How Engineering Education Guilds are Expanding our Understanding of Propagation in Engineering Education

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Abstract

Background: The National Science Foundation (NSF) and other organizations have spent millions of dollars each year supporting well-designed educational innovations that positively impact the undergraduate engineering students who encounter them. However, many of these pedagogical innovations never experience widespread adoption. To further the ability of innovation developers to advance engineering education practice and achieve sustained adoption of their innovations, this paper explores how one community-based model, engineering education guilds, fosters propagation across institutions and individuals. Engineering education guilds seek to work at the forefront of educational innovation by creating networks of instructor change-agents who design and implement a particular innovation in their own context. The guilds of interest are the Consortium to Promote Reflection in Engineering Education (CPREE) and the Kern Entrepreneurial Engineering Network (KEEN).

With these guilds as exemplars, this study's purpose is (1) to articulate how the approaches of engineering education guilds align with existing literature on supporting sustained adoption of educational innovations and (2) to identify how these approaches can advance the science, technology, engineering and math (STEM) education community's discussion of propagation practices through the use of the Designing for Sustained Adoption Assessment Instrument (DSAAI). The DSAAI is a conceptual framework based on research in sustained adoption of pedagogical innovations. It has previously been used in the form of a rubric to analyze dissemination and propagation plans of NSF educational grant recipients and was shown to predict the effectiveness of those propagation plans.

Results: Through semi-structured interviews with two leaders from each guild, we observed strong alignment between the structures of CRPEE and KEEN and evidence-based sustained adoption characteristics. For example, both guilds identified their intended audience early in their formation, developed and implemented extensive plans for engaging and supporting potential adopters, and accounted for the complexity of the higher education landscape and their innovations in their propagation plans.

Conclusions: Our results suggest that guilds could provide another approach to innovation, as their structures can be aligned with evidence-based methods for propagating pedagogical innovations. Additionally, while the DSAAI captures many of the characteristics of a well-designed propagation strategy, there are additional components that emerged as successful strategies used by the CPREE and KEEN guild leaders. These strategies, including having mutual accountability among adopters and connecting adoption of innovations to faculty reward structures in the form of recognition and funding should be considered as educational innovators work to encourage adoption of their innovations

Keywords

innovation propagation; educational innovation; STEM faculty; instructional change; engineering education guilds

Introduction

The National Science Foundation (NSF) and other organizations have spent, and will continue to spend, millions of dollars each year supporting educational innovation projects designed to positively impact undergraduate Science Technology Engineering and Math (STEM) students who experience them (National Science Foundation, 2021). However, research indicates that many faculty at U.S. colleges and universities have not adopted educational innovations for teaching STEM students (Borrego et al., 2007; Felder et al., 2011), even when there is substantial evidence for the utility of these innovations (Felder et al., 2011). The lack of adoption of educational innovations, especially those that promote student-centered and inclusive teaching, affects the entire range of STEM education stakeholders (e.g., students, faculty, employers). Therefore, it is critical to better characterize and understand how groups and individuals who design and wish to propagate educational innovations intend to facilitate sustained adoption of their innovations as well as how their approaches to propagation occur in practice.

This paper focuses on engineering education as a specific subset of STEM education, with the recognition that engineering students are stakeholders in general STEM education due to the core science and math courses that comprise the majority of their first two years of study. Within the engineering education subset of STEM education, we further focus on a particular set of innovators that we call engineering education guilds and their approaches to fostering sustained adoption. Engineering education guilds, as we define them, seek to work at the forefront of educational innovation in engineering by creating networks of instructor change agents. These instructor change agents work to design and implement a particular educational innovation in their own practice. Bringing together groups of engineering educators from specific institutions to adapt and integrate a particular innovation into their own institutional and teaching contexts is characteristic of guilds' approaches to propagation and sustained adoption. While there are several well-established examples of these guilds, this mechanism for educational innovation has not been extensively explored. Understanding the structure and efficacy of engineering education guilds can inform future attempts to facilitate sustained adoption within engineering education and more broadly, within STEM education.

In particular, the purpose of this study is two-fold: (1) to articulate how the approaches of engineering education guilds align with existing literature on supporting sustained adoption of educational innovations and (2) to identify how these guilds' approaches can advance the STEM education community's discussion of propagation practices. To achieve this dual purpose, we leverage the Designing for Sustained Adoption Assessment Instrument (DSAAI), which has been previously used to analyze dissemination and propagation plans of NSF educational grant recipients (Stanford et al., 2017), as a framework for exploring how guilds approach fostering adoption. Through semi-structured interviews with founders and leaders of two engineering education guilds, we are able to characterize their propagation plans, and explore the approaches, within and outside of the DSAAI, leveraged by each guild. The results are discussed in the context of existing Community-Centric Innovation Approaches and the implications are shared for both researchers and those interested in developing or propagating educational innovations.

Background

Challenges to Achieving Sustained Adoption

Within the context of STEM education, researchers and educators who develop educational innovations have commonly followed a change approach of "if we build it, they will come" (Froyd et al., 2017). This approach illustrates a dissemination paradigm where the development of an innovation is done with little input from stakeholders and the communication of the innovation's utility is predominately through conferences and journal articles. As a result, there is an expectation that others will simply begin to adopt an innovation as long as there is evidence for its benefits (Froyd et al., 2017; Henderson et al., 2011). Overall, the dissemination paradigm tends not to lead to sustained adoption on its own, as it relies on an individual-to-individual change approach where the intended outcome is a prescribed innovation (Henderson et al., 2011; Stanford et al., 2016, 2017). For example, oftentimes, these innovations are developed from data within a single case (i.e., course or institution) which makes it challenging for adopters to adapt the innovation for their particular context (Henderson et al., 2011). In addition, this approach limits adopters' engagement because the decision to adopt or not adopt the innovation relies on a high fidelity of use of the innovation (Borrego & Henderson, 2014).

Several sustained adoption strategies have emerged from examining the characteristics of educational innovations and dissemination plans that lead to adoption of new practices among faculty. For instance, grassroots initiatives led by faculty have been found to support sustained adoption (Borrego & Henderson, 2014; Dee & Daly, 2009). The resulting innovations are often developed based on shared interest and/or values of the faculty involved and seek to achieve a common goal (Cross et al., 2021). Innovations from faculty that incorporate ongoing support during development also more commonly lead to sustained adoption (Felder et al., 2011). This ongoing support can often provide continued engagement between the innovation developer and the individual(s) adopting the particular innovation (Margherio et al., 2021). Lastly, approaches that explicitly consider the complexity of the academic work and learning environments have a higher likelihood of sustained adoption (Henderson et al., 2011). Within the last decade, the NSF Revolutionizing Engineering Departments grants, for example, have sought to explicitly account for this complexity, requiring funded projects to include teams of faculty and administrators from multiple disciplines as they collaborate to achieve and sustain large-scale innovation efforts (Doten-Snitker et al., 2020).

Froyd, et al. (2017) introduced the concept of the "propagation paradigm" to conceptualize some of these emergent characteristics by more broadly defining how developers of educational innovations should view their goal of encouraging systemic adoption of their work. The propagation paradigm involves developers working with potential adopters throughout the development process to create innovations that meet the needs of a wide range of educators, thus providing motivation and opportunity for sustained adoption. As approaches to educational innovation continue to evolve, it is important to revisit and further refine our understanding of dissemination, propagation, and characteristics of innovations that lead to sustained adoption.

Community-Centric Innovation Approach

Over the last few years, some educational innovators have shifted away from individual-to-individual change approaches toward what we are calling community-centric models. While not entirely grassroots initiatives, these approaches bring faculty together to support innovation and, ideally, sustained adoption. While varying in scale, scope, and purpose, among other characteristics, these community-centric models tend to have a prescribed structure and resources, but at the same time, are designed to encourage emergent, and, in many cases, bottom-up innovation. For example, many of these models leverage Communities of Practice (CoPs) (Lave, 1991; Lave & Wenger, 2001), a long-standing, commonly used faculty development approach (Pulford et al., 2015), to create a collaborative organizational structure for faculty to engage with one another and possible innovation initiatives (Cross et al., 2021; Dancy et al., 2019; Gehrke & Kezar, 2017; Mestre et al., 2019; Pitterson et al., 2020). CoPs enable groups to work towards common, collective goals with the social, and sometimes political, support needed to enact sustained change. For instance, the University of Illinois at Urbana-Champaign (UIUC) created an internal funding mechanism for groups of faculty members to pursue an educational innovation project (Mestre et al., 2019). Each funded group was organized into a CoP and was provided a peer mentor with knowledge about and experience with educational innovation. The prescribed structure provided necessary support and resources for faculty to focus on an emergent educational reform. Overall, this model for innovation, which has seen large-scale success at UIUC, leverages aspects of grassroots initiatives and ongoing support. In addition, the collaborative nature means that potential adopters are on the same team as the innovators.

Community-centric models have also become central to particular federal funding mechanisms from the NSF (e.g., Revolutionizing Engineering Departments (RED), Widening Implementation & Demonstration of Evidence Based Reforms (WIDER)). These mechanisms require institutions to form teams of researchers and practitioners that will collaborate together on their innovation projects (Margherio et al., 2020). Studies of the projects funded through the RED program highlight an approach to innovation based on developing strategic partnerships and a shared vision (Doten-Snitker et al., 2020; Margherio et al., 2020, 2021). Similar to the approach at UIUC, these teams are brought together as a community of educational reformers and innovators to encourage sustained adoption through grassroots processes (Doten-Snitker et al., 2020). In addition, the funding mechanism provides critical financial and human resources. Unlike the CoP models, however, these RED teams may not have started out with a common goal, especially at the time of proposal submission (Margherio et al., 2021). Thus, those particular teams needed to develop a community and a shared vision at the start of the project timeline (Margherio et al., 2021). The RED project is also based on innovation within an entire department, which may require both bottom-up and top-down innovation and reform as well as a focus on hyper-local propagation at the start, which can make broader propagation more challenging. Still, the focus on community and shared vision development departs from previous individual-to-individual innovation approaches and, overall, is well-aligned with literature on sustained adoption and educational change (Henderson et al., 2011).

This paper explores another structure for community-centric change models that has emerged over the last decade. We call this structure an *engineering education guild* based on the definition of a guild as a "an association of people with similar interests or pursuits" (*Guild | Definition of Guild by Merriam-Webster*, 2021). In particular, the guilds described in this study seek to create networks of instructor change agents who design and implement a particular innovation in their own context. These change agents can work individually or collaboratively at their institution, but each are supported by a larger network/community within the guild. For example, the Kern Entrepreneurial Engineering Network (KEEN), which focuses on integrating the entrepreneurial mindset into engineering curricula, provides funding to institutional teams who are then part of a larger network of change agents from multiple institutions (Rae & Melton, 2017). Currently, little is known about the structure of these guilds and their approaches to sustained adoption. Existing literature on these individual guilds is limited to explorations of individual institutional experiences and innovations (e.g., Fry et al., 2010; Schlemer et al., 2017), examinations of the innovation and existing curricular structures (e.g., Estell, 2020; Petersen et al., 2012), or investigations on the innovation itself (e.g., Csavina et al., 2017; Riley et al., 2021; Sepp et al., 2015). Thus, given the potential for these guilds to have cross-institutional impact, further research is needed on the approaches of these guilds toward sustained adoption.

Conceptual Framework

Our conceptual framework for this work is the Designing for Sustained Adoption Assessment Instrument (DSAAI), which is grounded within educational change and sustained adoption literature. The DSAAI was introduced in 2016 and takes the form of a rubric that provides education developers, grant writing consultants, and funding agencies with a tool for describing and assessing the propagation plans of researchers developing educational change strategies (Stanford et al., 2016) (see Table 1). Since its development, the DSAAI has been shown to have predictive abilities for determining the effectiveness of propagation plans of NSF funded educational development proposals (Stanford et al., 2017). Up to this point, the DSAAI has seen limited use within research (e.g., Stanford et al., 2017). Most commonly, it is cited when innovators are describing components of their innovation that may increase their likelihood of sustained adoption (e.g., Sochacka & Delaine, 2021).

In the context of this study, we consider the four dimensions of the framework as lenses through which to examine engineering education guilds. These dimensions are: (1) product type, (2) features of the target curricula and/or pedagogies, (3) propagation activities, and (4) aspects of propagation strategies that influence likelihood of success. The first three dimensions are considered descriptive, capturing characteristics of the educational innovation, while the final is evaluative, assessing the propagation strategies used by the innovators. Table 1 includes each of the dimensions along with a description of how that dimension characterizes the educational innovation under study. In addition, the multiple dimensions allow us to look comprehensively into each guild's activities and overall vision from both a product (i.e., features of the educational innovation) and propagation activities perspective. Lastly, the DSAAI provides an opportunity to consider dissemination and propagation, not as mutually exclusive, but as ends of a spectrum. This new framing is critical for understanding differences in approaches and also advancing our overall understanding of features of educational innovations that support sustained adoption.

Dimensions of DSAAI	Description
1. **Product Type -** *Descriptive*	Broadly characterizes the type of product in terms of how much change to pedagogy or course content is required.
2. **Product Features -** *Descriptive*	Focuses on features of the target curricula and/or pedagogies and the degree of change required for adoption/adaptation.
3. **Propagation Activities** - *Descriptive*	Identifies the specific activities directed at three particular components of propagation: development, dissemination, and support.
4. **Aspects of propagation strategies that influence the likelihood of success -** *Evaluative*	Focuses on the degree to which the innovators have used strategies that have been identified in the literature as necessary for, or supportive of, successful propagation of education innovations. Scores can range from 6 to 30. With a score of 6 indicating no alignment with best practices and a score of 30 indicating significant alignment with best practice.

Table 1. An overview of the Designing for Sustained Adoption Instrument (adapted from Stanford et al., 2016)

Research Design

The research question we sought to answer was: *In what ways do the innovations and approaches for propagation of engineering education guilds align with and add to the field's existing understanding of sustained adoption of educational innovations?* To address this question, we conducted semi-structured interviews with the leaders of two prominent guilds in the engineering education community: the Consortium to Promote Reflection in Engineering Education (CPREE) and the Kern Entrepreneurial Engineering Network (KEEN). We used interviews to gather in-depth accounts of the intentional choices of guild leaders as they designed their guilds and aimed to achieve propagation of their innovations. These interviews were analyzed using a combination of deductive and inductive coding to identify how these guilds support sustained adoption of their educational innovation. The deductive codes were developed from the DSAAI and inductive codes were developed to capture propagation approaches that emerged from the analysis.

Study Context

CPREE and KEEN were chosen for three reasons: (1) both represent large networks of faculty from multiple institutions, (2) both provide funding to faculty and institutions as part of their community-centric innovation approach, and (3) one (CPREE) was established by engineering education researchers with experience studying pedagogical innovations, while the other (KEEN) was established by philanthropists with industrial, but not educational, experience. We conducted interviews with the guild leaders, rather than members of the guilds, because of their first-hand knowledge of the strategic activities they devised to encourage sustained adoption. The approaches of each of these guilds appear to support propagation based on Henderson's assertion that long-term projects and those that recognize the complexity of the academy are more likely to succeed (Henderson et al., 2011). Also, by examining two guilds whose core founders have very different experiences with educational innovation, we saw an opportunity to explore how that experience influenced their approach.

CPREE was founded in 2014 by Drs. Jennifer Turns and Cindy Atman, faculty at the University of Washington, with funding from The Leona M. and Harry B. Helmsley Charitable Trust. CPREE's goal was for faculty to incorporate reflection in their engineering courses. The approach Turns and Atman took was to enlist investigators at 12 partner institutions and have them "(1) identify and map practices that support reflective thinking by students; (2) produce field guides to support awareness and understanding of reflective practices; and (3) promote local use, development, and sharing of reflective practices through engagement of additional educators." (CPREE, 2021). CPREE has also sponsored workshops and presentations to encourage the use of reflection in engineering education. CPREE is no longer active as of 2018, though their website is still available. While CPREE is not actively recruiting guild members or producing new materials, understanding its structure as an engineering education guild provides valuable information for pedagogical developers. Many pedagogical innovations are created in the context of grant funding, which can constrain the period of active development and propagation of the innovation to a few years, as was the case for CPREE.

KEEN was initiated in 2005 as one arm of the Kern Family Foundation (KFF), which was established in 1998. KEEN's goal is for faculty to instill an entrepreneurial mindset (EM) in their engineering students. As conceptualized by KEEN, the EM is a set of attitudes and skills that facilitates an engineer's ability to innovate and create in a way that adds value to society. KEEN works with approximately 50 partner institutions to develop and study pedagogical innovations that encourage an EM in students. KEEN facilitates this through institutional grants, workshops, annual conferences, and other professional development opportunities.

Data Collection

To deepen our understanding of the vision and practices of each of these guilds, the first author conducted 60 to 75 minute interviews with the leaders of each guild: Drs. Jennifer Turns and Cindy Atman (leaders of CPREE) along with Dr. Douglas Melton and Mr. Thor Misko (Program Directors within the Kern Family Foundation that oversees KEEN). The CPREE leaders were interviewed together, while the KEEN leaders were interviewed separately. The KEEN guild is currently led by four program directors. The two directors interviewed each had five to eight years of experience with the program and were highly involved in the expansion of KEEN that took place in the late 2010s. Of the other two program directors, one had started at the foundation only a few years prior to the interviews being conducted and the other declined to be interviewed. Given Dr. Melton and Mr. Misko's extensive involvement in guild leadership and decision-making, the research team felt that their accounts were appropriate for this study.

The overall purpose of the interviews was to understand the leaders' intentions in creating and executing their guild and, how they approached propagation of their innovation. Interviews guided by a 10-question semi-structured protocol provided an opportunity for active sense-making by the interviewee and for the interviewer to probe more deeply into the discussions of guild approaches (Hatch, 2002, p. 94). The 10 set questions were designed based on the DSAAI (Stanford et al., 2016) (see Table 2). Prior to interviewing the guild leaders, we piloted the protocol with an outside researcher who had significant experience as an educational innovator and made adjustments to improve the flow and clarity of the questions.

Each interview had four phases. These phases sought to: (1) understand the guild's core pedagogical innovation from the leaders' perspectives (2) describe select implementations of the innovation, (3) characterize the propagation activities of the guild, and (4) summarize the guild leaders' vision for the future of their innovation. The interviewer asked follow-up questions in the second and third phase to understand the resources used by the adopting instructors, approaches for supporting widespread adoption, and barriers to implementation.

The audio recordings from each interview were transcribed by a third party and checked for accuracy by our research team. As a form of member checking, we then shared the transcriptions with the guild leaders, allowing them to make corrections.

Interview Phase	Sample Interview Questions
1 - understand the guild's core pedagogical innovation from the leaders' perspectives	Describe the pedagogical innovation your organization was trying to propagate.
2 - describe select implementations of the innovation	What is/was your guild's vision for how faculty would use your innovation in their classrooms?
3 - characterize the propagation activities of the guild	What approach did you take to propagating the innovation within the engineering education community?
4 - summarize the guild leaders' vision for the future of their innovation	Looking ahead-- what is your vision for the future of your innovation in engineering education?

Table 2. Sample Interview Questions

Data Analysis

Prior to analyzing the interview transcripts, two researchers collaboratively developed an initial codebook using the dimensions and subdimensions within the DSAAI (Cole et al., 2014; Stanford et al., 2016). The DSAAI provided an initial set of codes to describe how guilds might approach the design and propagation of their innovation. Given our aim to understand how the practices of guilds align with existing literature on sustained adoption, this structure established an empirically-grounded basis for deductive coding. Both researchers then independently analyzed one of the transcripts using deductive provisional coding (Miles et al., 2017), which combines deductive and inductive coding approaches, adding additional codes to the codebook as needed (see Supplemental Information for an abbreviated codebook). New codes were added when ideas emerged from the interview that seemed important to the guilds' innovation propagation but that were not part of the DSAAI. After this initial coding of a single transcript, the two researchers met to further refine the codes and their definitions. Then a single researcher analyzed the other transcripts using provisional coding, adding to the codebook when needed to capture emerging ideas. Once each transcript was coded, both researchers met to group the resulting codes into the relevant sections of the DSAAI and to score the two guilds' propagation approaches using the evaluative section of the DSAAI. These resulting codes were then used to develop emerging themes about the guilds' approaches and an overall evaluation of how the literature currently captured the approaches the engineering education guilds used to support sustained adoption.

Research Quality and Study Limitations

We used the *Quality in Qualitative Research (Q3) Framework* developed by Walther, et al. (2013) to guide our data collection and analysis. This framework outlines six validation and reliability criteria that researchers can use to evaluate their approaches to making and handling data within interpretative qualitative research projects. In our case, for example, we based our interview questions on the DSAAI and our research question to ensure that we would be able to capture the approaches used by guilds to support innovation propagation (see theoretical validation in Walther et al., 2013). We chose to interview guild leaders because of their ability to speak about their plans for the propagation of their educational innovations (see procedural validation in Walther et al., 2013). Throughout the analysis, we kept an audit trail to document any changes to the procedures and updated our codebook to reflect new codes and definitions (see process reliability in Walther et al., 2013). In addition, the codebook was developed collaboratively by two researchers using provisional coding (Miles et al., 2017) and themes were compared to existing literature (see procedural validation, communicative validity, and process reliability in Walther et al., 2013). The researchers who conducted the analysis had prior experience with both of the guilds in the study. These connections allowed them to develop the interview protocol, ask follow-up questions, and analyze the data with a deeper understanding of the guilds' practices and culture. In addition, their prior knowledge of the guild supported triangulation at some points of interpretation, as they were able to bring in outside literature describing the practices of members of each guild. During data analysis and interpretation, the researchers acknowledged their biases through memos and discussion, each asking critical questions of the other throughout (see communicative, pragmatic, and ethical validity in Walther et al., 2013 and Walther, 2014).

We believed it was necessary to disclose the guilds that were studied because this context is important for interpreting our findings (see communicative validation, ethical validation, and pragmatic validation in Walther et al., 2013 and Walther, 2014). By disclosing the guilds, we in turn disclosed the identities of the guild leaders, which we considered throughout the data collection and analysis process (see ethical validation in Walther, 2014). For example, we informed the guild leaders that their identities would be disclosed in all publications and presentations, provided the opportunity for the leaders to review and edit their transcripts, and shared quotes that were included in this paper for their review. All data collection and analysis approaches were approved by the Rowan University Institutional Review Board.

As with any research study, there are a few limitations associated with this work that are important to keep in mind when reading the results. First, we only focused on two engineering education guilds in this study. While these guilds are unique from each other, they do not represent the full range of guilds within the field. Second, we interviewed two leaders from each guild. By interviewing guild leaders, we were able to understand the systems that were put in place to facilitate propagation and the higher-level challenges faced related to propagation. Possible other sources of data would include archival information from each guild or interviews with guild participants, however these sources were considered less useful for the purpose of understanding the leaders' intentions in creating pedagogical innovations and how they approached the propagation of their innovation. Additionally, we did not collect data that allows us to understand what was propagated and if the practices mentioned by the guild leaders translated to adoption. Future research should aim to capture the experiences of Principal Investigators (PIs) at guild partner schools and guild members to understand the perspectives of those engaged in, but not driving, the guilds. Finally, the leaders from CPREE were interviewed as a pair whereas the set of leaders from KEEN were interviewed separately. We acknowledge that this may have led to more nuanced or richer data from the CPREE leaders as they had the opportunity to interact with each other during the interviews.

Results

The primary goal of both CPREE and KEEN is to encourage the widespread use (i.e., propagation) of reflection in engineering education and entrepreneurial mindset development in undergraduate engineers, respectively. Interview analysis and relevant examples from existing literature suggest that both CPREE and KEEN's propagation activities can be classified by the descriptive dimensions of the DSAAI and score highly in the evaluative dimension of the DSAAI. In other words, their approaches are well aligned with literature on successful propagation strategies. Three additional features of the guilds' propagation strategies emerged that are not captured currently in the DSAAI, yet were considered integral to the propagation structure of the guilds: (1) funding, (2) mutual accountability and (3) public recognition of faculty innovators. In the subsequent sections, we describe the formation and management of CPREE and KEEN in the context of each dimension of the DSAAI (summarized in Table 3). To close, we discuss aspects of CPREE and KEEN's propagation strategies that are important to the success of the guilds, but are not currently captured by the DSAAI. Overall, these results emphasize how guilds build on our existing understanding of approaches to sustained adoption and also advance our knowledge on how we, as researchers and innovators, can approach the development and dissemination of educational innovations to support sustained adoption.

Product Type

CPREE and KEEN's innovations have substantial differences in their product types with reflection requiring small, individual-level pedagogical changes and the integration of EM sometimes requiring large, systemic pedagogical changes.

From our interview with CPREE's co-directors, we were able to understand how the structure and activities of CPREE mapped to the DSAAI. CPREE's reflection innovation does not require substantial change in either content or pedagogy and could be categorized within the DSAAI as either "Organized learning activities that are not connected to a particular class" or "Flexible instructional tools to promote engagement in the lecture or laboratory. Use requires less than one class period and tools are often used regularly" (Stanford et al., 2016, p. 9).

As Turns noted, reflection is not in competition with instructors' existing pedagogical practice, which reduces the barriers to adoption:

> With reflection, it became easy because we weren't trying to do active learning, which is in competition with what you are already doing in your class. And we weren't promoting a new grading practice, which is in competition with how you're grading. And we weren't proposing a new process approach.

KEEN's entrepreneurial mindset innovation spans several of the categories outlined by the DSAAI for Product Type, but the primary vision from the KFF was that EM be ubiquitous in engineering education. When asked about the vision for how faculty would use EM in their classrooms, Melton, Program Director at the KFF stated "certainly in an integrated fashion… I would say programmatically, not [just]… at one point, not just as freshmen, not just capstone, but integrated not only in a classroom, but integrated across the program." From this focus on integration into curricula and course designs, it is clear that EM would be characterized by the DSAAI as "Implementation requires use of new/revised course content and pedagogy" (Cole et al., 2014). However, the actual implementations by KEEN partner schools could be

Dimension	CPREE	KEEN
1. **Product Type -** *Descriptive*	Implementation does not require substantial change in course content or pedagogy.	Implementation requires change in pedagogy, but not course content. Full implementation is a change in mindset for all levels of the academy (students to administrators)
2. **Product Features** - *Descriptive*	Reflection activities are easily implementable and customizable; they do not require cooperation among faculty or administrative support	Methods for instilling EM[1] are customizable. However, it is most powerful with institutional buy-in and alignment.
3. **Propagation Activities -** *Descriptive*	Development started with soliciting examples of reflection from faculty at partner institutions and then these examples were compiled and organized to share more broadly. Student attitudes were also being collected to advocate for the use of reflection. Dissemination was based on storytelling, engaging with instructors, and personal connections. Dissemination and adoption support also included workshops, funding, guidance, and recognition. Notably adoption support did not include a shared language.	Development involved faculty stakeholders from the beginning and throughout, but student data was not collected. Dissemination occurs via personal connections and community. Faculty development is critical to the propagation. Adoption support includes pedagogical materials, funding, shared language, community, and recognition.
4. **Aspects of propagation strategies that influence the likelihood of success -** *Evaluative*	Intended audience was identified early and actively engaged. Strong consideration given to the instructional systems involved.	Intended audience was identified early and subsequently refined. Potential adopters were, and continue to be, actively engaged. Propagation strategy is thorough and takes into account differing instructional systems. Propagation strategy took into account the value of having administration on board

[1] EM – Entrepreneurial Mindset is a set of attitudes and skills that facilitates an engineer's ability to innovate and create in a way that adds value to society.

Table 3. Alignment between the DSAAI and CPREE and KEEN.

categorized in several different ways in the Product Type dimension of the DSAAI. For example, some partners have developed extracurricular activities to develop EM in students (Brenner, 2021) which would be categorized as "Organized learning activities that are not connected to a particular class"; while other partners have made adjustments to their courses that would be categorized as "Rethinking of current course content" (Khan et al., 2021).

Product Features

When considering the features of reflection as an educational innovation from the perspective of the DSAAI, it is clear that CPREEE's reflection activities are easily implementable and customizable. Turns stated during our interview: "you can use it anywhere. You can use it at any level, you can use it with any topic". Using the language of the DSAAI, reflection is considered either "Partially Prescribed" or "Partially Emergent". In the partially prescribed model, instructors can use materials from CPREE with minor customization (e.g., the Muddiest Point). The partially emergent form of reflection describes how users could make substantial modifications to the provided activities while following a framework supplied by the original designer (Cole et al., 2014; Stanford et al., 2016).

Reflection, for some instructors, may require "some" degree of change to teaching practices. However, while reflection activities may require incorporating additional activities into one's teaching practices, it is not an innovation that requires major changes in one's teaching philosophy. As experts, we are reflective practitioners engaging in in-the-moment reflection as well as retroactively reflecting on our actions (Dancy et al., 2019). Thus, asking our students to reflect is part of modeling the behavior of practicing and experienced engineers. Finally, reflection does not require cooperation/coordination among faculty or institutional support, as Turns explains "If I ask you or invite you to do a reflection activity with your students, nobody around you ever has to know". This characteristic allows faculty to prototype reflection activities in their courses without concern of outside judgement. While, again, these early sections of the DSAAI are not meant to be evaluative, it is logical that an innovation that requires little change to current practice and no cooperation or institutional support would be more easily propagated than a more disruptive innovation.

EM, like reflection, is nearly infinitely customizable, and instructors are expected to develop and adapt pedagogical tools to reflect their local context. According to Misko, former Program Director at KFF, "It has to be kind of their individual journey. There's some things that you could adapt, probably, from others, but... if you're not adapting it to fit your own institution or fit your own. . . class or fit your own whatever, we all know it's not gonna stick." In fact, this customizability is one characteristic that the KEEN guild leaders point to in the guild's ability to propagate EM: "that's a powerful aspect of why I think the network works so well. . . it's not doctrine". However, in order to enact sustained adoption on a given campus, EM requires institutional buy-in: "how does that lead to the sustained change on campus? ...you have to have both the horizontal and the vertical buy-in, so that was something that was important to KEEN". As Melton put it, "if the guild were just faculty members from random colleges and there was no alignment with the mission of the institution, it would have much less gravitas".

Propagation Activities

The final descriptive section of the DSAAI focuses on the propagation activities undertaken by the developers of a given innovation. The three subsections within propagation activities are Development, which answers the question "*what student and instructor data was collected during the development of the innovation?*"; Dissemination, which answers the question *"what mechanisms for dissemination were used or planned?"*; and Support, which answers the question *"what forms of support were developed or made available to adoption instructors?".*

Development

One of CPREE's major goals was, according to Turns, "trying to create a foundation of ... these are what reflection activities can look like. And these are the ways that students report benefiting from them." To achieve this, CPREE solicited input from instructors as they developed their innovations. In fact, "the whole first year of the grant was people on [partner] campuses finding out what other people on [their] campuses were already doing." Data was gathered from a range of institution types, from state flagship universities to community colleges. This data was then used to create examples of reflection in engineering education that made up the field guides produced by CPREE that could be easily shared. In addition to input from instructors, CPREE also collected student data to advocate for the use of reflection in engineering education using a survey that asked questions such as "When you did this reflection activity, did you learn stuff related to the class? When you did this reflection activity, did you feel more like an engineer? When you did this reflection activity were you more excited about the future?".

At KEEN's founding, the Kern Family Foundation invited 11 private, Midwestern universities to participate in a seed funding opportunity. The group sought to imagine how one might integrate an EM into engineering and what outcomes that integration may enable. This network of universities and the KFF continue to explore this relationship between EM and engineering and the possibilities for supporting student development of this mindset. This exploration now occurs in the form of yearly strategy-planning meetings with leaders from the 50 KEEN partner institutions and with direct solicitation from faculty who aim to cultivate EM in their students. Melton characterized the KFF's approach as follows, "everything we seem to do... seems to have a socialization and gets informed and gets adjusted, and [we] try to work in a very open way."

Members of the KEEN network also regularly collect student learning and attitudes data along with instructor use data in the form of formal assessments for entities like ABET and through less formal mechanisms. This data is then used by the KFF and partner institutions to identify use cases to pursue further and areas where support from the KFF or the network is needed. For example, the KEEN program at Georgia Tech has been focused on storytelling and portfolios (Bell-Huff et al., 2020; Morgan et al., 2021) as their approach for integrating EM into engineering. The student and instructor data suggests this approach is powerful for developing EM in students. As a result, KEEN has created faculty development opportunities focused on storytelling and has funded projects to implement Georgia Tech's innovations at other institutions.

Dissemination

Often when we think about dissemination of innovative pedagogies, papers and workshops come to mind. CPREE used these traditional methods of disseminating their innovations through presentations and workshops at American Society for Engineering Education conferences and a standalone multi-day workshop, but they also pursued less commonly used avenues of dissemination. For example, and in alignment with their ethos, CPREE focused on storytelling and personal connections to bring awareness to the use of reflection in engineering education. According to Turns, "We were very much focused on the telling of stories about how an educator did it so that other educators could get what educators love to get, which is you're just telling me what you do in your practice. You're not trying to generalize it." Additionally, CPREE's very structure, which included PIs from many institution types and involved regular meetings of these PIs, facilitated dissemination. As Atman explained, "Our network itself was propagation. So, a student at Stanford benefited from what somebody at Bellevue College created."

Like members of CPREE, members of KEEN use these traditional methods of disseminating their innovations, and they also pursue less commonly used avenues of dissemination. Members of KEEN have leveraged personal connections and community to disseminate the idea of EM development in engineering students. These personal connections and community have come in the form of annual conferences and an online platform where instructors can share their use cases and other instructors can access those examples at any time. KEEN has also offered professional development opportunities for faculty in which they are guided through the process of modifying or creating new assignments or modules that integrate EM into their own courses.

Additionally, KEEN was intentionally set up as a network to disseminate and propagate the use of EM. According to Melton, Mr. and Mrs. Kern had the vision for this notion and decided that networks would be a prime vehicle for making this work. The main decision for focusing on networks at the time was because it was an accelerant… going alone would be slower. And even working with a bunch of independent folks, you know, and even if there [were] the same numbers [it] would be slower.

Adoption Support

Adoption support can include, for example, providing instructor guides in editable formats, providing materials in modules that can be adopted as needed, facilitating mechanisms for adopters to get feedback or having follow up conversations with developers (Cole et al., 2014). For CPREE, adoption support in the form of "engaging other instructors in the development or review of instructional strategies and/or materials" (Cole et al., 2014, p. 4) was the primary mechanism for the documentation and subsequent sharing of reflection in engineering classrooms. Adoption support was also provided in the form of the reflection field guide, which presents the details of each reflection as well as tips and inspiration from the original developer of the activity. For faculty who were not formally associated with CPREE, the leaders of CPREE conducted workshops that included reflection activities for participants to experience and experiment with. Interestingly, despite the CPREE's heavy reliance on propagating reflection through networks and community, the co-directors found that having a shared language about reflection was not critical to the function of the guild. In fact, according to Turns, "it was very rare in the entire consortium where having a definition ever added any value… the definition [of reflection] very rarely made any difference in the conversation we would subsequently have."

In line with the adoption supports that the DSAAI identifies, KEEN implements multiple forms of support, including instructor guides, easily implementable materials, and social support including individual consultations. The instructor guides and implementable materials are available on KEEN's website, EngineeringUnleashed.com. The goal of the website is to be, as Misko noted "an online collaborative platform… where we're trying to connect people to people and people to content." On KEEN's website, instructors can document their classroom innovations in the form of "Cards" that other instructors can then view and modify. The Cards can include details such as learning objectives, class timing, slides, handouts, and even examples of student work. In addition to the cards, the website includes videos on what EM is and how one might start to bring EM into their classroom. The information available on the website fulfills every category noted by the DSAAI under "Support adoption by developing:" (Cole et al., 2014, p. 4) which makes the bar to trying EM in a classroom quite low. In contrast to CPREE, KEEN was intentional about developing and using shared language. According to Melton, "This whole notion of a guild… having a shared language is so critical. When you think of frameworks, why do you have a framework? Well, frameworks help you reduce, dissect, understand things, but they also have this other important property that they create a shared language."

Having a shared language facilitated the more social aspects of adoption support provided by KEEN, which also represent multiple categories in the DSAAI including "Leveraging existing professional development communities" and "Individual consultations" (Cole et al., 2014). KEEN partners often present their work in EM at the American Society for Engineering Education conferences and KEEN's professional development opportunities include year-long coaching sessions for every participant to provide support as individuals begin bringing EM into their professional lives. Melton highlighted this social aspect of adoption support:

> I can't help but go back to the supporting nature of having other people doing something similar, whether it's [on EngineeringUnleasehd.com] or conferences or so on. That it's not quite saying it's a resource, but that, that's the supporting nature that you're not doing this alone.

Aspects of Propagation Strategies that Influence the Likelihood of Success

The final dimension of the DSAAI is the only evaluative section and it focuses on evidence-based propagation strategies that innovation designers could use to ensure propagation of their innovations. This portion of the DSAAI was shown to be reasonably effective at predicting the propagation of NSF-funded educational innovations (Stanford et al., 2017). In addition, because the final dimension of the DSAAI provides a scoring rubric with six sub-dimensions, we were able to use the interview data to give each guild a score between 6-30.

Overall, CPREE scores very high on the final section of the DSAAI with five points out of five given for every category except *SA3 Project begins to address issues of propagation from the very beginning of the project*, which scored four out of five points. This resulted in a total score of 29 out of 30, which illustrates the intentionality of the CPREE co-directors in their design of the guild. According to Atman:

> When we chose [the partner institutions]... we chose four research intensive, four more teaching focused and four community colleges, because we're really, really committed to… the fact that students everywhere are valuable and valued and faculty everywhere are valuable and valued.

This quote and the overall discussion with the co-directors demonstrated that Turns and Atman specifically identified their intended audience and considered different aspects of the instructional system, which included faculty at a variety of institution types, and how reflection could work in different settings. Their propagation strategy engaged potential adopters since the PIs at the 12 partner institutions were potential adopters themselves, as were the colleagues of those PIs. Turns and Atman also clearly addressed issues of propagation from the start of the project since CPREE was set up in its guild structure from the beginning. Still, an explicit discussion of how they would elicit formative feedback from their participants was not described in the interview (i.e., why SA3 was scored a 4, rather than a 5). Finally, they were intentional about matching the propagation strategies with their innovation as was discussed in the earlier dissemination section.

KEEN scored 30 out of 30 points on the final section of the DSAAI. There was, and continues to be, a great deal of intentionality in how KEEN is structured to promote propagation. To start, the KFF identified its intended audience early on in the process:

> There was a deliberate choice to focus on faculty... [Institutional] Leaders change on [a] five-year basis it seems. Students move through and graduate, and so on… so [we focus] on faculty as the lever of the transformation we'd like to see. [We] will often talk about the hearts and minds of faculty members... There is an appeal to faculty members to make the changes in their class, in their work, in their locus of control that comes through this appeal of the hearts as well as the minds.

Faculty engagement occurred from the outset of the formation of KEEN, starting with a summit in 2006 to which nine interested schools sent representatives who spent the summit talking through the idea of entrepreneurial mindset and what bringing EM to engineering programs might look like. The engagement with faculty continued as the KFF invited applications for small planning grants from 24 institutions, 11 of which were funded and formed the first partners of KEEN. These 11 institutions were all private, Midwestern universities, but the leaders at KFF/KEEN recognized that instructional system elements would affect adoption. According to Misko, KEEN implemented a co-creation strategy to determine what works in practice for individual instructors, "There's not a silver bullet or whatever that you can just give to everyone, take two of these, call me in the morning to make this happen, right?"

This understanding led the KFF to pursue the network or guild structure as their primary propagation strategy and to continue to engage potential adopters. Melton stated:

> Now, when we think about our work, we have four elements to our strategy. One is faculty development. The second is a thriving community both face-to-face and through a digital platform. The third element is around affiliations [with existing organizations, such as the American Society for Engineering Education, Project Lead the Way, etc], and then the fourth element is around emerging ideas in higher education.

This analysis shows that KFF's approach meets all of the criteria set forth in the DSAAI for an overarching propagation strategy to have a high likelihood of success.

Propagation Considerations Beyond the DSAAI

While the DSAAI captured many of the strategies that both CPREE and KEEN used to propagate their educational innovations, we identified three additional strategies that emerged as essential to the propagation of reflection and entrepreneurial mindset, respectively: (1) funding, (2) mutual accountability, and (3) public recognition of faculty innovators. The most prominent of these strategies was funding. Both CPREE and KEEN were able to provide potential adopters with funding to engage in the work of adoption. However, the two guilds had different views of the funding they were able to provide. In the case of CPREE, the funding allocated to partner institutions from the lead institution was approximately $200,000 per partner institution, but what Turns and Atman found more useful than the funding itself was the structure they, as co-directors, gave to the partnership, which revolved around mutual accountability. They based CPREE's structure on their prior experience running several academic centers and large multi-campus grants where issues of communication and meeting deadlines can sometimes be a challenge. To enable effective communication, Turns and Atman implemented a "virtual notebook" that was utilized at all partner meetings. As Atman explains:

> We would have a task and we would have a slide deck that was completely public to [all the partner PIs]. And [every PI] had to do one slide. They had to answer the same question and their answer was completely public to everybody else. And it was transparent and increased the chance that everyone was on the same page.

For KEEN, the funding to potential adopters has ranged from small grants on the order of $10,000 to large grants on the order of $500,000 and is seen as an integral piece of the guild's propagation strategy. For KEEN, funding on this scale incentivizes institutional buy-in as well as partner accountability. According to Melton, "A very small amount of funding suddenly makes a person go, 'Oh, I've got to do that.' And it raises priority. It creates activation energy...people are so busy that if you don't have some resources attached to something...it doesn't happen." KEEN's form of mutual accountability is their funding requirement that partner efforts be documented in the form of "cards", which are described in the adoption support section. Like CPREE's use of virtual notebooks, KEEN's cards publicly highlight the successful implementation of EM achieved by partners.

With respect to public recognition of faculty innovators, both CPREE and KEEN developed mechanisms beyond funding to highlight the efforts of their partners. The funding CPREE provided to investigators at 12 partner campuses was earmarked not only for accountability in investigating the existing uses of reflection on their campus, but also for hosting events to highlight those uses. This structure resulted in "people [getting] the opportunity to get credit for things that they had already made work on their campus, but never had thought to share or had the time to share… we were giving people space to be proud of what they [had] already done". "Providing recognition for innovating" is an additional propagation strategy not captured by the DSAAI that was identified by leaders of both CPREE and KEEN as integral to their approach. As Melton stated, "If a dean identifies faculty members as really being progressive, because they're working in EM... and makes that public and visible, wow. That's a big deal…'You become what you celebrate' is one of my favorite sayings. And so that signaling is of great importance."

Discussion & Implications

The purpose of this study was to (1) articulate how the approaches of engineering education guilds align with existing literature on supporting sustained adoption of educational innovations and (2) identify how these new approaches can advance the STEM education community's discussion of propagation practices.

Engineering education guilds are a promising method for innovation propagation leading to sustained adoption. Overall, these organizations demonstrated a strong alignment with the DSAAI's evidence-based principles for sustained adoption. Both guilds offer adaptability, customization, and encourage networking and community-building through their platforms. While KEEN strives for ubiquitous change and CPREE aims for smaller-scale changes, both groups gave faculty low-risk starter activities and provided extensive adoption support for more advanced activities. They also identified their intended audiences early and actively engaged adopters in the development and implementation of their innovations.

Implications for the DSAAI

Despite overall alignment between the guilds approaches and the dimensions of the DSAAI, there were aspects of the guilds' approaches that were not captured by the DSAAI. Recommendations for modifications to the DSAAI to capture these approaches are summarized in Table 4. Both guilds had access to funding from their inception, and so were able to accomplish goals more efficiently than non-funded groups might be able to (Mestre et al., 2019). The guild leaders also noted that funding and mutual accountability facilitated success as they worked through the difficult first stages of creating these groups, a dimension not explored deeply in previous literature. The influence of funding and mutual accountability is, however, well aligned with other community-centric models such as recipients of Revolutionizing Engineering Departments (RED) grants (Margherio et al., 2021) and the UIUC communities of practice (Mestre et al., 2019). CPREE and KEEN both included a structure through which contributors could be recognized for their accomplishments within the guild, another chance for community building and a different form of accountability, encouraging participants to become contributors (Jeon et al., 2011). Shared language is a concept the DSAAI does not specifically reference, but that fits well into the Adoption Support section. While KEEN took care to name and define entrepreneurial mindset, the leaders of CPREE found that having a shared language was not important for facilitating adoption of reflection activities in engineering classrooms. This is in contrast to results in the field of organizational management that have found that more shared language between colleagues results in more information sharing (Evans et al., 2012), likely due to an increase in feelings of trustworthiness (Levin & Cross, 2004).

These missing elements—and their differences between the guilds in question—imply a need for the DSAAI to be expanded. The presence and use of funding from a group's inception can mean success where similar groups might fail, especially when it comes to grassroots initiatives (Mestre et al., 2019). Similarly, defining shared language and a shared vision has previously been identified as a crucial aspect of early community development (Margherio et al., 2021), although CPREE provides a counterexample of forming community without an explicit framework. The DSAAI currently does not specifically take into account these aspects of innovation propagation, suggesting a low-scoring propagation plan could still succeed on the basis of good funding, and a high-scoring plan could fail without a concrete shared vision. These points may present a case for changes to the DSAAI.

Implications for Pedagogical Innovators

Forming a guild is a resource-intensive mechanism for facilitating pedagogical change. Nonetheless, the guild structure may be appealing due to its implementation of a substantial portion of the existing literature on successful propagation of pedagogical innovations (Henderson et al., 2011). Specific lessons pedagogical innovators can learn from CPREE and KEEN include focusing on tools that are adaptable and customizable, thereby appealing to a wider audience of potential adopters; forging personal connections with participants and contributors, providing a platform for sharing innovations and applications, and thoughtfully addressing faculty motivations.

Conclusions

Our results suggest that guilds could provide another approach to innovation, as their structures can be aligned with evidence-based methods for propagating pedagogical innovations. Additionally, while the DSAAI captures many of the characteristics of a well-designed propagation strategy, there are additional components that emerged

Dimension of DSAAI	Subsection	Additions Suggested by This Research
Propagation Activities - *Descriptive*	Support adoption by developing	• Shared language
	Support adoption by	• Facilitating a community of instructors who are implementing the pedagogical change • Providing funding for instructors who are developing materials that utilize the pedagogical innovation • Creating recognition mechanisms to highlight the work of instructors who are implementing the pedagogical innovation
Aspects of propagation strategies that influence the likelihood of success - *Evaluative*	New subsection: A7	• Propagation strategy accounts for instructor motivation. Rubric range of 1 to 5: 1. Not at all 5. Significantly: The developer has considered and implemented strategies that are likely to motivate faculty including funding, recognition, and shared vision.

Table 4. Recommended modifications to the DSAAI that emerged in this research.

as successful strategies used by the CPREE and KEEN guild leaders. These strategies should be considered as educational innovators work to encourage adoption of their innovations, including having mutual accountability among adopters and connecting adoption of innovations to faculty reward structures in the form of recognition and funding.

Further investigation of the propagation activities of guilds that were not captured by the DSAAI—particularly as they relate to funding, accountability, and shared language—is necessary to better understand the role these aspects play in the sustained adoption of pedagogical innovations. The effectiveness of engineering education guilds as mechanisms for innovation propagation, however, is clear: they align themselves firmly with principles of sustained adoption, and present focused hubs of activity for faculty and innovators to connect and share new ideas.

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Supplemental Table. Sample codes, definitions, and examples of their applications from the codebook. Items in quotes are from Cole, et al. (2014), except in the Example Quote column, which indicates which interview participant gave the quote.

DSAAI Category *Questions answered by this instrument category.*	**Sub-Code**	**Definition (Cole, 2014)**	**Example Quote**
Product Features: *What are the characteristics of the innovation in terms of how much user modification is possible, how much instructors must change their current approach to use the innovation, how much cooperation or administrative buy-in is required, and what sorts of resources are required?*	User Modification Encouraged	"Expectation that users will be inspired to develop their own principles and design their own materials or implementation since no set framework is provided." (p 3)	"I think the creative side of this on how you take the ideas where a framework, a language and a set of concepts stop and then translate it into your context is part of the beautiful part of this work. And so I would say in terms of flexibility, I hope it is as wide as possible. I think the only sacred cow here is whatever works." (Melton)
	Cooperation / Administration Required	"Requires active involvement of multiple instructors (possibly from multiple departments) and departmental and/or institutional approval." (p 3)	"You know, institutions last longer than... While we bank on faculty lasting a long time, the institutions last longer, even if the administrators change. And so you think about the culture and value system within an institution that has some longevity. And so institutional buy in is important" (Melton)
Development *What stakeholder information was integrated into the development of the innovation?*	Instructor Use Data Collected	"Collect instructor use data in courses taught by the developers; non-developer instructors in similar educational environments"	"So the whole first year of the grant, was people on campuses finding out what other people on the campuses were already doing. So we were like this huge amplification of existing practice. So what was coming from educators was going back to educators." (Turns)
Dissemination Plans / Venues *Sub-codes were emergent*	Personal Connections	Disseminating via one-on-one interactions.	"We said, 'When you get the money on your campus, you have to have two events.' [Our partners asked], 'What's an event?' We said, '...It just has to have people coming to it.'" (Turns)
	Faculty Development Workshops/Opportunities	Disseminating via workshops or other modes specifically focused on faculty development.	"We ran a workshop in Malaysia with the World Engineering Education Forum people. We ran an online ASEE workshop." (Atman)
Adoption Support Provided: *What support the guild is providing to potential adoptees*	Advice/ guidance	"Instructor guides, implementation guides, or FAQs; guidelines/advice for implementation in different environments" (p 4).	"We're gonna help you write up these [reflection activity descriptions] and you're gonna make them available to your own campus." (Turns)
	Shared Language / Framework (emergent)	A framework or set of definitions / shared language is provided to adopters to help them make sense of the innovation.	"Frameworks help you reduce, dissect, understand things, but they also have this other important property that they create a shared language." (Melton)
Aspects of Propagation Strategies that Influence Likelihood of Success: *What evidence-based best practices did the developers implement to propagate their innovation?*	Identification of Intended Audience	"Intended audience is identified with a clear description of why they were selected for the product, and the size of the audience is estimated." (p 5)	"We selected faculty members as the agents of change. That's why the guild or network is a collection of faculty members." (Melton)
	Engagement: Passive	"Passive means conference/meeting presentations, journal articles, websites are the primary communication channels" (p 5)	"You've got this awareness piece. Read a paper about something, and it changes what you do." (Melton)
	Engagement: Active	"There is an extensive plan for attracting, training, and supporting and/or following up with potential adopters." (p 5)	"Everything we seem to do seem, seems to have a socialization and gets informed and gets adjusted, and we're try to work in a very open way." (Melton)
	Instructional System Consideration: High	"Developer has identified the following instructional system elements likely to impact adoption: decision makers, local factors, interpersonal networks, department or institutional cultures" (p 6)	"The biggest challenge is connecting to the motivation of the faculty member X at institution Y… when I think about institutions, people are often attracted to them because of the autonomy that's afforded an individual. (Melton)

Cole, R., Froyd, J., Khatri, R., Stanford, C., & Gilbuena, D. (2014, December). Resources. Designing for Sustained Adoption Assessment Instrument. http://www.increasetheimpact.com/resources.html. Accessed September 10, 2021.