Collective Impact in Action: Implementation and Evaluation of a Multi-Institutional Network of Change Makers

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ABSTRACT

In this paper, we provide an overview of the Pathways to Innovation Program (Pathways), a faculty development and institutional change initiative designed to address the adaptive challenge of integrating innovation and entrepreneurship (I&E) into undergraduate engineering, nationwide. In particular, we build upon earlier papers that describe the Pathways program design and outcomes, by discussing how a collective impact approach was utilized to guide the programmatic and evaluation design of Pathways. Our goal is twofold: (1) to help inform the work of future adopters of the collective impact approach, by providing one of the few documented examples of collective impact program and evaluation design, and (2) introduce the cases in this special issue as demonstrable outcomes of the collective impact approach. Teams supported by the Pathways program were invited to submit manuscripts capturing exemplary contributions to I&E in engineering education (cases) that resulted from their work as part of Pathways. Nine 2500-word papers (cases) were accepted from institutions. These cases reflect a wide range of curricular, extra-curricular, programmatic, and institution-wide change efforts aimed at increasing access to I&E among undergraduate engineering students. Each case demonstrates one of two types of outcomes: 1) student exposure and engagement and 2) institutional change. This issue contributes to the innovation and entrepreneurship education literature by capturing the successes and challenges associated with a wide range of implementation efforts, including the impact of I&E infused engineering education on students, faculty and in certain instances the institutional culture as a whole.

Key words: Epicenter, Pathways to Innovation, institutional change, faculty development, collective Impact, evaluation

INTRODUCTION

The Pathways to Innovation program (Pathways) was designed as the institutional change and faculty development strategy for Engineering Pathways to Innovation (Epicenter), a center funded by the National Science Foundation from 2011 to 2016 with a mission to empower U.S. undergraduate engineering students to bring their ideas to life for the benefit of our economy and society. Pathways achieved this mission by convening fifty institutions (see Appendix A), with a team of faculty and administrators from each institution (from here-on referred to as teams), around the common goal of integrating innovation and entrepreneurship into undergraduate engineering.

In today's competitive, global economy, companies are able to inexpensively outsource high-skilled creation, and organizations create value through the innovativeness of their workers.[1,2] Engineering students can thus be better prepared to contribute to this competitive, global economy through exposure to innovation and entrepreneurship, and the skills imparted through that exposure including flexibility, resilience, creativity, empathy, effective communication, problem solving, multidisciplinary teamwork, using diverse contexts and constraints in design decisions, and the ability to innovate.[1] These skills improve students' job prospects and their performance in the workplace, and are highly sought by employers.[3]

In addition to aligning engineering education with workforce needs, the integration of entrepreneurship can prepare students to start their own companies based on their own innovations, which can positively contribute to the US economy.[4,5] Entrepreneurship education can also boost retention due to the increased intellectual and personal engagement that students develop working on their own projects.[6,7] Given that retention is the most effective strategy in increasing graduation rates, entrepreneurship education may also play a role in graduating sufficient numbers of STEM students to ensure the US remains globally competitive.[2,8]

Faculty across the country are increasingly recognizing the value of entrepreneurship education, as evidenced by the growth in the number of courses being taught, from single digits to thousands nationwide.[9] Despite this growth, a more inclusive, substantive, sustained, and institutionalized approach must be adopted to transition from individual programs, fostered by a single faculty champion and catering to select students in select disciplines, to entrepreneurial educational opportunities open to all students across the entire campus, and supported and sustained by multiple faculty and administrators across the institution.[10,11]

In this paper we build upon earlier articles that describe the Pathways program design and outcomes[12-14], by discussing how a collective impact approach was utilized to guide the programmatic and evaluation design of Pathways. Our goal is to help inform the work of future adopters of the collective impact approach, for while collective impact as a conceptual approach and framework is

well documented, there is scant literature capturing details of effective programmatic and evaluation implementations. This paper also introduces the cases in this special issue as demonstrable outcomes of the collective impact approach.

PATHWAYS PROGRAM DESIGN

Prior to its design, Pathways was envisioned as a program that would engage multiple institutions in the development of a more sustained and institutionalized approach to the integration of innovation and entrepreneurship education, in order to maximize student exposure and engagement.

The Pathways design process began with a literature review documenting best practices for both faculty development and institutional change. This literature review was then used to guide the program design.[15] In brief, the findings indicated:

- Peer network with interactions over a sustained period of time for the exchange of information, to provide support and foster systemic change.
- Change efforts must meet the needs of each unique campus.
- Exposure to implementable models using adult learning theory and instructional design.
- Collegial, collaborative and inclusive approach to campus engagement.
- Show success in the short and long term; provide regular reports to boost engagement.
- Staff have content knowledge and leadership skills to support and facilitate change; adequate levels of staffing.
- Plan for evaluation at every stage including an initial needs assessment; build efforts around a common theory of change.

The literature review provided important guiding principles for program design. From there a framework was sought to meaningfully integrate these individual design elements into a single, cohesive programmatic approach. The goal of Pathways was to foster a more sustained and institutionalized approach to the integration of innovation and entrepreneurship education across multiple campuses, nationwide. The type and scale of change being sought was complex and significant. The challenge may thus be described as adaptive i.e. there is no predefined way to address it and no single institution can solve it alone, but rather institutions must come together to develop a solution.[16,17] A *collective impact* approach was subsequently identified as the important conceptual framework for the program design.

The collective impact approach emphasizes the importance of moving beyond isolated impact, where one organization develops a solution. While an isolated impact approach can be effective for technical challenges, where a problem is well defined and single organization may be better

positioned than any other to solve it, it is not as effective when a problem is complex and adaptive. For such problems it is critical to bring together multiple stakeholders in order to innovatively develop solutions, change their behavior and learn.[17] When designing a collective impact approach, 5 conditions have been shown to be critical to the success of the initiative[16]:

1. A Common Agenda
2. Mutually Reinforcing Activities
3. Continuous Communication
4. Backbone Support Organization
5. Shared Measurement Systems

Before a collective impact initiative can begin, three preconditions must be met: "…an influential champion, adequate financial resources, and a sense of urgency for change."[18]. As the directors of Epicenter, Stanford University and VentureWell recognized the critical need for change in engineering education and articulated this sense of urgency. This sense of urgency was in turn recognized by the National Science Foundation as indicated by their funding of Epicenter. These three institutions, known across the field of engineering and entrepreneurship education, were thus positioned as the influential champions of the initiative. Having met these preconditions and by adopting a collective impact framework, along with best practices from both the faculty development and institutional change literature, our goal was to optimize and accelerate the outcomes for each of these institutions beyond what would happen on campuses without these interventions. The design and roll out of the Pathways program is outlined below, and illustrates in detail how we aligned with a collective impact framework in order to achieve this goal.

A Common Agenda

Using a collective impact framework, it is critical that all participants in the initiative have a common understanding of the problem and a shared approach for solving it.[18] Adding to that, the literature review indicated that the initiative be of sufficient duration to foster meaningful peer interaction and permit adequate time for systemic change; in an institutional context, change can take a significant amount of time. Pathways was thus designed to be an inter-institutional, peer-based network of approximately 400 individuals, organized as institutional teams of faculty and administrators, across a total of fifty institutions. There have been three cohorts of Pathways teams: 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). Teams applied to become part of the program and were accepted based on their commitment to the common goal of integrating innovation and entrepreneurship into undergraduate engineering, their desire to engage in a peer network, the availability of support from campus leadership including time for the team leader to work on this initiative, and the team leader's leadership and

content experience. Funding was not a motivator for teams that applied because no funding was provided, other than travel funds to attend Pathways convenings.

Over the course of one and a half to two years, Pathways provided opportunities for teams to establish communication networks whereby knowledge and ideas on I&E could flow readily between teams, and between teams and "experts," that served the role of advisor, presenter or Epicenter Staff. Teams advanced towards their common agenda through these in-person and online network opportunities, which were designed to foster a sense of community, experientially further their expertise in I&E, and were organized around a shared approach that (1) used a landscape analysis tool for teams to catalog existing campus assets in I&E, (2) adopted an agile approach to strategic planning called strategic doing, and (3) referenced the work of Ruth Graham and the need for a systemic approach to change that integrates 5 success factors: student led efforts, leadership support, university led efforts, departmental culture and the off-campus ecosystem.[19]A video describing Ruth Graham's 5 success factors may be viewed here https://youtu.be/7kKH9mv1LP0. The landscape analysis tool, the strategic doing process and Graham's 5 success factors together encouraged teams to adopt a systemic approach to developing their context-specific strategic plan. Additional information about the networking opportunities, the landscape analysis and strategic planning approach are discussed below.

Mutually Reinforcing Activities

When using a collective impact framework, it is critical that, even though participants are working towards the same goal using the same approach, they are empowered to realize that goal in different ways. The findings of the literature review underscored this need, emphasizing that change efforts meet the needs of each unique campus. The literature review also emphasized the exposure to implementable models using adult learning theory and instructional design. To that end, teams developed their own custom strategic plan that leveraged the assets and filled the gaps identified using the landscape analysis tool. The landscape analysis tool provided a way for teams to catalog existing I&E assets on their campus including courses, programs, and extra and co-curricular offerings. Physical spaces that foster I&E learning were also captured, as were leadership initiatives and strategies either from central or departmental administration that encouraged and supported I&E offerings (e.g. incentives for new course or program development, faculty professional development, or favorable policies including tenure and promotion, and intellectual property). Finally, teams document the champions that might have the skills, knowledge, enthusiasm and time to assist the team with their efforts (see Appendix B)[12].

Team leaders were first exposed to the landscape tool and strategic doing–the agile strategic planning approach utilized in Pathways– during the *Team Leader Gathering*.[20,21] During this one and a half-day event team leaders also started to be integrated into the Pathways community through

activities that broke down social and professional barriers while forging connections with the other Pathways team leaders. Upon their return to campus, team leaders were required to work with their team, and the broader campus, as needed, to use the landscape tool to systematically catalogue their assets. The landscape tool is a Google Sheet with multiple tabs that can be shared with and completed simultaneously by multiple campus stakeholders. This feature ensured multiple stakeholders from across campus engaged with the program early, and collectively contributed to a more complete understanding of the campus ecosystem. This inclusive process set the stage for future cross-campus collaboration and also provided teams with a robust sense of campus assets that could later be utilized in their strategic plans.

Following the completion of the landscape tool, each institutional team attended the *All Team Meeting*. This two and a half day convening: (1) provided teams with an opportunity to work on their institution-specific strategic plans using the strategic doing process, (2) engaged teams in a process of learning about and contextualizing best practices for integrating I&E, all while, (3) integrating attendees into the Pathways community through activities that fostered connections with other teams and speakers, and demonstrated the value of the community through a process of sharing approaches and challenges to implementation.

Strategic Doing is an agile process for developing and implementing strategy in loose networks, making it well suited to an initiative that requires engagement and collaboration, across departments and outside of hierarchies.[21] In Pathways, teams began the Strategic Doing process with the design of an appreciative question, which articulated their vision for what their campus would look like once innovation and entrepreneurship have been integrated into undergraduate engineering. Team members next listed all assets they might contribute to realizing that vision, a process they were primed for by the earlier completion of the landscape tool. This asset-based approach, in pursuit of a goal framed in an appreciative or positive way, has its roots in the appreciative inquiry approach to facilitation, that focuses on the strengths, successes and potentials, as opposed to a deficit-based approach, which can limit transformation.[22]

With the foundational knowledge of this asset-based process in hand, outside experts or members of the Pathways community then shared with the teams some best practices for integrating I&E. Departing from the transmission model of teaching, best practices were presented in ignite-style presentations that lasted no more than 5 minutes. Each best practice presenter then hosted a table conversation with attendees. The presentations introduced each best practice, and the conversations provided time and space to process as a group, and individually contextualize each practice, thus paving the way for custom implementations. With these best practices as a backdrop, teams gathered their assets, and commenced the process of linking and leveraging assets to design a unique strategy to realize their vision.[22]

The diversity of approaches produced by this approach can be seen in the case studies that follow from different Pathways institutions. Each case study provides insights into either a single I&E initiative developed and implemented on each campus, and in two cases, the way in which the team approached redesigning their entire campus ecosystem.

Continuous Communication

When adopting a collective impact approach, continuous communication is essential in order to promote trust, foster and share the realization of objectives, and maximize motivation. The literature review findings echoed these practices by highlighting the necessity of regular reports to boost engagement and checking in frequently to demonstrate success. Additionally, the literature review highlighted the essential role that peers play in exchanging information and providing support to change efforts, as well as the importance of utilizing an approach that is collaborative, collegial and inclusive. The Pathways program embraced these recommendations by developing a full schedule of online and in-person activities to realize these best practices:

- *Strategic Doing check-in calls* took place on a monthly cadence for the first 6 months and happened every four to six months thereafter. During these calls, teams met in peer groups of three to five teams with a Pathways staff member; teams self-selected their peer group at the All Team Meeting using a set of suggested match-making criteria that included geographic location, level of experience, similar or different strategies being pursued, size and type of institution, entrepreneurial mindset or venture creation focused, and same or complementary areas of expertise. During these calls, teams provided an update to staff and their peer group using a strategy map, which served as a snapshot of their plans and progress. Teams also discussed future goals and challenges associated with their implementation. This approach provided teams with a sense of accountability, and a forum for exchanging ideas, supporting each other and celebrating short-term successes. It resulted in a sense of inclusivity, trust and community among the peer group, and yielded forward momentum. Leaders were required to attend these meetings.

- *Webinars* occurred online each month and were 60 min sessions in which one to five leading experts engaged teams on a particular topic. Topical information helped teams advance their goals (e.g., Assessment or Fundraising), and interactivity was encouraged to create the sense of a social presence, help attendees contextualize the approach and ultimately grow the sense of value and trust in the network. Attendance was voluntary; team members and leaders received an invitation to attend.

- *Peer Group Advising* sessions were held online each month. They commenced when teams joined the program and lasted for a total of 6 months. Advising meetings were attended by

the Pathways peer groups and an expert advisor that had extensive experience starting and running an entrepreneurship program or center. By using a process of sharing challenges and reciprocally tapping into the collective wisdom of the group, these meetings provided just-in-time support and advice to participants and helped teams form connections and cultivate a sense of community with their advisor and peer group. Team leaders were strongly encouraged to attend and invite team members that might find the meetings useful.

- *Topical Workgroups* took place online and were comprised of small groups of participants addressing a common challenge, based on their institution's specific needs. The groups met approximately four times spanning a total of four to six months, were action-focused and were led by facilitators with significant expertise on the topic in question. Team leaders were invited to apply to join topical work groups of interest and were encouraged to invite team members that might benefit. This approach provided teams with the ability to dive deeply on a topic of interest and grow connections with peers and experts on the topic in question. Participation was voluntary.

- *The OPEN Conference* is an annual conference sponsored by VentureWell. Each spring, attendance at this conference provided Pathways teams with the opportunity to reconnect with each other in person and share best practices and challenges. Additionally, teams joined a broader community of approximately 500 educators, all motivated to share and learn best practices for integrating I&E into post-secondary education.

- *Workshops*: These two-day, hands-on workshops were hosted by a Pathways institution on their own campus. They covered topics identified as critical to helping teams integrate I&E on their campuses and provided an opportunity to experience I&E implementations in a campus context. The hosting process increased the visibility of the Pathways work across the host campus and thus provided an opportunity for the host campus to influence and engage a broader group of campus stakeholders. Team leaders and members were encouraged to attend these gatherings.

Backbone Support Organization

The successful creation and management of a collective impact initiative requires a backbone organization to coordinate the entire initiative, maintain engagement, all while leading from behind so that participants can chart their own strategy and own their successes.[18] In a similar way, the literature review emphasized that staff have sufficient time, content knowledge and leadership skills to support and facilitate change. When designing the leadership support systems for Pathways, it was clear that leadership was needed at two different levels: (1) the program level and, (2) the institution level.

At the program level i.e. the Pathways program, Epicenter served the role of the backbone organization. Epicenter thus needed to, "guide vision and strategy, support aligned activities, establish shared measurement practices, build public will, advance policy, and mobilize funding."[23] To that end, Epicenter had a dedicated staff for the project with expertise in strategic planning, program and instructional design, research and evaluation, communications, IT support systems, grant making, event management and a strong network of entrepreneurship education practitioners and researchers. This collective expertise meant Epicenter was well positioned to design and manage the program vision, model, tools and in person and online program activities, drawing upon proven practices in strategic planning, instructional design and entrepreneurship education and policy; provide funding to teams to attend and host in-person activities to grow expertise, advance network connectedness, and share and disseminate best practices; host and support the technological infrastructure needed to share best practices online both synchronously and asynchronously; collect and analyze formative data to inform pivots needed to the program model for maximization of outcomes, and establish and oversee the program's shared measurement practices.

At the institution level, each institution was required to assemble a team headed up by a single team leader or two co-leads. The team leaders were selected, not for their positional leadership ability, but rather for their proven ability to influence others without authority, including peers and institutional leadership. They were also required to dedicate 10% of their time to work on the Pathways initiatives and engage in program activities, and provide a letter from their supervisor in support of both the work and time that must be dedicated to the Pathways initiative. The team leader committed to leading the work of an institutional team that was comprised of faculty and administrators from different departments and schools. This diverse representation from across campus meant teams had a number of diverse assets from which to construct their project plans. Throughout the life of the program, team leaders and members were exposed to and engaged in strategic doing, a process which emphasizes distributed leadership across a loose network, and the skills needed to engage others in their strategic efforts. This meant the entire team was positioned to grow engagement in the Pathways program, leveraging different stakeholders from across campus. As such, team members also assumed a leadership role in these efforts.

Shared Measurement Systems

Under the collective impact framework, it is critical to measure outcomes in a manner that is consistent across all participants. This approach ensures that all participants are pursuing and making progress towards the shared vision, and provides a sense of accountability across all participants.[18] Pathways adopted what Kramer et al refer to as an Adaptive Learning Systems approach, which is characterized as a, "...facilitated process that establishes comparative performance metrics,

coordinates [organizations'] efforts, and enables them to learn from each other. Benefits include improved alignment of goals among the different organizations, more collaborative problem solving, and the formation of an ongoing learning community that gradually increases all participants' effectiveness."[24] The approaches for measuring outcomes were as follows:

- *Landscape analysis tool*: The completion of this tool provided teams with a list of assets they might leverage in their work. However, it also provided teams with an understanding of the current gaps or needs on their campus. Additionally, this tool provided all teams with a baseline measure of current campus activities against which teams could measure their progress.

- *Strategic doing process*: The strategic doing process and the schedule of check-ins for teams not only provided teams with an accountability and planning mechanism, the completion and submission of strategy maps also provided teams with a tool for measuring their ongoing progress. These check-ins tracked the teams' learning with regard to effective I&E offerings, mechanisms used for institutional change, and the overarching expansion of I&E offerings on campus.

In addition, the literature review underscored the need to plan for evaluation, including a needs assessment at the outset, and the utilization of a program logic model for the design of the evaluation plan. In Pathways, the design of common outcome measures outlined above and the evaluation plan were both guided by the logic model outlined below. This following section outlines how the collective impact framework was used to guide the evaluation design. For readers seeking a more detailed breakdown of the types of evaluation data collected, qualitative and quantitative methods used and outcomes of the evaluation effort, please refer to our earlier papers on this topic.[12,14]

PATHWAYS EVALUATION DESIGN

The evaluation of the Pathways program was also directly guided by the collective impact framework. Some elements of the evaluation were planned during the proposal phase. However, an actionable evaluation plan was not developed until after the program design (described above) had been completed. The evaluation design involved three key components: (1) Collaboration of the evaluation team and program staff, (2) The creation of a logic model and (3) alignment of the findings to the initiative's stages of development. In the sections that follow, these aspects of the evaluation design are described. However, as stated above, although the formative evaluation of the Pathways program was critical to Pathways program success, we do not describe specific Pathways program outcomes in this paper. These findings are published elsewhere.[12–14]
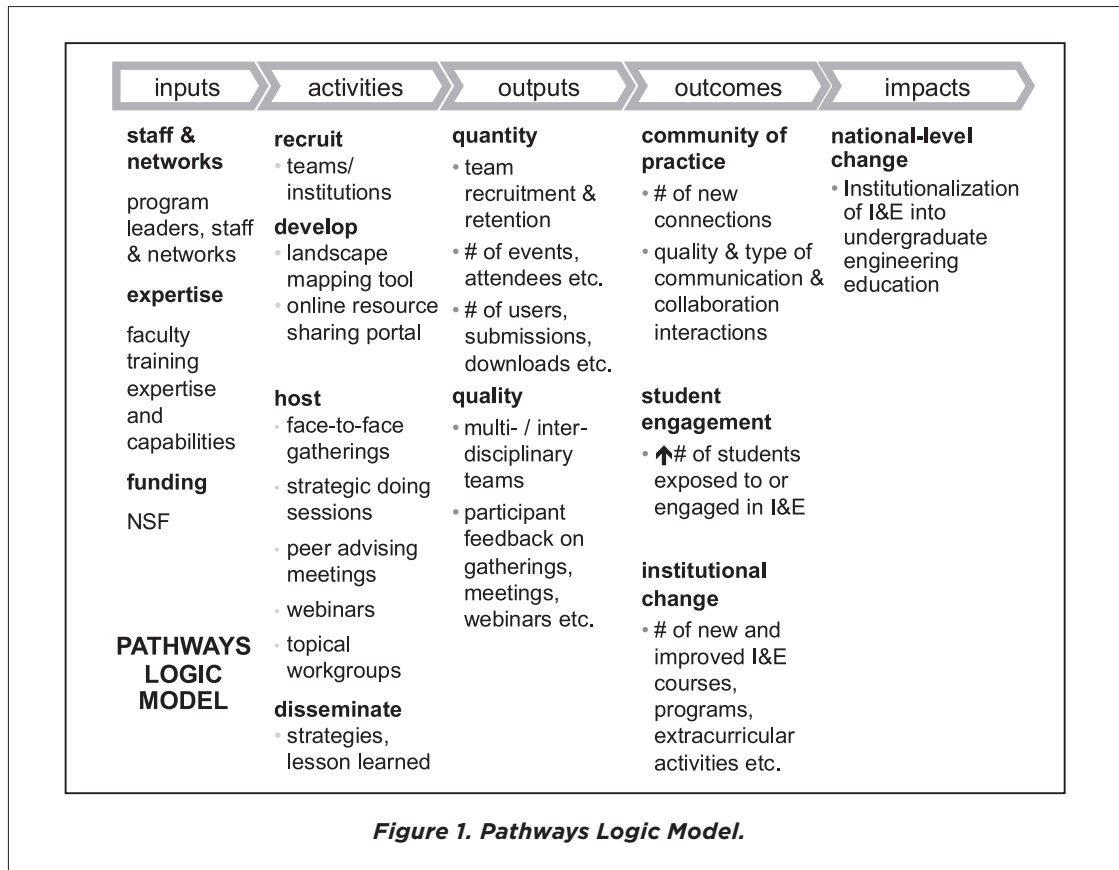
Collaboration of the Evaluation Team and Program Staff

Once the program design was complete, the evaluation and program staff worked collaboratively to align elements of the evaluation to the collective impact framework and program design via the creation of a logic model (as described below). This collaborative partnership facilitated consistent, accurate and well-reasoned measurement (i.e., as justified by the program logic). This fostered buy-in from participants because the benefits of the learnings to be yielded were clear, and the burden on participants intentionally minimized by the careful integration of evaluation into the program design.

Pathways Logic Model

The creation of the Pathways logic model (see Figure 1), a graphical representation of the program design, was shared for review and feedback with program staff, until all elements were agreed upon. The Pathways logic model incorporates the five core components of a traditional logic model: inputs, activities, outputs, outcomes and impacts, carefully linking desired outcomes with program activities.[25,26] Additionally, the five logic model components were aligned to the five core conditions of the collective impact framework, as described below.

inputs	activities	outputs	outcomes	impacts
staff & networks program leaders, staff & networks **expertise** faculty training expertise and capabilities **funding** NSF **PATHWAYS LOGIC MODEL**	**recruit** • teams/ institutions **develop** • landscape mapping tool • online resource sharing portal **host** • face-to-face gatherings • strategic doing sessions • peer advising meetings • webinars • topical workgroups **disseminate** • strategies, lesson learned	**quantity** • team recruitment & retention • # of events, attendees etc. • # of users, submissions, downloads etc. **quality** • multi- / inter- disciplinary teams • participant feedback on gatherings, meetings, webinars etc.	**community of practice** • # of new connections • quality & type of communication & collaboration interactions **student engagement** • ↑# of students exposed to or engaged in I&E **institutional change** • # of new and improved I&E courses, programs, extracurricular activities etc.	**national-level change** • Institutionalization of I&E into undergraduate engineering education

Figure 1. Pathways Logic Model.

- *Inputs:* This component of the logic model aligned most closely with the preconditions for collective impact initiatives of an *influential champion* (Stanford and VentureWell) and *funding* (as provided by NSF). Additionally, it aligns with the *common agenda* and *strong backbone organization* core conditions. The staff, networks and experts were convened by VentureWell (the backbone organization), all around the common agenda of integrating innovation and entrepreneurship into I&E. Through an evaluation lens, the role of the backbone organization is also to design and reinforce tool use and adoption for *shared measurement*. In this way, the evaluator worked closely with the backbone organization to ensure that data were collected, analyzed and results disseminated in a timely fashion to the appropriate audiences over the life of the Pathways program.

- *Program Activities:* This component aligned with the *continuous communication*, and *mutually reinforcing activities* core collective impact conditions. In the case of Pathways, this condition was strengthened and reinforced by the backbone organization leadership and staff by fostering the exchange of ideas, strategies and solutions between teams (e.g., peer groups meetings, webinars, topical workgroups), and teams and experts. These activities were designed to lead to the accomplishment of the desired program outputs, outcomes and (eventually) impacts. Perceived efficacy of these different activities were captured utilizing focus groups and an annual survey instrument.

- *Outputs*: Referring to the completed products of internal activities, outputs tend to be highly quantifiable. In Pathways, they included quantity and quality of program activities (i.e., types, levels and target audience of services delivered) and participation-levels for each. Documentation involved tracking participant attendance at events that align with the core conditions of *continuous communication* and *mutually reinforcing activities* (i.e., webinars, workshops, in-person gatherings).

- *Outcomes*: Meeting or exceeding your target outputs is expected to contribute to the successful completion of desired program outcomes. In Pathways, we identified three overarching desired outcomes: 1) evidence of a community of practice, 2) increased student engagement in I&E and 3) evidence of institutional change (see Figure 1). The formation of a community of practice (i.e., exchange of ideas, knowledge and/or resources) was measured via a retrospective pre-post social network analysis tool.[13] The tool identified the number of new network connections made and the types of inter-team communications and collaborations (e.g., exchange of knowledge or ideas, formal partnerships etc.). Student engagement was measured in terms of student enrollment numbers, participation and attendance at events and measures of institutional change were captured in terms of growth in the number of institutional offerings. Teams shared how they had set and accomplished strategic doing objectives (i.e., milestones achieved

per team), utilizing the landscape analysis tool to capture the creation, adaptation or adoption of new and/or improved courses (e.g., capstone design courses), co- and extra-curricular programs (e.g., competitions, pop-up classes), institutional or departmental programs (e.g., majors, minors, certificates) and physical spaces (i.e., makerspaces, innovation centers), along with student enrollment and attendance in documented activities. The program staff ensured participating teams completed the landscape mapping tools (see description above) at two time points 1) upon program entry in order to capture baseline data, and 2) eighteen months later to assess gains over time. The evaluation team then collected and analyzed these data as well as any anticipated or unanticipated outcome data via interviews, quantitative survey data, site visits to Pathways institutions, and regular check-in calls with the Pathways team.

- *Impacts*: The ultimate, desired impact (or *common agenda*) of Pathways was the institutionalization of I&E. In this context, institutionalization refers to putting into place new practices or procedures, or significantly modifying existing practices and procedures such that the institutional changes that have occurred are likely to remain in effect even if the originating local champion(s) were to leave. This *common agenda* remained at the forefront of the program design process and was reinforced in the logic model and evaluative design processes to ensure continued progression toward that overarching goal. Evidence of institutionalization was captured using the Policy, Funding and Partners, and Positions sections of landscape analysis tool.

Through the alignment of the program's logic model to the program design and collective impact core conditions, the program and evaluation team could better understand how program elements, and by extension, collective impact conditions, effected program outcomes (Table 1).

Alignment to the Initiative's Stages of Development

This framing is critical, as it recognizes the need for evaluation to evolve as the program evolves.[27] This approach acknowledges the need for evaluation design to evolve throughout the life cycle of the initiative and allows for the creation of a cycle of continuous improvement, providing evaluation feedback and insights to inform changes to program design or reinforce best practices on an ongoing basis. There are three such stages: developmental, formative and summative. These stages are described below, incorporating the various logic model components and outlining the ways in which the data collected were analyzed and used to provide ongoing feedback to program staff for continuous program improvement.

- *Developmental evaluation:* In this phase of the project, the initiative was highly exploratory and several project components were still being designed or were under development.[28] During this phase, uncertainty and frequent iterations to program design were probable. Program staff also

found themselves facing new questions and challenges requiring adjustments / pivots to the original evaluation design and/or logic model. The principle evaluation question at this stage of the Pathways initiative asked about early progress (i.e., what appears to be working well and where is there early progress?). Early evidence of success was collected around fidelity of implementation[29] and participation engagement. Measuring fidelity helped program staff understand the extent to which they were adhering to the original program plan and to acknowledge when, why, and to what extent they deviated from the original plan. These data were collected by tracking participant attendance at Pathways sponsored events, via focus groups / interviews with participants and measuring the percent of program tasks that were met or completed. This feedback was then shared with program staff so that they could make early adjustments to program design including those that might have affected program recruitment, implementation and/or knowledge sharing strategies.

- *Formative evaluation*: This second phase provided staff with near immediate feedback on the success of project activities, allowing them to further iterate on program design in an informed manner. The evaluation question at this stage of the collective impact initiative was "how can the initiative enhance what is working well and improve what is not?" The types of data collected at this stage related to event tracking w/ participant observations, participant attendance at events, regular check-in calls with program staff, participant post-event feedback (i.e., brief surveys, interviews and/or focus groups) and an annual end of year survey. The Pathways evaluation team led the formative assessment of faculty trainings and interventions primarily via feedback forms administered to participants immediately after training events and workshops. Data collection and analysis measured gains relative to specific learning objectives, participant satisfaction-levels, immediate reactions to events, leading indicators of progress towards program outcomes.

- *Summative evaluation*: This final phase of Pathways evaluation helped to determine the extent to which the program achieved its overall stated objectives and desired outcomes within the projected timeline. The broad evaluation question at this stage of the Pathways initiative asked "what difference(s) did the collective impact initiative make?" Data collected at this stage of the intervention provided evidence of outcomes achievement (i.e., evidence of a community of practice, student engagement and institutional change). Additionally, we learned through focus groups and interviews that this collective impact initiative provided site members with forward momentum via an accountability and goal oriented approach[30] along with "...a sense of legitimacy, belonging, and a network with which to exchange ideas and knowledge."[13]

Since collective impact is a framework and not a prescriptive approach for program and evaluation design, an iterative and collaborative approach, using a logic model as a guiding framework,

was necessary. This approach provided the guide rails to ensure the program and evaluation design remained aligned to the framework, while leaving the space to iterate based on new learnings and the evolving needs of the community.

PERCEIVED UTILITY OF THE COLLECTIVE IMPACT APPROACH

Table 1 on the next page serves to crosswalk all that was discussed above. It demonstrates how the Pathways program design and evaluation approach 1) were informed by the five core conditions for successful implementation of a collective impact initiative and 2) were mapped to the literature of best practices for faculty development and institutional change initiatives. The table also demonstrates how program design connects to each teams' lived experience and their perception of value of programmatic elements, based on the feedback provided by participants as captured by the evaluation team via documented written reports.

CASE STUDIES IN THIS ISSUE

Pathways not only supported the creation of a more cohesive community of practice around I&E in engineering education it also catalyzed significant increases in terms of the number of programs, extra-curricular activities and dedicated I&E spaces on partner institution campuses across the country[13] The articles in this issue speak to the variety of novel, impactful, sustainable and compelling approaches that Pathways teams took to increase access to I&E among undergraduate engineering students on their campus; and to the way in which the Pathways program, through its use of the collective impact framework, helped to facilitate the wide-variety of change efforts. The types of papers in this issue help illustrate the successful outcomes of the Pathways program at the institutional (five articles) and student (four articles) levels. The institutional change articles are focused on multi-pronged approaches to changes in I&E accessibility on campus, whereas the student- exposure and engagement articles focus on the enhancement and refinement of programs, initiatives and courses aimed at incorporating I&E into the undergraduate engineering experience. Each article describes a unique perspective and "pathway" to change, giving the reader a wide range of options to choose from when designing similar efforts on their own campus.

Institutional change

Clark et al. (this issue) leveraged the Pathways program's strategic planning process to address the University of Pittsburgh's I&E needs by taking a multifaceted approach targeting four P's:

Table 1. A Crosswalk of Pathways Program and Evaluation Designs Using the Collective Impact Framework.

Collective Impact Conditions	Literature Review Recommendations	Program Design	Evaluation Design	Teams' Perception of Value
A common agenda	Peer interaction over a sustained period of time to foster systemic change; network outside of the campus to offer support.	Sustained engagement of 2 years around the common goal of integrating I&E into undergraduate engineering, using a systemic approach. Institutions form part of a community of practice of a total of 50 institutions.	Multi-year annual survey of program participants assessing engagement along with bi-annual semi-structured interviews.	Consistent engagement across all institutions around value of incorporating I&E into engineering education. Wide variation in terms of the processes by which change is implemented and approaches manifest, due in large part to team composition and site-level institutional factors.
Mutually reinforcing activities	Change efforts meet the needs of each unique campus; exposure to implementable models using adult learning theory and instructional design.	Teams complete an initial landscape assessment; the assets identified form part of each institution's custom strategic plan. Teams are exposed to models in a way that fosters implementation.	Review of landscape analysis tools and strategic planning documents for alignment within and/or across institutions. Bi-annual semi-structured interviews on progress toward stated implementation goals.	Participants found value in the foundation for planning that the landscape tool provided.[12] shared articulation of implementation plans, including helpers and barriers to stated goals, as well as access to resources provided by the backbone organization on pre-existing successful implementation models.
Continuous communication	Peers, for exchange of information and support to promote change; collegial, collaborative and inclusive approach to campus engagement; show success in the short and long term; provide regular reports to boost engagement.	Ongoing online and in-person convenings provide a forum for idea exchange and peer support. Agile strategic planning process promotes an inclusive approach to growing campus teams, emphasizes "quick wins" and longer-term outcomes, and engages teams in regular progress updates with other teams for accountability and support.	Multi-year annual survey and semi-structured interviews assessing the value of peer exchange and collaboration	Strong value associated with the goal-oriented and accountability approach fostered by strategic doing, shared learning and exchange of ideas with peers (in particular via in-person convenings) who are working on change efforts at institutions with similar structural characteristics (i.e., institutional size, student populations, leadership structures etc.) [30] The dedicated time off campus to ideate and brainstorm ideas with fellow faculty members was consistently and highly valued across teams.[14]
Backbone support organizations	Staff have content knowledge and leadership skills to support and facilitate change; adequate levels of staffing.	At the institution level, each Pathways team is headed by a team leader with content knowledge, leadership skills and time dedicated to the program. At the program level, a dedicated, experienced staff supports the community's efforts.	Multi-year annual survey assessing perceived and realized value of dedicated institution-based Pathways leaders, and backbone organization staff and resources on institutional change efforts.	Participants emphasized the critically important legitimizing effect of having established leaders in the I&E field championing their institutional change efforts.[13]
Shared measurement systems	Plan for evaluation at every stage including an initial needs assessment; build efforts around a common theory of change.	Teams begin with an in-depth inventory of their school's needs and assets; Pathways incorporates an extensive evaluation plan guided by a logic model.	Standardized processes of data collection, analysis and reporting of team-level and institutional change efforts and outcomes	Consistent and standardized collection of data across all Pathways institutions allowed the successes and challenges that teams faced to be reflected upon in a collective as opposed to a combative orientation

Policies, People, Places and Programs. Roberts and Buckley (this issue) not only further refined and developed plans for their makerspace at Delaware State University, they also raised their own social capital on-campus by acting as internal consultants on larger makerspace projects. Rhoulac-Smith et al. (this issue) describe the successes and challenges associated with building an innovation ecosystem on Howard University's campus, an Historically Black University located in the nation's capital, in order to address the extreme lack of diversity in the technology industry. Nagel et al. (this issue) discussed lessons learned and successes achieved as they developed an I&E ecosystem composed of new courses, co-curricular activities and repurposed spaces, all designed to support I&E programs at James Madison University. Sanchez-Lopez and Pedraza (this issue) leveraged the Pathways Landscape Tool to catalog their existing ecosystem, and developed strategies to maximize its use by fostering the entrepreneurial potential of faculty and students.

Student exposure and engagement

Earle et al. (this issue) leveraged the dedicated team-time at Pathways' in-person convenings to identify a social network and bricolage approach to increase I&E participation among STEM students in their long-standing Business Proposal Competition at the University of New Hampshire. Boehm (this issue) outlines the structure, phases and outcomes assessment of their intensive 48-hr design experience at Texas A&M University, which was designed to cultivate an entrepreneurial mindset among participants. Walker et al. (this issue) focused on the redesign of the senior design capstone project at Clemson University by utilizing game-based learning practices. Zapata and Lugo (this issue) describe the implementation, assessment and student outcomes associated with a year-long, two-semester sequence, multidisciplinary program in innovation and entrepreneurship at the University of Puerto Rico, Mayagüez.

CONCLUSION

Throughout the Pathways to Innovation Program's collective impact process, data was a critical tool used to reinforce best practices and challenge assumptions about how to best facilitate change. One of the key drivers behind this approach, was the strong collaborative partnership with those responsible for gathering and analyzing the data and those responsible for program implementation. This partnership allowed for the creation of immediate formative feedback loops that were used to make informed decisions regarding network-wide program design and implementation needs. The successful dissemination of tools, program outcomes, and the volume of information collected (developmental, formative and summative) over the course of the Pathways program in many ways speak

to this alignment.[12,13] The articles in this issue are also indicative of the varied, successful approaches adopted across the Pathways community. There is no one size fits all model of success – something that the collective impact approach recognizes and deftly supports; the framework's successful adoption and implementation is visible in the variety of projects generated by Pathways teams over the course of many stages and phases of project growth and development. By acknowledging and supporting teams to customize their implementation practice, as demonstrated by the cases in this issue, Pathways has expanded our understanding of how to support I&E for generations of undergraduate engineering students across this country.

REFERENCES

1. Tryggvason, G. & Apelian, D. *Shaping our world: engineering education for the 21st century*. (Wiley, 2012).

2. Carnevale, A. P., Smith, N. & Melton, M. STEM: Science Technology Engineering Mathematics. (2011).

3. Lattuca, L. R., Terenzini, P. T. & Volkwein, J. F. *Engineering change: A study of the impact of EC2000*. (ABET, Inc., 2006).

4. Duval-Couetil, N. Assessing the Impact of Entrepreneurship Education Programs: Challenges and Approaches. *J. Small Bus. Manag.* **51**, 394–409 (2013).

5. Kuratko, D. F. The Emergence of Entrepreneurship Education: Development, Trends, and Challenges. *Entrep. Theory Pract.* **29**, 577–598 (2005).

6. Ohland, M. W., Frillman, S. A., Zhang, G., Brawner, C. E. & Miller, T. K. I. The effect of an entrepreneurship program on GPA and retention. *J. Eng. Educ.* **93**, 293–301 (2004).

7. Goldberg, D. E. *A whole new engineer: the coming revolution in engineering education*. (ThreeJoy Associates, Inc, 2014).

8. PCAST STEM Undergraduate Working Group. *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*. (Office of the President, 2012).

9. Kuratko, D. F. *Entrepreneurship: theory, process, practice*. (2014).

10. Hoskinson, S. & Kuratko, D. F. *Innovative pathways for university entrepreneurship in the 21st century*. (2014).

11. Jamieson, L. H. & Lohmann, P.E., J. R. *Innovation with Impact: American Society for Engineering Education*. (American Society for Engineering Education, 2012).

12. Nilsen, E. A., Matthew, V., Besterfield-Sacre, M. & Monroe-White, T. Landscape Analysis as a Tool in the Curricular Change Process. in *Frontiers In Education Conference Proceedings* (2015).

13. Matthew, V., Monroe-White, S & Engelman, S. Fostering Institutional Change in Innovation and Entrepreneurship: A Social Network Analysis Approach. in *Proceedings of the American Society of Engineering Education* (2016).

14. Nilsen, E., Matthew, V., Shartrand, A. & Monroe-White, T. Stimulating and Supporting Change in Entrepreneurship Education: Lessons from Institutions on the Front Lines. in *2015 ASEE Annual Conference and Exposition Proceedings* 26.1401.1-26.1401.17 (ASEE Conferences, 2015). doi:10.18260/p.24738

15. Giersch, S., McMartin, F., Nilsen, L., Sheppard, S. D. & Weilerstein, P. Supporting Change in Entrepreneurship Education: Creating a Faculty Development Program Grounded in Results from a Literature Review. in *ASEE Conference Proceedings* (2014).

16. Kania, J. & Kramer, M. Collective Impact. *Stanf. Soc. Innov. Rev.* **9**, 36–41 (2011).

17. Heifetz, R. A., Kania, J. & Kramer, M. R. Leading Boldly: Foundations Can Move Past Traditional Approaches to Create Social Change Through Imaginative – Even Controversial – Leadership | IssueLab. Available at: http://www.issuelab.org/resource/leading_boldly_foundations_can_move_past_traditional_approaches_to_create_social_change_through_imaginative_even_controversial_leadership. (Accessed: 1st February 2016)

18. HanleyBrown, F., Kania, J. & Kramer, M. *Channeling change: Making collective impact work*. (Stanford Social Innovation Review, 2012).

19. Graham, R. *Creating university-based entrepreneurial ecosystems evidence from emerging world leaders*. (Massachusetts Institute of Technology, 2014).

20. Sullivan, P., Pines, E. & Morrison, E. Strategic Doing: A Tool for Curricular Evolution. in (2016).

21. Ed Morrison. "Strategic Doing" : A New Discipline for Developing and Implementing Strategy within Loose Regional Networks (PDF Download Available). in *ResearchGate*

22. Cooperrider, D. L. & Whitney, D. K. *Appreciative inquiry: a positive revolution in change*. (Berrett-Koehler, 2005).

23. Turner, S., Merchant, K., Kania, J. & Martin, E. Understanding the Value of Backbone Organizations in Collective Impact: Part 2 (SSIR). *Stanf. Soc. Innov. Rev.*

24. Kramer, M., Parkhurst, M. & Vaidyanathan, L. *Breakthroughs in Shared Measurement and Social Impact*. (FSG Social Impact Advisors, 2009).

25. Hatry, H. P. *Performance measurement: getting results*. (Urban Institute Press, 2006).

26. W.K. Kellogg Foundation. *Logic Model Development Guide*. (2004).

27. Preskill, H., Parkhurst, M. & Splansky Juster, J. *Guide to Evaluating Collective Impact*. (2014).

28. Patton, M. Q. *Utilization-focused evaluation*. (Sage Publications, 2008).

29. O'Donnell, C. L. Defining, Conceptualizing, and Measuring Fidelity of Implementation and Its Relationship to Outcomes in K–12 Curriculum Intervention Research. *Rev. Educ. Res.* **78**, 33–84 (2008).

30. Nilsen, E., Monroe-White, T., Morrison, E. & Weilerstein, P. Going Beyond 'What Should We Do?': An Approach to Implementation of Innovation and Entrepreneurship in the Curriculum. in *2016 ASEE Annual Conference & Exposition Proceedings* (ASEE Conferences, 2016). doi:10.18260/p.25405

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APPENDIX A

Participating Pathways Institutions

Binghamton University, SUNY

California Polytechnic State University

California State University, Northridge

Case Western Reserve University

City College of New York

Clemson University

Colorado School of Mines

Cooper Union, The

Florida A&M University-Florida State University
   College of Engineering

Florida Institute of Technology

Grand Valley State University

Hampton University

Howard University

Illinois Institute of Technology

James Madison University

Louisiana Tech University

Loyola University Maryland

Michigan Technological University

Missouri University of Science and Technology

New Mexico State University

New York Institute of Technology

North Carolina A&T State University

Oregon State University

Portland State University

South Dakota School of Mines & Technology

South Dakota State University

Southern Methodist University

Temple University

Tennessee Technological University

Texas A&M University

Universidad del Turabo

University of Alabama at Birmingham

University of California - Merced

University of Delaware

University of Hawaii at Manoa

University of Massachusetts - Lowell

University of Nebraska - Lincoln

University of Nevada - Las Vegas

University of New Hampshire

University of North Alabama

University of North Dakota

University of Pittsburgh

University of Puerto Rico - Mayagüez

University of South Florida

University of Texas at Arlington

University of Texas at El Paso

University of Wisconsin - Milwaukee

Washington State University

Western Carolina University

Western Kentucky University

Wichita State University

APPENDIX B

Landscape Analysis Tool

Below is a screenshot of the Landscape Analysis Tool. A view-only version of the tool accessed at

http://bit.ly/LandscapeTool