Providing Meaningful Change in the Engineering Classroom

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***Abstract*—This study aims to address how change agents assist engineering instructors in adopting new curriculum. During a two-day workshop, 16 mechanics of materials instructors from community colleges and universities around the Pacific Northwest developed hands-on activities and models that they later implemented in their classrooms. Five additional instructors became interested in the materials developed at the workshop through their interactions with some of the instructors that attended the workshop. After the workshop and during the academic year, a change agent was assigned to each instructor. The change agents communicated with their instructors on a regular basis in order to identify any needs the instructor had for implementing their new materials. Interactions between the instructors and change agents were tracked through the change agents' personal notes on their interactions and two semi-structured phone interviews held during and after the term in which the course was taught. Instructors most often requested assistance from the change agents in how to manage and use some of the materials. These interactions indicate that a change agent working in a pull-model approach encouraged the instructors to be more engaged in the change process throughout their entire course and therefore benefited their teaching and course effectiveness.**

Keywords—Change agent, Diffusion of innovations, Pull-model, Engineering education

I. Introduction

In attempt to understand what motivates people to change, extensive research has been done in several fields on what makes innovations adoptable, how the concerns of potential adopters affect change, and how does the dynamic relationship between promoters and adopters influence change. Specifically, in education there is interest in the adoption mechanism of interactive teaching strategies by teachers in their classrooms. This paper aims to introduce the preliminary findings of an on-going, iterative, action research project. This project looks at how college engineering instructors perceive the evolution of their curricula and professional development through developing and implementing new teaching strategies with engineering education researchers.

II. Background

Dissemination of innovations has been frequently modeled as a push versus pull mechanism in which innovators push change onto adopters or adopters pull innovations from innovators; or, in some cases, a multidimensional model combining push and pull [1]. Previous research has focused on the mechanisms and effectiveness of the push model, with only a handful of studies examining the pull model; even though it is well understood that allowing potential adopters a larger role in the innovation process facilitates a greater willingness to change [2]. While recent research has examined more variables affecting the change process other than whether it is being pushed or pulled, it is important to understand this dichotomy as all change processes can still be described as one or the other.

In *Diffusions of Innovations* [3], by Everett Rogers, there are five variables that affect the rate of adoption of innovations. These are: 1) perceived attributes of innovations, 2) type of innovation design, 3) communication channels, 4) nature of the social system, and 5) the extent of change agent promotion efforts. Extensive research has looked at potential adopters' perceptions of innovations, but not nearly as much has been done on the latter four variables, particularly relating to the adopters' perspective [3]; which is important in any pull model. While all of these variables are important, this paper focuses on the extent and perception of change agent promotion efforts amongst engineering educators. Rogers defines a change agent as an "individual who influences clients' innovation decisions in a direction deemed desirable by a change agency" [3]. This definition fits more accurately in a push-model since it is the change agency directing the diffusion in the way they best see fit. A similar definition for a change agent in a pull-model is an individual who aids in clients' innovation decisions in order to create and sustain the clients' desired change. That being said, the other variables are intrinsically linked in the interaction between the change agents and the instructors; which will be further discussed in the methods section of this paper.

This paper examines the importance of understanding instructors' utilization of a change agent, or facilitator, to help them pull the innovation that they want in their classroom. The reasoning for this is based on research examining barriers to instructors implementing research-based instructional strategies (RBIS) in their curricula. Dancy and Henderson [4] identified two main barriers for why instructors struggle in adopting RBIS: 1) the instructor is often not considered in the development of the RBIS and 2) the developers of the RBIS rarely follow up on the implementation process of their RBIS. Both of these barriers are characteristic of a push model. Therefore, it is worth investigating a pull model that

implements a change agent working with the instructors rather than for the developers in order to see if these barriers can be resolved.

III. PURPOSE

The purpose of this research project is to gain a holistic understanding of how instructors interact with, utilize, and perceive the promotional efforts of a change agent to aid them in implementing instructional innovations. These instructional innovations were co-developed by the instructors and education researchers or were developed by their peers. Obtaining such information is an important step in understanding how instructors perceive changes to their curriculum and what motivates them to make such changes.

IV. METHODS

Over the last three summers, a two-day workshop has been held with roughly 15-20 mechanics of materials instructors and four to six engineering education researchers. A fourth workshop is planned for August of 2016. The instructors that have participated thus far in the workshops were initially recruited as colleagues of the PI with new instructors attending each year through snowball sampling.

At these workshops, the mechanics of materials instructors discuss their classes and what they wish to change about them as well as what types of new strategies and curricular activities they want to try and implement. The instructors then break into groups based on similar goals and interests and are provided access to a variety of materials to develop innovations for their classrooms. At the end of the workshop, the groups present their innovation to the other groups and discuss ways of improving or making the innovation more adaptable to different classroom settings. After the workshop, the engineering education researchers work on developing and providing the innovations to the instructors in a timely manner before they need to implement them in the classroom.

To be clear, the engineering education researchers are encouraging, pushing, the instructors to implement more interactive teaching strategies into their classrooms. However, the workshop and change agent are resources provided to the instructors to give them the freedom to pull these innovative strategies in a manner that best suits them to make actual change in their classroom. Indeed, as the economist, Christopher Freeman, put it: "any satisfactory theory [of adoption] must simultaneously take into account both elements [of push and pull]" [5].

Since this is an iterative action research project, the methods have slightly evolved over the years. Consequently, the remaining portion of this section will focus on the current on-going methods that are being used with the instructors that taught mechanics of materials during the 2015-16 academic year. At the 2015 summer workshop there were 16 mechanics of materials instructors from the Pacific Northwest. Of these 16, nine teach at universities and seven teach at community colleges. There were seven female instructors and nine male instructors. After the workshop, many of these instructors shared their experience and the materials they developed at the workshop to colleagues at their institutions that would also be teaching mechanics of materials. As a result, six additional instructors were added (4 teach at universities, 2 at community colleges; 4 females, 2 males) to the research project. Class sizes for this group of instructors range from 5 – 200 students, with three to six hours of class time/week and/or zero to three lab hours/week. Teaching experience of the instructors varies from some being in their first year of college teaching, to others who have experience teaching other courses, but this is their first time teaching mechanics of materials, all the way to highly experienced professors who have been teaching for several years. Thus it can be seen that even though the sample is relatively small, there is substantial diversity in the experiences the instructors have had and will face while developing their curricula.

The major difference in this year from previous years of the project is that each of the instructors discussed in the paragraph above have been assigned a change agent. This change agent communicates with them regularly over the phone, email, and through a Canvas course webpage. The change agents are two undergraduate research assistants that have each dedicated roughly five hours/week to work with and help meet the instructors' wants and needs in order to aid in the implementation of the innovations developed at the workshops. This illustrates how Rogers' other variables: such as communication channels and the nature of the social system are important aspects that influence the efforts of the change agents and the perception of the change agent by the instructors.

While the change agents document their interactions with each instructor, the researchers also will conduct semi-structured interviews with each instructor before and after their terms in which they teach mechanics of materials. The interviews aim to understand how the instructors perceive the efforts of the researchers and change agents and how their professional development and classes have evolved since the inception of their participation in the project. These interviews were transcribed and then coded using the qualitative data analysis software, Dedoose. Initial coding began after the first interview was completed and transcribed. As more interviews were completed, the coding scheme evolved by adding new codes and dropping or merging less reliable codes. This evolution of the coding allows for greater reliability to be achieved as the codes become more tailored to the project [6-8]. The primary author developed the coding schemes and reviewed them with the secondary author, who is also the PI on the project, in order to make sure the codes were reliable and agreeable [9].

Multiple, descriptive-explanatory case studies were chosen as the means of analysis for the data obtained from each instructor through the in-depth, semi-structured interviews. Case studies were chosen because they allow for the study of complex phenomena within specific contexts and are valuable for developing theories, evaluating programs, and developing interventions [10]. More specifically, descriptive-explanatory case studies focus on describing an intervention or phenomenon within a real-life context and explaining the implementation and effectiveness of said intervention [11]. In regards to this project, the intervention of interest is the instructors' involvement with the workshop and their change agent, and the phenomenon is the adoption of new teaching

strategies and materials. The context is defined by the teachers' experiences with the workshop, their change agent, and their students in the classroom.

V. Anticipated Results & Disussion

Interviews are still being conducted with instructors throughout the remainder of the 2015-16 academic year. That being said, there has been an extensive amount of data collected from the previous three years of this project that has influenced the introduction of change agents and will be presented in this section.

At the 2014 summer workshop, several instructional activities and demonstrations were developed for the instructors to use when teaching axial loading, bending, combined loading, St. Venant's principle, and stresses and strain in their mechanics of materials classes. It was found that even though the instructors developed these innovations, some still struggled in adopting and implementing them into their classrooms. The researchers believed some of the main reasons for this related to the time span between development at the summer workshop and implementation during the academic school year and not having the personnel to provide the innovations to the instructors far enough in advance. As a result of both of these reasons, the instructors expressed not having enough time and resources to plan their curriculum. Thus, a major goal after the 2015 summer workshop was to provide the instructors with their innovations well before the term they teach mechanics of materials and also provide them with timely and continuous support throughout their term. This led to the decision to implement a change agent to work with the instructors in providing them the materials and technical support in applying their innovations.

Since the summer 2015 workshop, there have only been three participants to teach a whole term of mechanics of materials. From the interviews conducted with these instructors, the most salient perception of the change agent made by the instructors has been the accountability created by the change agent's presence. All three instructors have expressed that the main benefit of the change agent is that their frequent communication keeps them more engaged with the materials developed at the workshop. This led to them being more aware of their own implementation process; which they felt held them more accountable to implementing their innovations. One participant when referring to their change agent said: "he was almost like an instructor, counselor in a way. He didn't provide a ton of recommendations or ideas, but it caused me to recognize the times when I should have used the packet a little better or more." Another participant put it more simply when referring to their change agent, stating: "He kept me on task…For me then, he was just a reminder that, 'Oh, right I said I wanted to try something new. I should stay on top of that'". These interactions demonstrate that the instructors perceive their change agent similar to a peer instructor/co-worker that they might share stories with and bounce ideas off of each other.

The action research approach to this project has enabled a progression to the pull model being developed in order to understand how instructors perceive changing their curricula. The workshop started as a way to allow instructors to pull innovations in a manner that suits their situational concerns. After the first two workshops, it was found that in order to enhance adoption of innovations amongst this group of mechanics of materials instructors, more needed to be done than simply having the teachers develop their own materials. This has led to the added dimension of the change agent to aid the instructors in implementing their innovations. Perhaps even more importantly than providing technical assistance with implementation, the change agents' interaction with the instructors helped each instructor be more reflective of their change process in voicing out their concerns and needs that otherwise would have gone unnoticed.

VI. Conclusion

While extensive research has been done on what factors influence adoption of innovations and how to facilitate change in the field of education, there is still some confusion and myths that are attributed to the lack of adoption of innovations by educators. In order to help resolve some of this confusion, this project has set out to understand the teachers side of adoption over the last few years and has found that by increasing efforts to work with the teachers, adoption of interactive teaching strategies and providing actual change to the engineering classroom is possible. With at least one more workshop planned for the summer of 2016, the researchers look forward to examining more ways to improve the adoption of more interactive teaching strategies into the engineering classroom.

Acknowledgment

This material is based upon work supported by the National Science Foundation under Grant No. 1225036 and 1361417.

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