

# Adoption of Pedagogical Innovations: Resource Networks of Engineering Education Guilds

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**Abstract**—This Full Research paper uses resource network analysis to explore what resources faculty use when they make changes to their pedagogy, and how an engineering education “guild” is situated among those resources. The process of influencing pedagogical change can be understood as lying along a spectrum. On one end of the spectrum is the dissemination model, where research is simply made available and instructors are expected to seek out new tools. On the other end is the propagation model, where researchers, developers, and instructors work as one cohesive team to get innovative tools into classrooms. While each of these models and the instructor resources associated with them have been separately studied and defined, approaches on the spectrum between them remain understudied. Engineering education guilds employ an approach that falls along the dissemination-propagation spectrum; they use both dissemination and propagation techniques to influence pedagogical changes. Despite lack of formal research on the subject, engineering education “guilds” have become an increasingly popular vehicle for pedagogical change in engineering education classrooms. One such engineering education guild is the Kern Entrepreneurial Engineering Network (KEEN), which is focused on integrating entrepreneurial mindset (EM) into engineering curricula. By constructing resource networks for educators who have been exposed to KEEN, we aim to understand the role of KEEN among the myriad resources used by engineering educators when they integrate EM-related content into their classrooms. Results suggest that engineering education guilds are central to the resource networks of faculty looking to innovate their pedagogy, with the most popular resources all falling under the guild’s umbrella. These resources are also strongly interconnected, especially during the integration process. However, the resources networks of those who saw successful, complete, sustained adoption reached beyond the guild’s umbrella, forging connections with a variety of other materials from different sources.

**Index Terms**—component, formatting, style, styling, insert

## I. INTRODUCTION

It is the primary mission of most educational research communities to innovate on best practice, always searching for new and better ways to teach. Implicitly, the secondary mission

of these educational research communities is to help these innovations reach students. However, the process of adopting new practices into the classroom is a complex one, and the mere existence of new, research-supported methods does not necessarily lead to classroom changes.

Unfortunately, this important link between published pedagogy innovations and their adoption into classrooms is often weak or broken [1], [2]. While innovations continue to be developed, tested, and published at an overwhelming rate, instructors often struggle to incorporate these new methods into their classrooms [3]. Examining and defining the resources faculty use when they make changes to their pedagogy will help build an accurate picture of which resources are most effective, especially when it comes to sustained adoption of these changes.

While many resources have been studied on an individual basis [4], [5], [6], [7], newer methods of pedagogy adoption have not yet been the subject of formal research. One such method has become an increasingly popular tool for innovation: engineering education “guilds”, professional development groups aiming to bring pedagogical best-practices into engineering classrooms.

The purpose of this paper is to understand the role of engineering education guilds among the resources faculty use to make changes to their pedagogy through network analysis. The results orient guilds as a singular resource, as well as considering the variety of resources they produce and host (such as workshops and conferences).

## II. BACKGROUND

The existing literature on pedagogy innovation outlines two adoption strategies: dissemination and propagation [8]. Dissemination captures most educational journals and other publications; when the knowledge is supplied to the community, the community will pick it up and find a way to fit it into their curriculum at will [8], [9]. Propagation, on the other hand, seeks to provide potential adopters with the support of

pedagogy developers [8], [9], [10]. While these methods are currently treated as separate boxes into which other strategies are sorted, they can also be examined as extremes on the ends of a spectrum [8].

It is from this spectrum approach that the concept of engineering education “guild” arises. Much like a medieval guild of merchants and craftsmen, we define engineering education guilds as professional development groups that aim to bring pedagogical best-practices into engineering classrooms. Some examples of organizations like this are the Consortium to Promote Reflection in Engineering Education (CPREE) and the Kern Entrepreneurial Engineering Network (KEEN). These organizations put considerable resources towards innovating and developing new educational tools [11], [12], some of which are taught through workshops and colleague collaboration [13], [14], and some of which are merely presented in the hopes that instructors may find them and make them work on their own [11], [12].

Despite the complexity involved in categorizing the overall approach to adopting pedagogy changes, the individual resources faculty use in this process are much more familiar, and more broadly studied. As previously mentioned, publications are considered one of the primary methods for disseminating pedagogy innovation to instructors; however, despite their popularity in the discovery process, they have been found ineffective at promoting sustained adoption [6], [7]. In fact, when it comes to finding or seeking out new educational tools and theories, conference presentations and pure word of mouth proved to be better methods than traditional journal articles [7]. Innovations presented in conferences [15] or through workshops [4], [15] also stand a better chance of being adopted into classrooms. In the opinion of faculty and administration, workshops have overtaken teaching courses and textbooks as a more effective method of keeping up with educational trends [4], [16], [17], [18].

Of course, many instructors also place value in their peers and coworkers as resources to support innovation. Much of the literature relating to the spread of pedagogical innovation places a strong importance on the interpersonal networks of faculty, both in the form of colleagues and mentors [4], [5], [6], [7], [16], [19], [20], [21]. This importance is leveraged through other, more structured resources: workshops present focused networking opportunities [4], peer observation and review help instructors improve through constructive feedback [5], [20], and mentorship programs establish and build relationships with the end goal of improved and innovative pedagogy [16], [20], [21].

Within the structure of an engineering education guild, faculty can access many of these diverse resources they might have otherwise sourced from separate locations. For example, KEEN not only funds and publishes research in traditional journal articles [12], but also hosts workshops and conferences [14], and provides a hub website where members can network [12]. As such, guilds cannot be accurately categorized with these other, more comprehensively studied resources. This makes it difficult to predict their usage and their effectiveness

based upon existing research.

This paper confronts the lack of focused research on the presence of guilds among other faculty resources. By surveying members of a guild, we hope to both show how guilds function as a singular resource, as well as how faculty use them in combination with other resources. These results will then be reported back to the engineering education guild discussed in this paper. The research question addressed in this paper is: What are the characteristics of the resource networks for faculty who adopted the pedagogical innovations championed by KEEN?

### III. METHODS

The goal of this study was to model the resources used by engineering educators when they make changes to their pedagogy, and understand how KEEN, an engineering education guild focused on entrepreneurial mindset, fits among those resources. This information was collected through a survey distributed to members of KEEN identified as leaders / primary participants. Within the survey, respondents were also able to identify other KEEN participants, which allowed the team to then distribute the survey even further through snowball sampling. No incentives were offered for completion of the survey.

A total of 34 KEEN participants responded to the survey in its entirety. The survey was designed to collect information regarding respondents’ inclusion of the entrepreneurial mindset (EM) in their classrooms—KEEN’s primary goal as an organization. The following questions are a subset of those in the survey and were used to answer the research question:

- 1) How often do/did you make use of assignments relating to the development of Entrepreneurial Mindset (EM) in your classroom(s)? (Multiple choice: constantly / often / sometimes / rarely / never)
- 2) How did you learn about EM in engineering education? Select all that apply. (14 checkbox options, including a write-in “other”)
- 3) What resources did you use to support your integration of EM-building activities in your classroom? Select all that apply. (14 checkbox options, including a write-in “other”)
- 4) Of the resources listed above, which was the most influential in helping you build EM your classroom(s)? (Open-ended)

The data was analyzed in two ways. Firstly, the responses to questions 3 and 4 were used to generate resource network diagrams. Resource network diagrams were generated through a 14x14 matrix, where each cell represented the connection between two resources. Each time a respondent indicated the use of two resources in conjunction, the cell representing their connection was increased by one. The result is a diagram that not only shows the connections between the listed resources, but also the strength of those connections—a line in the network indicates that at least one respondent listed those resources together, and the thickness of those lines represents the number of respondents who listed them together. Separate

resource network diagrams were generated for question 2 and 3, allowing the research team to compare introductory networks with integrative networks.

Secondly, the data from question 3 was further separated by responses to question 2, and two additional resource networks were generated. This allowed the research team to analyze which resource networks supported sustained, constant adoption of pedagogy into the classroom.

#### IV. RESULTS AND DISCUSSION

Of the 34 responses to question 2, six respondents noted only a single resource (four indicated KEEN alone, and two indicated a colleague at their institution). These responses are not represented within the resource network diagram, as they do not demonstrate any sort of connection between available resources. In the following diagrams, resources marked with a ‘K’ denote resources related to KEEN, while resources marked ‘NK’ denote resources not related to KEEN.

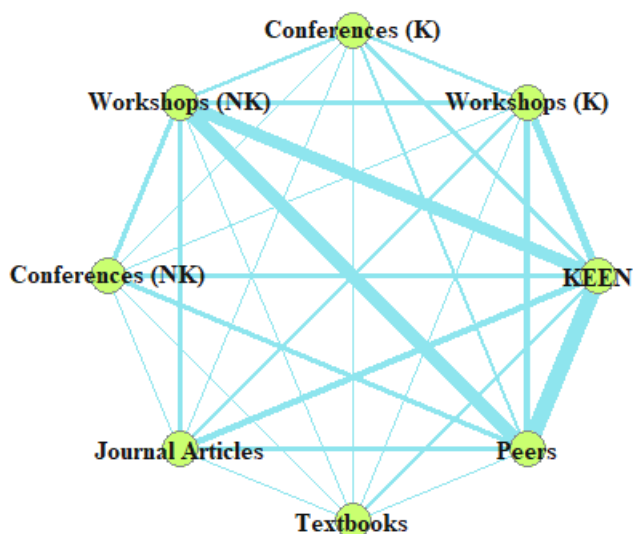


Fig. 1. Network of resources educators used to learn about EM

First and foremost, the top three resources were KEEN itself (with 21 responses), some kind of peer (27), and some kind of workshop (24). While KEEN’s major role in this diagram is an expected result, its connections to other resources are of interest. KEEN’s connection to peers is the strongest, and its connection to non-KEEN workshops is the second strongest. Across the 34 responses, 17 connections between KEEN and non-KEEN workshops were identified, and 22 connections between KEEN and peers. The interconnections between these resources are also strong, suggesting that all three of these resources are frequently used in conjunction. Across the 34 responses, 15 connections were made between peers and non-KEEN workshops.

For question 3, only two respondents indicated the use of a single resource (one colleague alone, and one KEEN workshop alone). This decrease in isolated resources indicates

that integrative resource networks generally require more than one resource to be effective.

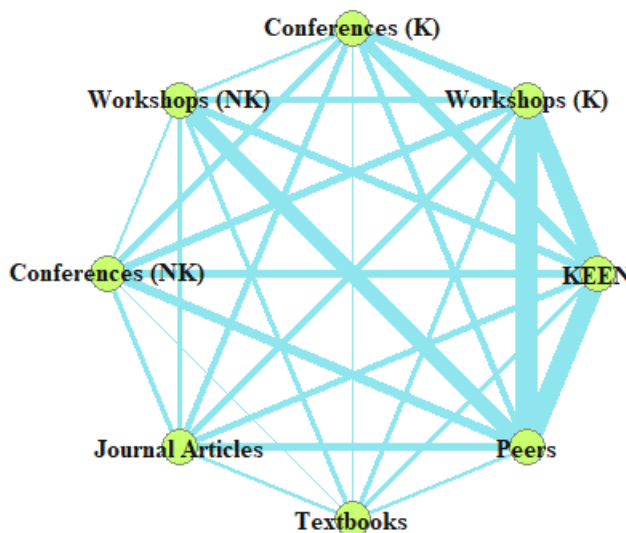


Fig. 2. Network of resources educators used to integrate EM into their classrooms

While the top three resources remain the same (KEEN with 29 responses, peers with 28, and workshops with 26), the integrative resource network has a greater breadth of connections when compared to the introductory network. The connections between non-KEEN workshops and KEEN have weakened, dropping from 17 to 11. However, the interconnections between KEEN resources have all increased. Most noticeably, the connections between KEEN workshops and other KEEN resources have all grown. This indicates that faculty are using a variety of KEEN resources while they integrate EM-related pedagogy into their classrooms. Also of interest are the connections to peers—across the 34 responses, 26 respondents noted a connection between peers and KEEN and 29 between peers and KEEN workshops. In some ways, it is expected that faculty will reach out to peers for help with integration, especially through feedback or collaboration. However, one interesting dimension of these interactions is the opportunity to teach others about EM; of the 21 respondents who offered their peers’ contact information, seven noted that they had taught at least one peer about EM. As one respondent advised in an open-ended question, “teach it to someone else. As we all know you retain much more when you teach something.”

From this comparison, a few important points can be drawn out. The first is that KEEN itself is an important resource both in introducing faculty to new pedagogy (analogous to dissemination strategies), as well as in supporting the adoption of this new pedagogy into the classroom (analogous to propagation strategies). The second is that, while these networks do have a few differences, they display a fairly similar structure overall: the most common resources (KEEN, some kind of peer, and some kind of workshop) are the same across both networks,

with similar relative interconnectedness. Applying this to the dissemination-propagation paradigm, we see that the types of resources used for each style of pedagogy adoption do not have any truly notable differences.

That said, this comparison does not tell the whole story. While these diagrams do display an overall similarity, they can be further broken down by a vital metric: the success of adoption into the classroom. As part of the survey, respondents noted how often they used EM-related material in their classes from the following choices: constantly and consistently, often, sometimes, rarely, and never. The diagrams created within these categories show not only which resources are more connected, but which connections are more effective in sustained adoption.

Of the 34 respondents, none marked “never” (an expected result, as these individuals all have primary involvement with KEEN), and only one marked “rarely”. 12 respondents marked that they use EM “sometimes” in their classrooms, 12 as using EM “often”, and 9 as using EM “constantly and consistently”. The following diagrams visualize the responses to question 3 (What resources did you use to support your integration of EM-building activities in your classroom?) for the “sometimes” and the “constantly and consistently” cohorts, and have been normalized for more direct comparison.

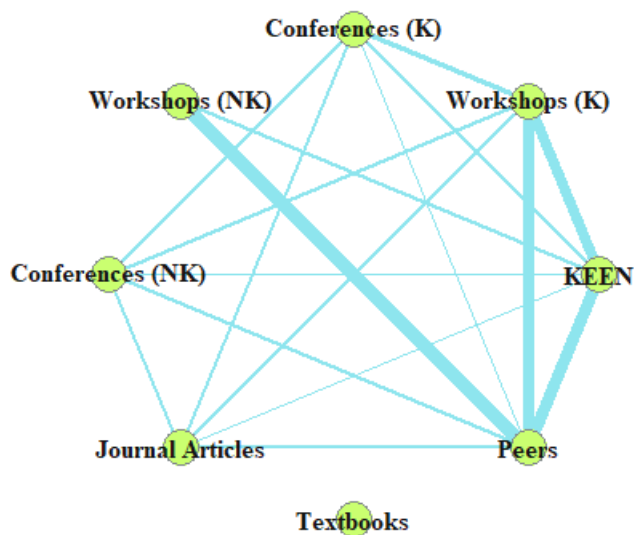


Fig. 3. Network of resources educators used to integrate EM into their classrooms “sometimes”

The most obvious result of this type of analysis is the increased interconnectedness of the networks for instructors who “constantly and consistently” use EM compared to instructors who “sometimes” use EM. While “sometimes” users place a heavy emphasis on KEEN resources, peers, and workshops, “constant” users reach further into resources like journal articles and educational textbooks. This suggests that a wider, more heavily-connected resource network leads to sustained adoption.

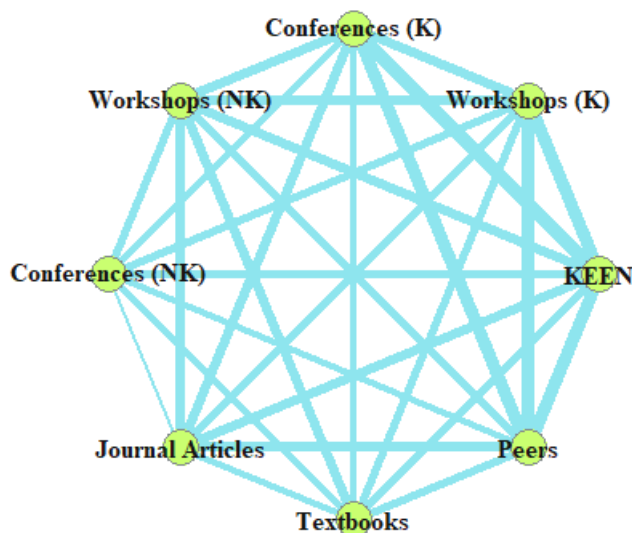


Fig. 4. Network of resources educators used to integrate EM into their classrooms “constantly and consistently”

One other useful metric by which we can examine these diagrams is the average number of resources per response. A wide, even network does not necessarily imply the use of many materials on an individual basis. Across the 12 responses marked “sometimes”, the average number of different resources selected was 3.75, compared to the average of 5 resources across all nine “constantly and consistently” responses. From this, we can see that individuals who have a more successful and complete integration of EM into their classrooms utilize more types of resources on average. This suggests that a diversity of resource types leads to more successful and sustained adoption.

Regardless of the level of adoption, workshops and peers appear to be popular sources for introductions to new pedagogy. Looking beyond their popularity, however, we can begin to examine which resources were perceived as most influential. This reliance on resources under the KEEN umbrella holds true in the open-ended question 4, where respondents were asked to identify their most influential resource in sustained adoption. Of the 34 total respondents, 11 identified peers (both through KEEN and through their institutions) as being the most supportive influence, 13 referenced KEEN-led workshops, six referenced KEEN conferences, and two referenced KEEN in general. The remaining two responses replied “none”.

From this, we can conclude that KEEN’s resources are not only central to the resource networks of KEEN members, but also the greatest influence on KEEN members’ adoption processes. However, only two respondents pointed to KEEN as a whole—most, instead, pointed to a specific resource or experience as being most influential. This suggests that KEEN participants judge their experiences with KEEN on a case-by-case basis, and consider resources under the KEEN umbrella as largely separate.

## V. CONCLUSION

The goal of this research is to model the resource networks of faculty as they make changes to their pedagogy, and where engineering education guilds fall among these resources. Based on these preliminary results, effective resource networks (those which led to sustained adoption and consistent use in the classroom) utilize many diverse resources in combination, with guilds, workshops, and peers being the most influential and the most popular resources. The influential power of workshops and interpersonal relationships aligns with previous research [4], [5], [15], [19], [20], [21], and the addition of guilds to this group is unsurprising—all of them offer strong support networks to aid in the integration process. However, educators who reached further and used other supportive materials (such as journal articles, conference presentations, and educational textbooks) reported even more consistent use of the innovations in their classrooms. As such, it is suggested that guilds such as KEEN focus their efforts on creating and maintaining strong faculty support networks and workshop experiences, but take care not to neglect other, more dissemination-focused resources as auxiliary tools for innovation. It is also important for KEEN to realize that, in the most successful cases, they are one of many diverse resources; it is in the best interest of educators that guilds such as KEEN educate themselves on other available resources, and provide appropriate recommendations.

Currently, these results are limited by their singular nature. In the future, this analysis method will also be applied to members of the Consortium to Promote Reflection in Engineering Education (CPREE) for a broader look at the similarities between engineering education guilds, and to push towards a more comprehensive understanding of guilds' place in faculty resource networks.

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