

Supporting Change in Entrepreneurship Education: Creating a Faculty Development Program Grounded in Results from a Literature Review

Sarah Giersch, Broad-based Knowledge

Sarah Giersch is a Consultant for Broad-based Knowledge (BbK) where she conducts quantitative and qualitative evaluations for BbK's higher education clients. Giersch also consults in the areas of archiving digital materials. Prior to joining BbK, Giersch worked for Columbia University libraries guiding the growth and development of the online research repository. Giersch has also consulted in the area of education technology and specifically on implementing, evaluating, conducting outreach for and promoting the sustainability of education digital libraries. Prior to establishing a consulting practice, Giersch worked in the private sector conducting market analyses and assessments related to deploying technology in higher education. She received a M.S.L.S. from the University of North Carolina at Chapel Hill.

Dr. Flora P McMartin, Broad-based Knowledge, LLC

Flora P. McMartin is the Founder of Broad-based Knowledge, LLC (BbK), a consulting firm focused on the evaluation of the use and deployment of technology assisted teaching and learning. Throughout her career, she has served as an External Evaluator for a number of NSF-funded projects associated with faculty development, community building, peer review of learning materials, and dissemination of educational innovation. She is PI for the project "Learning from the Best: How Award Winning Courseware has Impacted Engineering Education." This research focuses on determining how high quality courseware is being disseminated and how it is impacting the culture of engineering education as measured by changes in student learning, teaching practices, and the careers of the authors of these materials.

Elizabeth Nilsen, National Collegiate Inventors & Innovators Alliance (NCIIA)

Elizabeth Nilsen is Senior Program Officer for Epicenter at NCIIA. Her professional focus is on the development and growth of STEM and innovation ecosystems. Prior to joining NCIIA, she led STEM initiatives at the Penn State Center - Pittsburgh, was the southwest regional coordinator for the Pennsylvania STEM Network, and served as Director of Outreach and New Economy Program Development at the Institute of Advanced Learning & Research, a Virginia Tech initiative. She earned her BA from Stanford and an MBA from Northeastern University.

Dr. Sheri Sheppard, Stanford University

Mr. Phil Weilerstein, National Collegiate Inventors & Innovators Alliance (NCIIA)

Phil Weilerstein Executive Director, National Collegiate Inventors and Innovators Alliance (NCIIA) As an entrepreneur in a not-for-profit organization, Phil has grown the NCIIA (<http://www.nciia.org>) from founding as a grassroots group of enthusiastic university faculty to an internationally known and in-demand knowledge base and resource center that supports and promotes technology innovation and entrepreneurship to create experiential learning opportunities for students, and successful, socially beneficial businesses. NCIIA does this by providing a linked sequence of programs that move faculty and student entrepreneurs from innovative ideas to launching start-up companies. Phil began his career as an entrepreneur as a student at the University of Massachusetts. He and a team including his advisor launched a start-up biotech company. This experience, coupled with a lifelong passion for entrepreneurship, led to his work with the National Collegiate Inventors and Innovators Alliance. He is a founder of the Entrepreneurship Division of the American Society of Engineering Education and is a recipient of the 2008 Price Foundation Innovative Entrepreneurship Educators Award.

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Abstract

The goal of the Engineering Pathways to Innovation Center (Epicenter), an NSF-funded partnership between Stanford University and the National Collegiate Inventors & Innovators Alliance (NCIIA), is to enable engineering programs at institutions across the U.S. to develop effective and accessible innovation and entrepreneurship offerings for undergraduate engineering students. To achieve this goal, Epicenter staff members are creating the multi-year, team-based Pathways to Innovation program to support institutional change and faculty development by embedding entrepreneurship and innovation education into formal and informal undergraduate engineering curriculums in higher education.

During the summer of 2013, Epicenter engaged Broad-based Knowledge, LLC to conduct an independent literature review to identify promising models and practices that could guide the design and implementation of the Pathways program, specifically on the topics of *faculty development* and *change in higher education*. Since then, Epicenter staff members have incorporated the recommendations from the literature review into the design of the Pathways program, which plans to launch in January 2014.

This paper reports findings and recommendations from the literature review, synthesizes the recommendations with design decisions, and provides examples of how the decisions have been realized in components of the Pathways program. Finally, the conclusion offers reflections on the design process from Epicenter staff members as they balance implementing the (sometimes overwhelming number of) promising practices from the literature.

1.0 Introduction & overview

Engineering faculty from institutions across the United States, and around the world, have developed and implemented effective ways to incorporate innovation and entrepreneurship into undergraduate education. The experiential courses and activities they launched have provided students with a varied set of skills, including qualitative and analytical reasoning, creative thinking and problem solving. The results of these efforts have been positive. However, many classroom and extra-curricular advances to integrate innovation and entrepreneurship into undergraduate engineering education have occurred on a small scale, driven by a limited number of faculty who often work alone within their institution. The vast majority of engineering students only encounter innovation and entrepreneurship in a minimal way in their studies. ^[5]

This paper describes efforts to address the uneven distribution of entrepreneurship and innovation education across undergraduate engineering education through the Pathways to Innovation (Pathways) program. This initiative, from the Engineering Pathways to Innovation Center (Epicenter), is designed to make an impact on large numbers of faculty and students through a comprehensive approach that scales effective courses and programs and that engages institutions and their engineering programs in far-reaching change. The Pathways program directly addresses the need to work with the primary deliverers of content by teaching faculty at participating institutions to create programs that integrate innovation and entrepreneurship content in order to reach a substantial number of their engineering undergraduate students.

This paper describes the research-based process for designing the Pathways program, which is part of the pre-planning phase of activities (Table 1). First, we report the methodology, findings and recommendations from an independent literature review for an annotated bibliography that was conducted by Broad-based Knowledge, LLC, in Summer 2013. Then the following sections provide a synthesis of the recommendations from the literature review with key design decisions, and provide examples of how the decisions have been realized in components of the Pathways program, which was developed by Epicenter staff members during Fall 2013. Finally, the conclusion offers reflections on the design process from Epicenter staff members as they balance implementing the (sometimes overwhelming number of) promising practices from the literature as they prepare to launch the Pathways program in January 2014. The authors will be able to report on results from the first six months of the Pathways program at ASEE 2014.

**Table 1: Pathways program activities
(phases 2-4 occur on a two-year cycle)**

1. Pre-Plan	2. Prepare	3. Immerse	4. Scale
<ul style="list-style-type: none"> • Independent literature review • Synthesize findings; recruit participants • Design research-based program 	<ul style="list-style-type: none"> • Local Landscape and needs analysis • Planning workshop 	<ul style="list-style-type: none"> • Workshops • Resources • Accountability Process • Tracking and Evaluation 	<ul style="list-style-type: none"> • Increasing depth within the institution • Spreading to other institutions

The primary partners in Epicenter – Stanford University and the National Collegiate Inventors & Innovators Alliance (NCIIA) – have worked extensively with individual faculty members for more than a decade. Broad-based Knowledge, LLC, evaluates innovations in higher education especially in the area of science, technology, engineering and mathematics education.

2.0 Learning from the literature

To identify resources for the literature review that would inform the design of the Pathways program, Broad-based Knowledge (BbK) conducted exploratory and known-item searches, continually assessed the results to further refine search terms and parameters, and made comparisons across the existing results set for relevance-to-topic. The final set of resources was compiled into an annotated bibliography, along with a set of findings from the literature and recommendations for the Epicenter staff.¹

¹ Giersch, S., & McMartin, F. (2014). Promising Models and Practices to Support Change in Entrepreneurship Education. Epicenter Technical Brief 2. Stanford, CA and Hadley, MA: National Center for Engineering Pathways to Innovation. <http://epicenter.stanford.edu/documents/191>

2.1 Selecting Resources through an Iterative Search and Review Process

BbK team members employed an iterative search process using the web and reference databases (see Bibliography) from the library systems of New York University and the University of California at Berkeley during June-July 2013. During the first phase of assessing the search results, we grouped resources into three topic areas: (A) Faculty Development; (B) Fostering Change; and, (C) Revising Curriculum (Figure 1). Though there was some overlap between A and B or B and C, we did not find any resources that addressed all three topics.

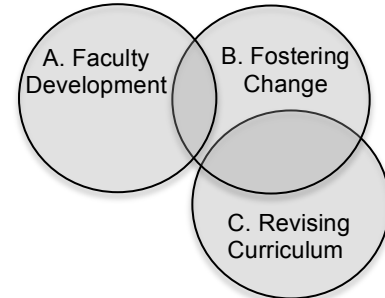


Figure 1: Topic Areas of Initial Results Set

Literature in (C) Revising Curriculum contained many examples of institution-specific curriculum revision efforts that reported outcomes, but these resources did not analyze the change process. As a result, we removed topic area C from the search parameters. And, while some resources

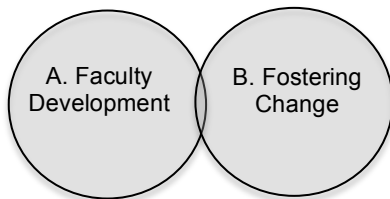


Figure 2: Revised Priorities for Topic Areas

addressed (A) Faculty Development *and* (B) Fostering Change, these articles proved to be irrelevant because they focused on results for individual faculty members rather than the process and outcomes of development and change at the institutional level. As a result, we modified our strategy for the remainder of the search process and focused on identifying effective models within the two discrete areas of Faculty Development and Fostering Change (Figure 2).

The second phase of assessment involved a two-stage review of the resources. Each resource was independently reviewed by two members of the BbK research team who evaluated relevance against the parameters detailed in Figure 3. Once a body of resources was sufficiently developed in each topic area, team members re-assessed the resources against the topic area corpus and resolved any differences through discussion.

Figure 3: Relevant resources addressed these parameters.

1. Scale: the faculty development program should be regional or national;
2. Topic: the program should support engineering faculty members in adopting or adapting curricula;
3. Context: engineering administration and faculty members should integrate entrepreneurship and innovation curricula into their school or college offerings;
4. Sustainability: successful changes should be institutionalized at all levels of the institution;
5. Evaluation: faculty development programs should demonstrate changed attitudes, knowledge, and practices in engineering faculty and students.

Although articles that definitively addressed all of these parameters were not found, we identified articles that reported promising practices and models around Scale, Context, and to some extent, Evaluation. From this set, we selected resources that demonstrated: *best-in-class* examples of faculty development models or change management processes; *thoroughness* in describing the development processes; *rigor* in model design and evaluation; and, *complementarity* to other resources in the results set.

At the conclusion of the iterative search and assessment process, BbK team members had reviewed 91 resources, including articles that provided context for the Pathways effort to integrate entrepreneurship education into engineering courses.^[5, 16] Ultimately, 26 resources were selected for inclusion in an annotated bibliography: 11 in Faculty Development and 15 in Fostering Change. By continuing to organize resources in the final results set into topic areas, we ensured a balanced representation for each topic and provided a high-level point of access into the resources. The next section discusses observations about the literature in teach topic area and then provides findings, which are synthesized into recommendations for developing the Pathways program.

2.2 Observations & recommendations

The findings below are situated within the context of higher education in the U.S. While there is some overlap between the topic areas, we found that authors rarely linked faculty development interventions with institutional change efforts. Faculty development articles discuss successful projects at the local level to improve teaching with technology or to revise curriculum that promotes specific STEM topics. These articles focus on process with little discussion of outcomes or evaluation. Organizational change articles often describe campus-wide or national initiatives, and they report outcomes while avoiding detailed discussions of change processes.

2.2.1 Faculty development

Faculty development can lead to changes in engineering education and is a worthwhile activity to focus on in order to achieve this change.^[4] However, the literature on faculty development has a tree/forest ratio problem. There are many specific, and sometimes anecdotal, examples of faculty development interventions that impact individuals (the trees) and few reported models that lead to systemic changes (the forest). The site-specific combinations of several factors (i.e., context, intervention, content, audience, support, and incentives) make it difficult to extrapolate and apply larger lessons learned.

Another limitation of the literature is that it is long on evaluating faculty development interventions according to short-term factors (immediate changes in attitudes, skills, beliefs; satisfaction). However, the literature is short on evaluating the long-term outcomes or impacts of faculty development interventions. Rigorous reviews of faculty development interventions in higher education have not identified significant programmatic outcomes that had an impact on institutions. Rather, the interventions described had an impact on participating individuals. Despite these shortcomings, we were able to identify three common factors that contributed to meaningful faculty development (Figure 4).

Figure 4: Components of Meaningful Faculty Development Interventions

1. The combination of *duration*, *experiential learning opportunities*, and *peer interaction* are factors that contribute to meaningful faculty development interventions.
2. The content and activity of faculty development interventions should be constructed around a learning theory and principles of instructional design.
3. Evaluation should be incorporated into every stage of a faculty development intervention, including pre-planning activities. Additionally, significant effort should be directed towards evaluating programmatic effectiveness of faculty development interventions rather than exploring faculty satisfaction.

2.2.2 Change in higher education

The resources on change were identified primarily in the business literature; authors writing in higher education publications often referenced theories of change from this discipline. However, we found that it is even more common for resources about change in higher education to avoid references to theory altogether.

Most of the resources about change in higher education described the change process as a systemic effort. Articles about curriculum revision reported how changes were made "mechanically" by putting new and modified courses together almost like a puzzle. However, relevant resources on institutional change reported that modifying a curriculum or innovation is a holistic process, which recognizes that change has an organizational and individual impact, and that the process must be fully supported, through ownership and resource allocation, to be successful. Successful, systemic change efforts shared several common factors (Figure 5).

Figure 5: Factors that Support Fostering Change in Higher Education

1. Change is less about the 'thing being changed' (i.e., innovation, curriculum) and more about changing beliefs about teaching and learning.
2. Context and environment matter at all stages of the change process.
3. Curriculum change must be viewed systemically. It is not merely a matter of 'adding-on' or 'adding-in' new or missing curriculum components.
4. Theories of change must guide the work of making change. A theory of change makes it possible to evaluate the success of particular approaches or the impact of the effort.
5. Change takes time; plan for the long term.
6. Working collaboratively, building partnerships, and creating networks among collaborators, partners, and participants are key to establishing support and buy-in for change.
7. Communicate early, often, and broadly to build support and buy-in and to reduce potential alienation of allies.
8. Facilitators are essential to managing group processes. An effective approach to creating a less stressful learning environment in situations that require faculty members to question their approaches is to engage a facilitator external to the institution.
9. During the change process it is important to show success in the short- and long-term to help keep participants and stakeholders motivated.

2.2.3 Recommendations

Figure 6 contains recommendations from BbK to Epicenter staff that synthesize observations and findings from the literature on faculty development and change in higher education.

**Figure 6: Summary of Recommendations:
Designing a Faculty Development Program to Foster Change
in Entrepreneurship and Innovation Education in Engineering**

1. Create faculty development interventions of a sufficient duration as to support multiple opportunities for active learning and meaningful peer interaction because it can take five to ten years before the impact of large change efforts are fully manifested.
2. Construct faculty development interventions around learning theory and principles of instructional design in order to assess if learning has occurred.
3. Ensure staff members have content knowledge and leadership skills to support and facilitate change, and ensure adequate levels of staffing to support participants at all stages of change. Volunteers are not always the best team leaders.
4. Choose incentives that are specific, motivating, and meaningful enough to engage faculty members, who may be at different career stages, to participate in and own the change process. Plan for the reality that the best incentives cannot overcome structural or organizational barriers
5. Plan for evaluation activities at every stage of a faculty development intervention using, for example, a logic model to help identify short- and long-term outcomes and to help guide when, and with what frequency, results are reported.

The next section shows how recommendations from the literature review are integrated with findings from the literature and how key design decisions will be realized in components of the Pathways program.

3.0 Translating recommendations into action: putting the pieces together

Even before the literature review was completed, Epicenter staff members began the process of recruiting participants for the Pathways program. During conversations with faculty members and school leaders, particularly deans, Epicenter staff collected feedback, and once completed, they triangulated participant feedback with the findings and recommendations from the literature review. During Fall 2013, Epicenter staff members designed Pathways program details such as sequence, pace, and incentives that would best meet participants' needs while adhering to promising models and practices from the literature. In this pre-planning phase (see Table 1 above), the following components or activities were a priority for Epicenter staff and Pathways program participants.

- Engage upper-level administrators;
- Develop work plans that respond to and anticipate the opportunities and challenges that are specific to each institution;
- Commit to participating in the program for a sustained duration to support change initiatives;
- Incorporate experiential learning opportunities for faculty;
- Participate in peer interactions among faculty within and across institutions.

As the Pathways program advances through its two-year cycle, other design components will become a priority. Table 2 synthesizes the recommendations and findings from the literature review with the design choices that Epicenter staff members have made in developing the Pathways program.

Table 2: Synthesis of Recommendations, Findings, and Design Choices

Recommendation 1: Create faculty development interventions of a sufficient duration as to support multiple opportunities for active learning and meaningful peer interaction because it can take five to ten years before the impact of large change efforts are fully manifested.	
<i>Findings from the Literature</i>	<i>Design Choice</i>
<p>1. Faculty development that is sustained and intensive is more likely to have an impact than interventions of shorter duration. ^[3, 9]</p> <p>2. Focus on the systemic nature of making change. ^[6, 13]</p>	<p>1. The Pathways process is 1-2 years, with the explicit expectation that schools will begin a process that will last beyond the project.</p> <p>2. Pathways schools map out a change process that spans the entire range of undergraduate engineering education: required and elective courses, co- and extra-curricular offerings, and space and policy considerations.</p>
Recommendation 2: Construct faculty development interventions around learning theory and principles of instructional design in order to assess if learning has occurred.	
<i>Findings from the Literature</i>	<i>Design Choices</i>
<p>1. Faculty development interventions that adhere to theories of adult learning and instructional design promote more effective teaching and learning. ^[18]</p> <p>2. Faculty members need to practice what they learn. Immediate relevance and practicality are key. It is best to use a number of approaches or methods for teaching to accommodate different learning styles. ^[18]</p> <p>3. Peers are valuable as role models, for mutual exchange of information and ideas, and for the importance of collegial support to promote and maintain change. ^[18]</p> <p>4. Change in higher education requires that stakeholders and participants change how they think about learning and teaching ^[6, 7, 12, 14, 19]</p>	<p>1. Faculty at Pathways institutions will have a range of experiential & interactive learning opportunities throughout the program. ^[1]</p> <p>2. Pathways will expose faculty members to a broad range of learning opportunities using a variety of approaches.</p> <p>3. Institutions are recruited as a cohort, beginning the process together, and in-person and online experiences will incorporate a peer learning and accountability structure.</p> <p>4. The Pathways program is explicit about the expectation that engineering curricula (and the faculty teaching it) must incorporate new models of instruction and learning.</p>
Recommendation 3: Ensure staff members have content knowledge and leadership skills to support and facilitate change, and ensure adequate levels of staffing to support participants at all stages of change. Volunteers are not always the best team leaders.	
<i>Findings from the Literature</i>	<i>Design Choices</i>
<p>1. Leaders of change-related processes should be selected carefully for their ability to manage people and process, not just be passionate about change. ^[17]</p>	<p>1. Each team is headed by a team leader who has demonstrated the ability to work with peers and institutional leaders and who is prepared to dedicate ~10% of his or her time for the duration of the Pathways program.</p>

<p>2. Successful change is often facilitated by having collegial, collaborative teams of participants at the local level. ^[2, 8, 19] It is also important to have a network outside the campus to lend support and expertise to the effort. ^[7, 11, 12]</p> <p>3. The change process should not be exclusionary but should be viewed as open and welcoming of all participation. ^[14, 17]</p>	<p>2. Each participating school assembles a team that includes both leadership (deans) and faculty. Each institution will be asked to specifically commit to participate within a community of practice with other institutions engaged in the Pathways program by sharing their plans and goals and participating in a peer accountability process.</p> <p>3. While each school assembles a team to begin the change process, they are encouraged to expand participation as the change process evolves from planning to implementation. Each team will incorporate student perspectives into their process, but a student team member is not mandatory.</p>
<p>Recommendation 4: Choose incentives that are specific, motivating, and meaningful enough to engage faculty members, who may be at different career stages, to participate in and own the change process. Plan for the reality that the best incentives cannot overcome structural or organizational barriers</p>	
<p><i>Findings from the Literature</i></p>	<p><i>Design Choices</i></p>
<p>1. During the change process it is important to show success in the short- and long-term. ^[17]</p> <p>2. Even though creating change is a long-term activity, provide regular reports to keep participants engaged in the change effort. ^[17] Remember that change takes the time of participants in the process. ^[2, 11]</p> <p>3. Change efforts should be organized to meet the needs of the environment and its people. ^[2, 8, 12, 14, 17]</p>	<p>1. As part of their strategic action planning, teams will identify “quick wins” as well as longer-term outcomes.</p> <p>2. Each team will engage in proactive communication of their progress with local stakeholders to build momentum and support for the program. And, teams will share progress on a regular basis with other teams in the Pathways program.</p> <p>3. Each school is developing its own action plan to respond to the specific institutional context.</p>
<p>Recommendation 5: Plan for evaluation activities at every stage of a faculty development intervention using, for example, a logic model to help identify short- and long-term outcomes and to help guide when, and with what frequency, results are reported.</p>	
<p><i>Findings from the Literature</i></p>	<p><i>Design Choices</i></p>
<p>1. Planning for evaluation is integral to the design of faculty development interventions, including a needs assessment during the pre-planning stage. ^[10, 15]</p> <p>2. Building change efforts around specific theories of change allows for strategic planning and evaluation of efforts. ^[7, 19]</p>	<p>1. Pathways institutions begin with an in-depth inventory of their school’s needs and assets.</p> <p>2. The Pathways program as a whole incorporates an extensive evaluation plan that is guided by a logic model</p>

Figure 7 provides details about how the recommendations, findings, and design choices above have been translated into an outline for the Pathways program activities.

Figure 7: High-level outline of Pathways program activities for 2013-2014

- December 2013: initial cohort of institutions selected to participate in the Pathways program; kick-off webinar about expectations, administrative deliverables. Two additional cohorts will be added over the next two years.
- January 2014: Team leaders gather at Stanford for a one-day workshop on facilitator training, inventory tool, and goal-setting process.
- February: institutional teams meet in Phoenix to create action plan for their campus
- March: Selected team members participate in NCIIA OPEN 2014 conference on innovation and technology entrepreneurship in higher education
- March-May: teams engage with local institution groups; webinars for team leaders and team members on topics that support change process
- June: Team leaders convene in Indianapolis for a workshop on the process of curricular and co-curricular change to lay the foundation for scaling their local programs
- Fall 2014, 2015: Team gatherings to support extending efforts of the original institutional teams to the next circle of faculty on their campuses

4.0 Reflections on the design process and next steps

As Epicenter staff members prepare to launch the Pathways program in January 2014, their reflections on the effort to use a research-based design process in developing the Pathways program offer insights that BbK did not find in the literature. Often, documenting in-process observations can be as useful as reporting outcomes. For example:

1. Recommendations from the literature review about faculty development and managing change apply to developing the Pathways program and are also entirely relevant to the Pathways participants as they go about planning and implementing programs at their respective institutions. One of the challenges is for Epicenter staff to be aware of the level(s) at which recommendations are being implemented.
2. Because the literature review recommendations are often complementary, it has been a challenge for Epicenter staff *not* to overload a single Pathways program component with multiple best practices or models. Epicenter staff members anticipate that Pathways teams will also face this challenge. At the level of the Pathways program, Epicenter staff will have to prioritize their resources to focus on the most relevant, of the many, topics on which to provide support. Then Epicenter staff members will need to guide institutional teams to set priorities about their own capacity to implement new processes and content knowledge.

3. The literature recommended demonstrating outcomes throughout a change process. While Epicenter staff members would like to see quick progress from Pathways participants, they also recognize that institutions are starting a long-term, systemic change process. Epicenter staff members are committed to allowing participants to conduct their site-specific institutional analysis and planning, while recognizing the stakeholders at institutions will also want to see demonstrable progress.
4. While the literature does not distinguish between short- and long-term recommendations, the reality faced by Epicenter staff during the design process is the challenge of balance: 1) helping teams develop their institution-specific plans while 2) providing teams with discipline-relevant content – and doing both in a way that respects the specific needs and contexts of individual institutions. An ongoing priority for Epicenter staff will be to optimize the timing and balance of providing support for program development assistance and offering materials on a wide variety of curricular models and learning opportunities information related to innovation and entrepreneurship.
5. The recommendations about incorporating evaluation have been adopted by Epicenter staff to the point that coordinating evaluation activities is critical to avoid overlap of efforts between internal and external evaluative activities. Epicenter staff members have defined Pathways program activities around a common logic model and will need to ensure the close cooperation of program evaluators to ensure that formative and summative program evaluation needs are met.

Even in these early stages, the Pathways to Innovation program shows promise for making innovation and entrepreneurship part of the everyday experience of undergraduate engineering students. By the time of publication, participating Pathways institutions will be well into their change processes. We will be able to provide information about challenges and successes from the first six months of implementing the Pathways program as well as about how the participating institutions are approaching their respective paths towards implementing change in innovation and entrepreneurship curriculum for undergraduates.

5.0 Acknowledgements

The work is supported by the National Science Foundation: DUE 1125457

6.0 Bibliography

The following electronic databases were used to identify resources for the literature review: ERIC, PAIS, Scopus, ISI Web of Science, and the ACM Digital Library.

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