of the campus ecosystem that are capable of fostering I&E knowledge, skills, attitudes and experiences[17]. A brief description and example of each worksheet tab is provided below:

Table 1. Examples of Pathways '14 Institutional Outcomes

	Definition	Examples
Courses	All formal I&E course offerings available to engineering students	• Freshman seminar with I&E module • Interdisciplinary (Business, Engineering, Architecture, Art) I&E capstone design course
Programs	Multi-course curricular opportunities	• Certificate in Entrepreneurship and Innovation • Entrepreneurship Minor
Extracurricular Activities	Co-curricular and extra-curricular offerings	• TEDx talks • Pop-up classes • Business plan competitions
Spaces	The degree to which the campus provides	• Makerspace

	spaces that foster entrepreneurship and innovation	• Incubator • Accelerator
Champions	Individuals who have the knowledge, influence and time to move I&E education initiatives forward	• Center Directors • Provosts • Faculty
Catalysts	Strategies, governance philosophies and/or external connections that might be leveraged to promote I&E courses, programs, projects and faculty development on campus	• Strategic plans • Faculty development initiatives • Industry donors

Landscape data were collected from P'14 teams in February, 2014 (Pre) and again in September, 2015 (Post). All twelve P'14 teams completed their landscapes in February 2014, just 11 teams completed their Landscapes in Fall, 2015. Analyses were conducted on the 11 teams for which complete data were available (RQ2).

Pathways Attendance
Pathways staff tracked attendance patterns for P'14 leaders and members for all in-person and online events. Pathways '14 in person gatherings included the Team Leaders meeting (Jan. 2014), the All Team Meeting (February, 2014), the VentureWell Open Conference (March, 2014) and two Workshops (September, 2014 & October, 2015) (see descriptions above). In-person attendance data was aggregated and used in subsequent analyses. Online attendance data comprised leader and member attendance at Pathways hosted webinars, peer group advising sessions, strategic doing check-in calls and topical workgroups (see descriptions above). Online activity attendance data were analyzed independently as well as in aggregate in subsequent analyses.

All three datasets were also used to determine if the network structure relates to outcomes (i.e., the changes in the number of offerings as captured by their landscape tools) and to investigate the extent to which team-level participation in the various Pathways online and face-to-face gatherings influenced the network structure or institutional outcomes (RQ3 & 4).

ANALYSIS & RESULTS

Answers to the research questions were examined using results obtained from NodeXL, a social network analysis (SNA) open-source template for Microsoft® Excel®. This software allowed us to measure change in inter-organizational (between-team) collaborations around I&E, as well as growth and change in a team's influence network before and after joining Pathways. Paired samples t-tests revealed changes in institutional outcomes by institution from pre to post. Correlational analyses were conducted to determine the extent to which relationships between institutional outcomes and program participation levels related to the Pathways network structure.

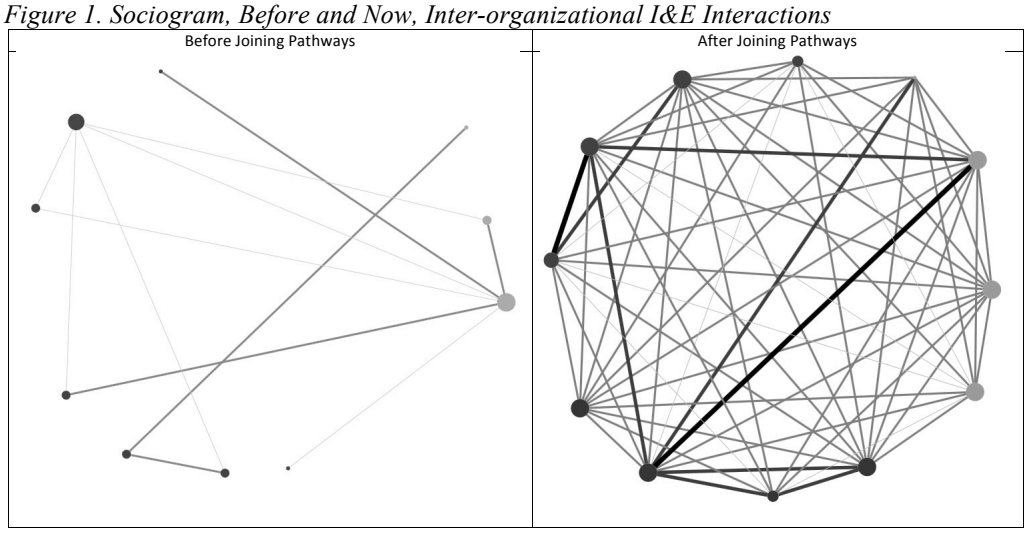
RQ1: How have team communication/collaboration and influence networks evolved from before joining Pathways to now?

Communication/Collaboration

Examining the overall structure of the network, Figure 1 shows a striking contrast from before to after joining Pathways. As a result of participating in Pathways, the network of team interactions

significantly increased from before participating in the program to now. The network has a non-hierarchical structure whereby all teams play an equal role in the network (see Figure 1). A non-hierarchical network is associated with the following characteristics: a) decision making is shared among cohort members; b) activities are orchestrated as a group; and c) little conflict and informal communication. According to previous research, this network structure is best for facilitating common understanding, a clearinghouse for information, and a base of support[35].

Figure 1. Sociogram, Before and Now, Inter-organizational I&E Interactions



Note. Nodes denote P'14 teams. Line opacity reflects extent of interaction: Scale= 1, We communicated; but, never exchanged knowledge or ideas on I&E to 4, We formally collaborated on at least one I&E related project. Teams who rated the interaction with another team as 0 (No one met or communicated) are not represented in the sociogram. Size of the nodes reflect degree centrality or the number of connections a teams has with others in the network.

Social network analysis also allows us to calculate overall metrics—such as *Graph Density* and *Geodesic Distance*—that describe the network as an entity. The degree of connectedness of a network is denoted by the graph density measure, which is calculated as the percentage of the number of actual connections divided by the total number of possible connections. As shown in Table 2, the graph density increased from .27 to .94 after joining Pathways. Additionally, the average geodesic distance decreased from before to after participating Pathways. Geodesic distance is the amount of time for communication to pass through the network. A metaphor for conceptualizing geodesic distance is to think of the edges as roads and the nodes as houses. The geodesic distance would be the number of roads someone must take to get from one house to another. The average geodesic distances gives a sense of how "close" teams are to one another. Thus, a smaller geodesic distance (e.g., 0.97) suggests that that communication can more readily pass through the network than a larger geodesic distance (e.g., 2.06).

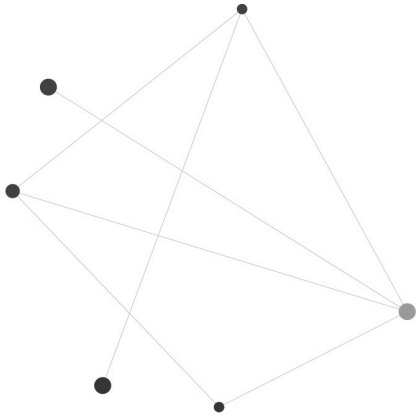
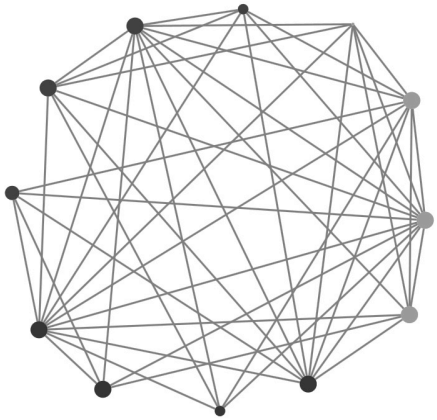
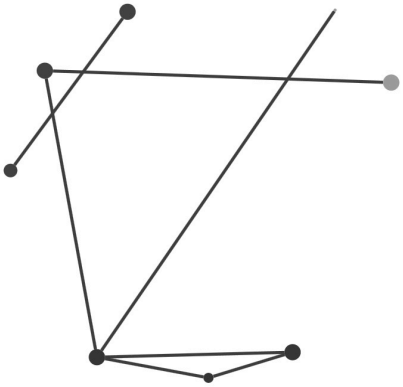
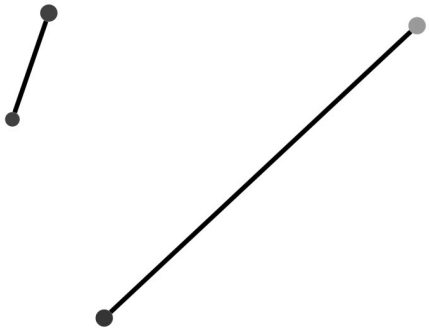
Table 2. Metric Data, Inter-organizational Collaborations

	Before Joining Pathways	After Joining Pathways
Graph Density	0.27	0.94
Average Geodesic Distance	2.06	0.97

Despite increases in network density from before joining Pathways to now, it is important to note that most teams have not yet made plans to collaborate on an I&E related project. In fact, the network is most dense or interconnected at category 2 (*We shared knowledge or ideas on I&E;*

but never made plans to collaborate on a project) as most teams shared knowledge with others, but have not yet made plans to collaborate (Figure 2). Figure 2 also suggests that while the network after joining Pathways is structurally non-hierarchical, disentangling the network and examining it at each interaction category reveals a different story. Namely, at deeper levels of interaction (e.g., formal collaboration), several clusters of Pathway teams exist.

Figure 2. Sociogram, After joining Pathways, Inter-organizational I&E Interactions per category

We communicated; but, never exchanged knowledge or ideas on I&E (1): 6 teams; 7 dyads	*We shared knowledge or ideas on I&E; but never made plans to collaborate on a project* (2): 12 teams; 46 dyads
	
We made plans to collaborate on an I&E related project (3): 8 teams; 7 dyads	*We formally collaborated on at least one I&E related project* (4): 4 teams; 2 dyads
	

Note. Teams who rated the interaction with another team as 0 (*No one met or communicated*) are not represented in the sociogram.

Influence

Overall, the network of influence for each team intensified from before joining Pathways to now. That is, the individuals that teams cited as having influenced their team's thinking with respect to increasing opportunities for I&E, were rated as being *more* influential after joining Pathways. On average, each team identified 7 individuals that influenced their thinking about increasing opportunities for I&E on their campus. Before joining Pathways, these individuals were rated a

2.32 on a 5-point Likert scale of influence (1, *not all influential* to 5, *extremely influential*); after joining Pathways, their ratings increased to 4.39. The increase in ratings is significant and suggests that the identified individuals were *more* influential after teams joined Pathways than before. Likewise, on average, these individuals were *very* to *extremely* influential in shaping teams' thoughts regarding increasing opportunities for I&E in undergraduate engineering after joining Pathways (see Table 3).

Table 3. Overall Ratings, Influence

	n	Mean	Paired samples t-test (p-value)	Not at all Influential (1)	Slightly (2)	Somewhat (3)	Very (4)	Extremely Influential (5)
Before	7	2.32	0.000**	52%	8%	13%	13%	15%
After	7	4.39		--	--	13%	35%	52%

Note. *p<.05; **p<.01.

In addition, teams also selected the role of each influential individual. The majority of influential individuals were identified as faculty members or Epicenter staff, presenters and/or advisors. Interestingly, of the influential faculty members, nearly three quarter's (~74%) were Pathways '14 team leaders or members. This suggests that teams are influenced by the knowledge and expertise of their Pathways peers. Furthermore, Table 4 indicates that the influence of Epicenter staff, presenters and/or advisors showed the largest gains from before to after joining Pathways. Likewise, Epicenter and Pathways individuals appeared most frequently in the network of influencers with the highest number of connections to P'14 teams (Table 5). The higher degree centrality scores of these individuals suggests that individuals with these roles are strategically important for communication across the network.

Table 4. Ratings per Role, Influence

	Type of Influencer	N	Mean (1, not at all influential to 5, extremely influential)		Paired samples t-test (p-value)
			Before	Now	
Role	Faculty Member	26	2.50	4.46	0.000**
	Epicenter Staff, Presenters, Advisors	22	1.23	4.23	0.000**
	Univ. Leader	15	2.80	4.47	0.000**
	Industry Rep	7	3.14	4.86	0.037*
	Other	6	3.67	4.17	0.363
	UIF or Lead. Circle Member	2	1.50	4.00	--
	Other Grad/Undergrad Student	1	2.00	4.00	--

Note. *p<.05; **p<.01. Epicenter's University Innovation Fellows program trains student fellows (UIFs) to become change agents at their home institutions, institutions that sponsor up to five fellows at a time are known as Leadership Circles.

Table 5. Degree Centrality per Role, Influence

Role	Detailed Role Description	Degree Centrality
Epicenter Staff, Presenters, Advisors	Epicenter staff member #1	6
	Advisor #1	4
	Advisor #2	3
	Presenter and P'14 Team Leader #1	3
	Epicenter staff member #2	2
Faculty Member	P'14 Team Leader #2	2
University Leader	P'14 Team Member #1	2

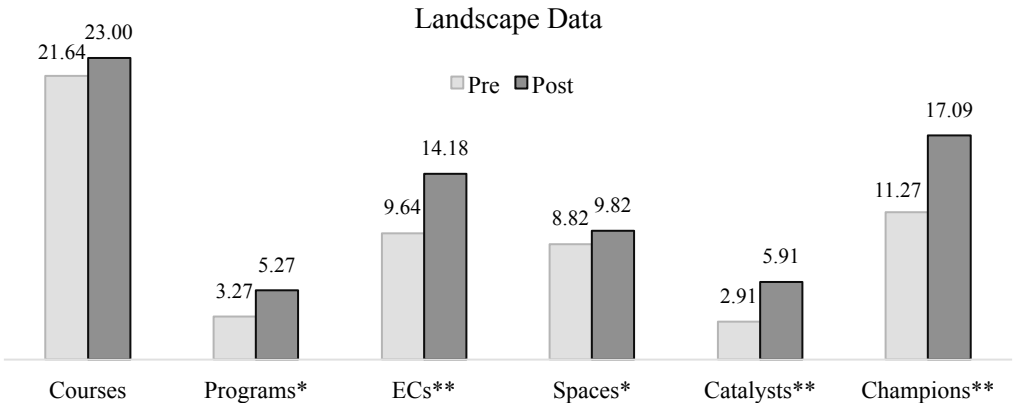
Note. Degree centrality is a measure of the number of connections a node (or individual) has in the network.

Institutional Outcomes

RQ2: How have Pathways institutional landscapes (i.e., the quantity of I&E offerings) changed before joining Pathways to now?

Paired samples t-tests were used to determine the extent to which there were significant changes from Pre to Post along each dimension of the landscape tool. There were statistically significant increases across 5 out of 6 of the landscape parameters: Programs, Extracurricular activities (ECs), Spaces, Catalysts, and Champions. The largest gains are observed in the number of ECs and Champions from pre to post. For instance, before joining Pathways, the number of ECs was, on average, 9.64 per institution; after Pathways, the number of ECs jumped to 14.18, on average. Overall, these data suggest that institutions show measureable progress in enhancing the I&E ecosystem after participating in Pathways. See Figure 3.

Figure 3. Landscape Data, Pre and Post



Note. *p<.05; **p<.01.

RQ3: How does the network relate to outcomes (e.g., quantity of and change in I&E offerings)?

Correlational analyses were conducted to determine the extent to which increases in the number of I&E offerings (e.g., courses, extra-curricular activities etc.) for undergraduate students in engineering relate to inter-team collaborations and intra-team influence. Unfortunately, results suggest little to no direct relationship between P'14 networks of collaboration/influence and institutional outcomes.

Participation in Pathways Programming

RQ4: How does participation in Pathways (e.g., attendance data) relate to team networks or institutional outcomes?

Three separate analyses were conducted in order to answer this question:

Attendance

First, we determined the frequency of participation in programmatic activities for team leaders and members. Descriptive statistics revealed differences in attendance between leaders and team members for in-person and online Pathways activities. Participation data are summarized in Table 6 and are parsed by role type (Leaders vs. Team Members). These data suggest that, on average, leaders attended 3.21 in-person events and 5.21 online activities (e.g., webinars). Team members, on average, attended 1.21 in-person activities and .71 online activities.

Table 6. Participation Data, Leaders and Team Members

Team Role	**Average Attendance**					
	In Person	**Online***	Webinar	PG Advising	SD Check-in	Topical Workgroup
Leaders and Co-Leaders (n=15)	3.21	5.21	1.58	2.54	1.08	--
Members (n=80)	1.21	0.71	0.42	0.14	0.13	0.02

Note: *Online attendance data was computed by totaling the attendance from webinar / online workshop attendance, peer group advising, strategic doing check-in calls and topical workgroup sessions for all P'14 teams.

Linking participation to the Network

Participation data were then used to examine the relationship between participation in programmatic activities and network data. Correlational analyses examined the extent to which participation in programmatic activities for team leaders and members—either online or in person—relate to inter-team collaborations and influence networks. This examination revealed that online attendance among leaders is positively associated with increases in influence among faculty members. That is, participating in online webinars and peer group advising is correlated with the growth in influence among faculty members (Table 7).

Table 7. Spearman's (r_s) Correlation Analysis- Leader Participation and Influence Metrics, Intra-organizational Influence

		Leaders: Average Attendance					
		In Person	**Online[a]**	Webinar	PG Advising	SD Check-in	Topical Workgroups
N (# of influencers)		.025	.117	.037	.245	-.048	--
Influence[1]- Δ		.096	.417	.489	.402	.022	--
Influence Rating per Role Type[2]	a- Δ	.093	**.746***	**.664***	**.787****	.322	--
	b- Δ	.138	-.036	-.066	.220	-.381	--
	c- Δ	--	--	--	--	--	--
	d- Δ	--	--	--	--	--	--
	e- Δ	-.257	-.213	--	-.210	-.118	--
	f- Δ	-.632	.200	.200	**.949**$^{+}$ (p=.051)	-.400	--
	g- Δ	-.500	-.500	-.866	--	-.500	--

Note. [1]Scale=0, Not at all influential; 1=Slightly influential; 2=Somewhat influential; 3= Very influential; 4=Extremely influential. + p<.10 (approaching significance); *p<0.5; **p<.01. [2]Role: a=Faculty Member; b=University Leader; c=UIF or Leadership Circle Member; d=Graduate or Undergraduate Student; e= Epicenter Staff, Presenters and Advisors; f=Industry

Representative, g= Other. [a]Online attendance data was computed by totaling the attendance from Webinar, PG Advising, SD Check-in and Topical Workgroup.

On the other hand, no significant correlations were found between average team leader attendance at in-person or online events and network communication/collaboration outcomes (Table 8).

Table 8. Spearman's (r_s) Correlation Analysis- Leader Participation and Influence Metrics, Intra-organizational Communication/Collaboration

	Leaders: Average Attendance					
	In Person	**Online[a]**	*Webinar*	*PG Advising*	*SD Check-in*	*Topical Workgroup*
Degree Centrality- Δ	.168	-.327	-.433	-.031	-.343	--
Extent of Collaboration[1]- Δ	.480	.133	.156	.063	.029	--

Note. [1]Scale=0, No one met or communicated; 1=We communicated; but, never exchanged knowledge or ideas on I&E; 2=We shared knowledge or ideas on I&E; but never made plans to collaborate on a project; 3= We made plans to collaborate on an I&E related project.; 4=We formally collaborated on at least one I&E related project. + p<.10 (approaching significance); *p<0.5; **p<.01. [a]Online attendance data was computed by totaling the attendance from Webinar, PG Advising, SD Check-in and Topical Workgroup

Notably, team members' attendance at programmatic activities did not correlate with any of the network metrics related to communication/collaboration or influence.

Linking participation to Institutional outcomes

Finally, we examined if frequency of participation in programmatic activities related to increases in the number of I&E offerings for undergraduate engineering students. Spearman's Rho correlational analyses revealed significant relationships between leader average in-person attendance (r=.634, p=.036) and webinar / online attendance (r = .632, p = .037) and change in the number of champions (i.e., administration, faculty and staff who have the knowledge, influence and time to move I&E education initiatives forward) identified. No significant relationships were found between member in-person or online attendance and institutional outcomes (See Table 9).

Table 9. Spearman's (r_s) Correlation Analysis- Leader Attendance and Institutional Outcomes

Institutional Outcomes (n = 11)	**Leaders: Average Attendance**					
	In Person	**Online[a]**	Webinar	PG Advising	SD Check-in	Topical Workgroup
Courses Δ	-.002	.352	.078	.395	.105	--
Programs Δ	.152	.322	.310	.010	.345	--
ECs Δ	.499	.333	.454	.115	.095	--
Spaces Δ	.022	.251	.110	.058	.550+	--
Catalysts Δ	.307	.345	.398	-.209	.562+	--
Champions Δ	.634*	.552+	.632*	.262	.314	--

Note: *Online attendance data was computed by totaling the attendance from webinar / online workshop attendance, peer group advising, strategic doing check-in call and topical workgroup sessions for all P'14 teams. Correlation significant at the +p<.1 (approaching significance), *p<0.5; **p<.01.

This suggests that leaders' involvement in programmatic activities seems to be more relevant to influence networks and institutional outcomes (e.g., change in quantity of I&E offerings) than

team members' involvement in activities. Likewise, results suggest that online participation is more relevant to institutional outcomes than in-person attendance.

DISCUSSION

Communication/Collaboration & Influence Networks

Results demonstrate that the various activities put in place to foster connectedness among Pathways teams including in-person gatherings, webinars, working groups, advising and strategic doing meetings, have increased connectedness. When examining the structure of these connections, what we observe is a non-hierarchical network, essentially one without gatekeepers where teams predominantly know and connect with each other. Such a structure typically fosters communication about a common goal, exchange of information and support for those within the network[35]; these are all network characteristics that serve Pathways teams well.

After joining Pathways, the teams became more familiar with each other, and were significantly more likely to communicate and share knowledge and ideas. In this way, teams demonstrate what Wenger et al. refer to as "potential value" and more specifically they accrued "personal assets"[34] i.e. teams have grown the network of individuals with whom they might turn to for insights and support, and exchange knowledge and ideas with. This sharing of knowledge, ideas and support may also be leveraged in the future for "applied" and "realized value". By comparison, however, to date, just one third of P'14 teams (n=4) indicated that they collaborated on a project since joining Pathways. Limited collaboration within a network might imply insufficient trust and commitment in the network or community[28,29]. However, one may also argue that the structure and goals of the P'14 network fits closely with the notion of community discussed by Wenger (2011)[22], whereby the community comes together, and shares best practices and mutual support. Teams then return to their institutions to pursue their custom strategic goals independently. And yet, results indicate that those teams that elect to collaborate on projects, and particularly the two teams at the center of these collaborative efforts, have found added value in such a collaborative level of engagement, for such activities are entirely voluntary in nature. Additional research should be undertaken to understand more about these collaborative relationships, including the trust and commitment required to foster them, and the potential benefits that fostering such collaboration might afford individual teams and the Pathways community as a whole.

Within the Pathways network, we also examined the level of influence exerted by those individuals that are a part of, or connected to, the network. While some of these influencers were known by Pathways teams prior to joining Pathways, all influencers grew in the degree of influence they exerted over the teams. This implies that the Pathways program exposes teams to individuals that have relevant experiences and resources to share, and also that Pathways lends some legitimacy to these influencers, which builds trust. Additionally, Pathways fosters interactions with these influencers in a way that increases the likelihood of applied value. More specifically, presenters and advisors interact with participants in an egalitarian and constructivist manner. Rather than adopting a traditional transmission method of interacting with Pathways teams, these "experts" engage in a more constructivist approach that encourages participants to apply their knowledge. Essentially, participants attend online and in-person activities with their own implementation goal or challenge in mind; presenters provide short presentations, but, more

importantly, engage in discussions so that participants can contextualize and apply their learning[36].

Further analysis of the specific influential individuals illustrates that faculty members and specifically Pathways faculty members exert the greatest levels of influence across the network. In addition, eight individuals were highlighted as having the most significant influence across the network. Of these highly influential individuals, 5 are Epicenter staff, presenters and advisors, and 3 are from Pathways teams. This indicates that those experts that Pathways introduces to the teams, have expertise that aligns with the needs of the teams. It also points to the legitimizing impact associated with having these individuals assume the more traditional role of expert. Indeed this is evidenced in the fact that Epicenter staff, presenters and advisors experienced the greatest gains in influence rating after as compared to before joining Pathways. However Pathways team members that are highly influential across the network did not assume that more traditional expert role, but rather brought expertise to the network as peers and network members. Their influence and to some degree, the influence of other faculty, might be attributed to those drivers that impact collaboration including similarity of experiences, level of trust and the belief that they hold critical resources[27]. Indeed, similar people find it easier to communicate and predict each other's behaviors, which increases trust and reciprocity[37]. These findings lead the authors to hypothesize that while Pathways team members already exert influence on the network, the degree of influence exerted might be further increased by utilizing Pathways team members in the traditional role of expert. The Pathways program has already begun to test this hypothesis by recruiting Pathways members to share their expertise at Pathways online activities and in-person gatherings.

Institutional Outcomes: Pre to Post

Understanding how connections among the teams in the network have evolved and how individuals influence the network provides insights into some of the "potential value" provided by the network. Pre and post landscape analysis tool data provides insights into how Pathways teams' I&E ecosystems have evolved, and thus serves as an indicator of institutional outcomes and "realized value" in the network. A comparison of baseline data of I&E offerings provided by teams with their updated landscapes 18 months later illustrates statistically significant growth in Programs, Extracurricular activities (ECs), Spaces, Catalysts, and Champions with the largest gains in the number of ECs and Champions.

Correlational analyses suggested little to no relationship between the P'14 network of collaboration/influence and institutional outcomes. This lack of statistical significance may be due to the fact that, as previously discussed, institutions work independently on their own, custom strategic plans, coming together to share knowledge and not necessarily collaborate. The authors plan to perform additional research to understand the nature of the existing collaborations and how collaborations might be fostered among Pathways teams in future, and to what end. For example, maximizing collaboration among teams may provide the Pathways community with the benefits of a "networked improvement community", which emphasizes the importance of shared targets with a view to fostering greater focus across the entire community on critical issues[38]

This lack of correlation between collaboration and institutional outcomes may also be because the landscape tool was not completed to the fullest extent possible, since thorough completion of

the instrument involves multiple individuals and significant effort; anecdotally, teams expressed reluctance about updating their landscapes to Pathways staff and external evaluators. Pathways may thus leverage this information to refine the tool, focusing on key measures needed rather than an exhaustive, detailed inventory. The tool also fails capture projects currently underway that have not yet reached fruition. Given that the largest gains in the landscape were found on ECs and Champions, which have arguably the shortest time to implementation, it is likely that projects that have a longer time to implementation e.g. programs and spaces, are not yet fully represented by this data. Refinements to the landscape tool, may thus include the addition of features to capture projects underway, but not yet completed.

Linking Participation to the Network and Institutional Outcomes

The network data reviewed is based on the perceptions of the team leader, since the team leader responded to the SNA and thus served as a proxy for the entire team. Attendance data, however captures participation at the individual level. By reviewing this data, we learn that, on average, team leaders attend more in person and online gatherings than team members. This is likely connected to the fact that when team leaders apply to be part of Pathways, they commit 10% of their time to these efforts. Team leaders are also required to attend the Strategic Doing meetings, are strongly urged to attend peer advising meetings, and have historically served as the communication conduit for inviting other team members to peer advising meetings, topical workgroups and to in-person gatherings. Requiring or strongly encouraging team leaders to participate in these early online activities will of course directly impact their attendance at these specific events. However, drawing upon network theory, early engagement in online activities, and the perceived value that these activities provides, may result in self-perpetuating levels of participation among team leaders in other online activities[23,27]. By contrast, team members only receive direct invitations to webinars, and yet, team members' participation in webinars is not significantly higher than in other online activities. This would seem to illustrate that direct communications with team members does not appear to enhance levels of participation. It may be that team members simply do not have the same level of commitment as leaders, or identify with the common domain as significantly. It may also be that team members have not had sufficient experience of online activities to galvanize their understanding of the value these activities provide, which might in turn foster additional participation.

Participation data does, in addition, relate to patterns observed in the influencers in the network and the landscape data. We observe correlations with team leader attendance, but no correlations with team member attendance. Specifically, as the participation of team leaders increased in online activities, and more specifically in webinars and peer advising, so too does the size of the teams' influence network and specifically the number of faculty (and Pathways faculty in particular) that teams highlight as being highly influential. This is likely due to the fact that increased attendance continually exposes team leaders to a larger group of faculty and potential influencers, who reciprocally share resources and ideas, a process that engenders trust.

In a similar fashion, team leaders' attendance of online activities in general, and more specifically in webinars and peer advising, is significantly related to the growth in the number of I&E champions that teams have identified on their landscape. Again, through regular participation in the network, team leaders may experience the benefits of connecting with other members of the network, so may be encouraged to expand their network within their campus and across the broader ecosystem.

Looking at these data in the aggregate, it is reasonable to conclude that participation in Pathways results in promising outcomes for individual teams and their institutions. However, the network itself is young, and teams are working within academic institutions where progress is sometimes hampered by tradition and policy. Consequently, changes are hard won and slow moving. Gains observed at this stage can be characterized as evidence of immediate, potential and to some extent, applied, value. Indeed, preliminary analyses of interviews with P'14 teams point specifically to the potential value (i.e., a sense of legitimacy, belonging and support) that being part of the network brings. To assess the final, realized value of this community, it will be necessary to revisit members of this community over the coming years to learn the outcomes of longer-term projects such as new courses, programs and spaces.

Conclusion

This research utilized an innovative methodological tool—SNA— to visualize and understand the myriad relationships that facilitate knowledge creation and transfer within a community of practice. By tracking the network over time, SNA proved to be a useful tool to visualize and statistically measure the evolution of relationships from before joining Pathways to now, after joining Pathways. Thus, SNA represents a novel tool within this context that can be used by other network leaders in the post-secondary context to drive discussions with stakeholders, and to identify potential successes and opportunities for improving operations.

The results of the SNA suggest that Pathways has fostered the development of an early-stage community that is characterized by open communication, information exchange and support, around a common goal of integrating I&E into undergraduate engineering. As part of this community, teams are exposed to influential individuals that can positively impact their work on the integration of I&E. Faculty, and specifically Pathways faculty have the greatest influence across the network due to the relevant experiences and resources they bring, as well as the fact that they share characteristics and experiences in common with one another.

Being a member of this community appears to have resulted in an increase in the number of I&E offerings on Pathways' campuses, specifically, with regard to the number of institutional programs, extracurricular activities and spaces afforded to engineering students. By parsing out what membership in Pathways means, in terms of participation in programmatic activities, we learn that team leaders have higher rates of attendance than team members, and that leader attendance is positively correlated with the degree of influence exerted by other faculty, and increases in the number of institutional champions on campus (i.e., administration, faculty and staff who have the knowledge, influence and time to assist Pathways teams in their goals).

These data point to four primary conclusions:

One: Pathways has created potential value for participants in the form of a sense of legitimacy, belonging, and a network with which to exchange ideas and knowledge. This potential value seems to be related to significant growth in teams' I&E ecosystems. The value gained from participation also appears to foster ongoing participation and an increased sense of the utility of connecting with others in the network (be they other Pathways teams or experts) as well as others on Pathways' home campuses.

Two: Team leaders attend community-sponsored events more often than members. Therefore, while the community developed can, to some degree, help to sustain leaders in this work, it will be critical over the long term to offset team leaders' workload by finding ways to more fully engage team members, and members of their campus community, in these efforts.

Three: The work being undertaken by the Pathways community is not yet complete. Integrating I&E into undergraduate engineering is not an easy task. Many of the projects undertaken may not be complete for months or years to come. Additional research charting the ongoing evolution of teams' I&E ecosystems and the realized value created by this community is required.

Four: While the Pathways community is still early-stage, this research points to the promising nature of communities of practice as a means of tackling systemic, adaptive problems, and the use of SNA as a tool for measuring the success of such initiatives, particularly in the design of large-scale, team-based change initiatives.

Future Research

This study presents the preliminary results associated with the first cohort of Pathways to Innovation Program teams. While analysis of the trajectory and outcomes of this inaugural class provided critical insights into the degree to which networks can influence the growth of I&E ecosystems, a more longitudinal approach will better capture the outcomes for projects with a longer timeline, for example the development of a new curricular pathway or entrepreneurship center. Analysis of the broader data set of all 50 Pathways institutions will strengthen this study, as the small sample size limited our ability to conduct more robust analyses. Likewise, the inclusion of narratives as discussed by Wenger at al[34], both of participants and other stakeholders will provide additional qualitative insights into the findings. The authors plan to collect additional network data from P'14, P'15 and P'16 teams in the coming months, and to conduct case studies of individual institutions in future publications.

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APPENDIX A: Social Network Analysis (SNA) Instrument

PATHWAYS TO INNOVATION PROGRAM: NETWORK ANALYSIS – PAGE 1

Your Name		Role	(L) Lead or Co-Lead (M) Member	Pathways Institution	

INSTRUCTIONS: Select the **best** answer that captures the nature of your teams' collaborations regarding innovation and entrepreneurship (I&E) **BEFORE** joining and **NOW**, after joining the Pathways to Innovation Program. NOTE: Leave the row for your own team blank.

U.S. Region	Pathways Team	Please rate the extent of these interactions: BEFORE joining Pathways: Select only One Number (0-4)					NOW, after joining Pathways: Select only One Number (0-4)					If you selected (4) in the NOW, after joining Pathways column; please briefly describe the nature of the collaboration: Brief Description (if applicable)
		(0) No one met or communicated	(1) We communicated; but, never exchanged knowledge or ideas on I&E	(2) We shared knowledge or ideas on I&E, but never made plans to collaborate on a project	(3) We made plans to collaborate on an I&E related project	(4) We formally collaborated on at least one I&E related project	(0) No one met or communicated	(1) We communicated; but, never exchanged knowledge or ideas on I&E	(2) We shared knowledge or ideas on I&E, but never made plans to collaborate on a project	(3) We made plans to collaborate on an I&E related project	(4) We formally collaborated on at least one I&E related project	
Midwest	Michigan Technological University	0	1	2	3	4	0	1	2	3	4	
	University of Wisconsin, Milwaukee	0	1	2	3	4	0	1	2	3	4	
Northeast	Cooper Union for the Advancement of Science and Art	0	1	2	3	4	0	1	2	3	4	
	University of Massachusetts, Lowell	0	1	2	3	4	0	1	2	3	4	
	University of Pittsburgh	0	1	2	3	4	0	1	2	3	4	
Pacific	California Polytechnic State University, San Luis Obispo	0	1	2	3	4	0	1	2	3	4	
	University of California, Merced	0	1	2	3	4	0	1	2	3	4	
R. Mtn.	University of Nevada, Las Vegas	0	1	2	3	4	0	1	2	3	4	
Southeast	Howard University	0	1	2	3	4	0	1	2	3	4	
	Tennessee Technological University	0	1	2	3	4	0	1	2	3	4	
Southwest	New Mexico State University	0	1	2	3	4	0	1	2	3	4	
	Texas A & M University	0	1	2	3	4	0	1	2	3	4	

PATHWAYS TO INNOVATION PROGRAM: NETWORK ANALYSIS – PAGE 2

Please list up to 10 individuals that have **most influenced** your thinking about increasing opportunities for innovation and entrepreneurship (I&E) in undergraduate engineering education on your campus. Select the **best** answer that captures the nature of this individual's influence **BEFORE** joining and **NOW**, after joining Pathways. NOTE**:** We are interested in individuals who work both *inside* and *outside* of your home institution.

Select roles from this list:
a. Faculty Member (incl. Adjunct, Non-Tenure or Tenured)
b. Univ. Leader (incl. Administrator, Staff or Program/Center Director)
c. University Innovation Fellow (UIF) or Leadership Circle member
d. Other Graduate or Undergraduate student
e. Epicenter staff, presenters and advisors**
f. Industry representative
g. Other

First and Last Name	Role (a-g)	Does this person work at your home institution? Yes	No	Please rate the strength of the interaction: BEFORE joining Pathways Select only One Number (1-5): Not at all influential	Slightly influential	Somewhat influential	Very influential	Extremely influential	NOW, after joining Pathways Select only One Number (2-5): Slightly influential	Somewhat influential	Very influential	Extremely influential
1.		Y	N	1	2	3	4	5	2	3	4	5
2.		Y	N	1	2	3	4	5	2	3	4	5
3.		Y	N	1	2	3	4	5	2	3	4	5
4.		Y	N	1	2	3	4	5	2	3	4	5
5.		Y	N	1	2	3	4	5	2	3	4	5
6.		Y	N	1	2	3	4	5	2	3	4	5
7.		Y	N	1	2	3	4	5	2	3	4	5
8.		Y	N	1	2	3	4	5	2	3	4	5
9.		Y	N	1	2	3	4	5	2	3	4	5
10.		Y	N	1	2	3	4	5	2	3	4	5