AC 2012-4455: BRIDGING THE VALLEY OF DEATH: A PRELIMINARY LOOK AT FACULTY VIEWS ON ADOPTION OF INNOVATIONS IN ENGINEERING EDUCATION

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Bridging the Valley of Death: A Preliminary Look at Faculty Views on Adoption of Innovations in Engineering Education

Abstract

There is a nationwide need to better translate engineering education research into the classroom setting. Moving engineering education research into practice is a more complicated task than it might initially seem. There are many significant barriers to hinder the transition from research to implementation. These barriers can be categorized into two groups: (1) individual barriers, such as personality characteristics that contribute to a lack of willingness to implement innovations, as well as a lack of knowledge about engineering education research; and (2) environmental perceptions, such as perceptions of the tenure and promotion process that suggest a lack of support for innovations.

The project discussed in this paper investigates the characteristics of faculty members who successfully adopt engineering education innovations and studies the impact of their working environment on their decision to adopt. Additionally, the project investigates characteristics of faculty members who do not adopt engineering education innovations and whether that decision was affected by perceptions of their working environment.

This paper describes preliminary results of a data collection effort identifying current barriers faculty members have in the adoption of innovations in engineering education. This paper presents data from two perspectives, that of self and colleagues. These perspectives are part of a larger 360° approach for data collection that also includes the perspectives of students, experts in education innovation—such as the director of a center for teaching and learning, administrators, and published documents. This 360° approach provides a foundation for bridging the gap, often referred to as the 'valley of death,' between engineering education research and the common practice of engineering education.

Introduction

The act of translating research into practice is often a tenuous one, regardless of the context. Money and time are spent performing research, the results of which may be later abandoned or ignored instead of moving forward the knowledge gained—or product—into practices—or market. This chasm between research and practice where innovations disappear is sometimes referred to as the 'valley of death'[1]. It has also been described by some with a 'survival of the fittest' analogy[2]. Regardless of terminology, the end result is the same—investments in research are made, the results of which often get lost or never transferred to practice when the intermediary step is ignored.

This concept is true for product innovations—many products and inventions never evolve beyond the inventor's desk, simply lacking the funding to progress to the next step[2]. Research in engineering education is supported through funding from organizations such as the National Science Foundation (NSF) and is published in journals such as the Journal of Engineering Education, the results of which are not often put into practice in classrooms across the United States[3].

Organizations such as the American Society for Engineering Education (ASEE) and the National Academy of Engineering (NAE) agree that we must produce engineers today and into the future with competencies well beyond those expected of past engineers and prepare our new engineers to work in a global society[4, 5]. Engineering education itself must change and become both more effective and efficient at accomplishing this feat[5]. We must draw on the available engineering education research to improve our classrooms and our teaching both now and in the future.

Moving engineering education research into practice is a more complicated task than it might initially seem. There are many significant barriers to hinder the transition from research to implementation. These barriers fall into two categories: (1) individual barriers and (2) environmental perceptions. Some examples of these barriers are listed below.

- Individual barriers:
  - Personality characteristics contribute to an individual faculty member's desire and willingness to implement or ignore innovations in engineering education[6, 7].
  - Current and emerging faculty members are highly skilled in the technical aspects of his or her engineering specialty while lacking skills in pedagogy[6, 8].
  - Many faculty members lack specific knowledge of current research in engineering education[5, 6].
- Environmental perceptions:
  - Perceptions of the tenure and promotion system at many institutions suggest that innovations in engineering education re not supported[5, 6, 9].
  - Faculty members perceive that rewards and incentives for implementing innovations in engineering education are not made at the same level as advances in scholarly pursuits[10, 11].
  - Demands of faculty members to teach courses, conduct research and scholarly activity, and perform service contribute to a perceive lack of time to implement innovations in engineering education[10, 12].

There are also barriers at a level beyond an individual and his or her organization, including the lack of funding for the intermediate step in bringing research findings into practice. Another important barrier is a lack of engineering education programs, particularly at the graduate level, that promote engineering educational research and its value. There are currently only four such programs in the United States.

This research project addresses these challenges by investigating the characteristics of faculty members who successfully adopt—and who do not adopt—engineering education innovations and also studies how the working environment impacts on his or her decision to adopt—or not adopt. This work promotes successful faculty characteristics and work environments by recognizing aspects that are effective in the transition from research to practice. It also acknowledges faculty characteristics and work environment perceptions that may impede the successful adoption of engineering education innovation into the classroom. This project promotes a realignment of individual and institutional priorities through the development of an implementation model aimed at increasing the number of faculty members successfully adopting engineering education innovations.

Objectives

The goal of this study is to promote successful faculty characteristics and work environments by recognizing aspects that are effective in the transition from research to practice. The project will develop new knowledge in the areas of innovation adoption, change management, and attitude-behavior theory. Specific research objectives for this project include:

- Characterize faculty members who:
    - successfully implement engineering education innovations;
    - choose to not implement engineering education innovations.
- Characterize work environment perceptions of faculty members who:
    - do implement engineering education innovations;
    - do not implement engineering education innovations.
- Develop an implementation model that promotes successful faculty characteristics and work environments.

Specific tasks, discussed in further detail elsewhere[13], must be performed in order to achieve these research objectives, including:

- Assess, document, benchmark, and validate: (a) characteristics of individuals who adopt—or choose not to adopt—engineering education innovations and (b) his or her respective work environment;
- Analyze faculty characteristics of adopters and non-adopters to determine the correlation of faculty characteristics with successful adoption;
- Analyze interactions between the work environment perceptions and individual faculty member characteristics to identify relationships for model creation; and
- Develop and validate a new implementation model to enable more successful transfer of engineering education research to practice.

Approach

The research approach is comprised of three phase: (1) assessment, (2) analysis, and (3) model development. The first phase assesses, documents, benchmarks, and validates characteristics of individual faculty members who adopt—or choose not to adopt—engineering education innovations. This phase also assesses, documents, benchmarks, and validates perceived characteristics of the respective faculty members' work environment. The second phase analyzes faculty member characteristics of adopters and non-adopters to determine which correlate to successful adoption of engineering education innovation. Interactions between the work environment perceptions and individual faculty member characteristics will also be analyzed to identify relationships for model creation. The third phase of this research develops and validates a new implementation model to enable more successful transformation of engineering education research into practice. This paper focuses on the first phase of this research and is described in detail below.

Phase I: Assessment

Phase I addresses the first two objectives of this research, which are (1) to characterize faculty members who successfully—or choose to not—implement engineering education innovations, and (2) to characterize work environment perceptions of adopters and non-adopters. Phase I consists of one task—data collection.

Data Collection. The first phase of this research involves extensive data collection. Data collection techniques include self-report surveys, focus groups, individual structured interviews, and document analysis. The data for this research are being collected using a 360-degree—or multi-rater—method. The 360-degree method is commonly used in performance evaluations, providing feedback to an individual from multiple perspectives[14]. This method is being used to collect data from many different perspectives forming a reliable and valid picture of faculty member characteristics and work environment perceptions. Perspectives include that of self, colleagues, students, experts in education innovation—such as the director of a center for teaching and learning, the reality—from administrators and published documents, and individual perceptions of the tenure process and rewards/incentives (see Figure 1).

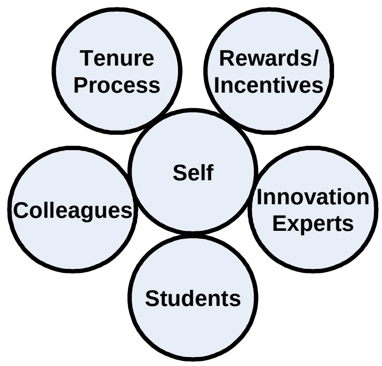

Figure 1. 360-degree data collection

While it is desirable to sample engineering faculty members throughout the United States, the current research's scope is limited to a single university, focusing instead on data collection and analyzing the issues in greater depth. The sample for this research are the faculty members in the College of Engineering at Boise State University (BSU), a predominantly undergraduate university. The College of Engineering (COEN) has seven Master's degree programs and two Ph.D. programs, in addition to six undergraduate programs. There are approximately 70 faculty members in COEN serving approximately 1,500 undergraduate and 300 graduate students.

Self-report surveys are one data collection method that has been used initially to characterize individual faculty members ('Self' in Figure 1). Data collected includes demographic questions such as age, sex, and level in the organization—instructor, assistant professor, et cetera. Another set of questions evaluates an individual's attitude toward change and includes metrics such as the Change Scale[15], the Reaction-to-change Inventory[16], and the Irrational Belief Scale[17]. These questions enable us to evaluate the willingness a faculty member exhibits toward using engineering education innovations in his or her classroom. Additional question sets were included for individuals to self-evaluate his or her knowledge about pedagogy, engineering education innovations, and whether he or she uses engineering education innovations in the classroom, as well as questions regarding perceptions of the tenure process and the reward/incentive structure in the work environment.

The same self-report survey was used to gather data from colleagues. Data collected includes ratings regarding whether his or her colleagues use engineering education innovations in the classroom. This survey was randomly distributed, completely anonymous, and administered similar to an anonymous performance evaluation of a colleague or superior. Anonymity is important to avoid inflated rating of colleagues. This data will be used to validate the self-report data from individual faculty members.

Preliminary Results

An initial self-report survey consisting of eighty-five questions was developed and administered during the fall 2011 semester to 64 COEN faculty members—14 women and 50 men—at BSU. A 47% response rate was achieved—30 respondents. Academic rank of faculty members surveyed included non-tenured/tenured track—instructors and research professors whose responsibilities include teaching—and tenured/tenure-track—assistant, associate, and full professor. Over half of the respondents—57%— indicated having some sort of formal training related to teaching. This training ranged from workshops at BSU's Center for Teaching and Learning to one individual who earned a Ph.D. in education.

We first focus on select questions evaluating faculty members' attitude toward change and individual uses of engineering education innovations in his or her classroom. Nearly all of the respondents—90%—indicated that his or her approach to teaching has changed over time. Most respondents indicated a shift away from using a lecture approach to more student involvement, tending more toward active learning. Initial responses indicate that faculty members at BSU are very willing to change. Perceived lack of time appears to be one barrier to change with 67% of respondents indicating he or she would change teaching methods if given more time. Virtually half of the respondents—47%—indicated that he or she uses engineering education innovations in the classroom. Examples of self-reported engineering education innovations ranged from the use of content-specific technology to service learning. The other half of respondents were either unsure of what constituted engineering education innovation or self-reported as non-adopters.

We next focus on select questions evaluating faculty members' perceptions of the reward/incentive structure in the work environment and the tenure process. It is widely accepted that teaching constitutes approximately one-third of a tenured or tenure-track faculty member's time. When asked what percentage of time he or she spent developing new ways to present ideas, 70% of respondents indicated spending up to 30%. Over one quarter of respondents—27%— indicated that the tenure process at BSU has or would have impacted his or her ability to be an outstanding teacher. To the contrary, less than one quarter of respondents—23%—believe that being an outstanding teacher at BSU is sufficient for achieving tenure. While nearly all respondents—93%—agree at some level that good teaching is important, only 17% agree that good teaching is very important for achieving tenure at BSU. These preliminary perceptions indicate that good teaching is not valued when considered for achieving tenure.

Where do we go from here?

These observations represent an initial pulse of faculty members' attitudes toward engineering education innovations at BSU. Results from the self-report survey conducted during the fall 2011 semester are currently being analyzed in detail. We are examining individual faculty members' knowledge about pedagogy and engineering education innovations, and determining which faculty members were identified as adopters and non-adopter. Once these adopters and non-adopters have been identified, we will continue the 360-degree data collection by surveying former students and conducting individual structured interviews with experts in engineering education innovations—center for teaching and learning directors and supervisors—department chairs, the College of Engineering dean, and the Provost. This process is likely to provide very different perspectives than those self-reported by individual faculty members.

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References

1. Ford, G.S., T.M. Koutsky, and L.J. Spiwak. (2007). "A Valley of Death in the Innovation Sequence: An Economic Investigation." Phoenix Center for Advanced Legal and Economic Public Policy Studies.
2. Auerswald, P.E. and L.M. Branscomb. (2003). "Valleys of Death and Darwinian Seas: Financing the Invention to Innovation Transition in the United States." Journal of Technology Transfer, 28, 227-239.
3. Fincher, S.A. (2009). "Useful Sharing." Journal of Engineering Education, 98(2), 109-110.
4. Watson, K. (2009). "Change in Engineering Education: Where Does Research Fit?" Journal of Engineering Education, 98(1), 3-4.
5. Jamieson, L.H. and J.R. Lohmann. (2009). "Creating a Culture for Scholarly and Systematical Innovation in Engineering Education: Ensuring U.S. engineering has the right people with the right talent for a global society." ASEE.
6. Loui, M.C. (2007). "Moments of Inertia: Toward an Agenda for Sociological Research on Why Engineering Professors Resist Changes in Pedogogy and Curriculum." The Acceptance and Diffusion of Innovation: A Cross-Curricular Perspective on Instructional and Curricular Change in Engineering, R. Spalter-Roth, N. Fortenberry, and B. Lovitts, eds., American Sociological Association, Washington, DC.
7. Fox, M.F. (2007). "Institutional Transformation in Academic Science and Engineering: What is at Issue." The Acceptance and Diffusion of Innovation: A Cross-Curricular Perspective on Instructional and Curricular Change in Engineering, R. Spalter-Roth, N. Fortenberry, and B. Lovitts, eds., American Sociological Association, Washington, DC.
8. Croissant, J. (2007). "Organizational Contexts and Faculty Behavior: Frameworks for Research on the Social Dynamics of Campus Change." The Acceptance and Diffusion of Innovation: A Cross-Curricular Perspective on Instructional and Curricular Change in Engineering, R. Spalter-Roth, N. Fortenberry, and B. Lovitts, eds., American Sociological Association, Washington, DC.
9. Spalter-Roth, R., N. Fortenberry, and B. Lovitts. (2007). "The Acceptance and Diffusion of Innovation: A Cross-Curricular Perspective on Instructional and Curricular Change in Engineering." American Sociological Association, Washington, DC.

10. Bowen, D.M. (2007). "Engineering Education Innovations: Modeling the Influence of Organizational Context and Faculty Behavior." The Acceptance and Diffusion of Innovation: A Cross-Curricular Perspective on Instructional and Curricular Change in Engineering, R. Spalter-Roth, N. Fortenberry, and B. Lovitts, eds., American Sociological Association, Washington, DC.
11. Ambrose, S. (2007). "Exploring the Role of the Reward System in the Diffusion of Innovation in Engineering Education." The Acceptance and Diffusion of Innovation: A Cross-Curricular Perspective on Instructional and Curricular Change in Engineering, R. Spalter-Roth, N. Fortenberry, and B. Lovitts, eds., American Sociological Association, Washington, DC.
12. Kramer, L. (2007). "Greedy Institutions and Faculty Involvement in Retention." The Acceptance and Diffusion of Innovation: A Cross-Curricular Perspective on Instructional and Curricular Change in Engineering, R. Spalter-Roth, N. Fortenberry, and B. Lovitts, eds., American Sociological Association, Washington, DC.
13. Davis, K.A., Miller, S.M., and Perkins, R. (2011) "Bridging the Valley of Death: A 360° Approach to Understanding Adoption of Innovations in Engineering Education." 2011 ASEE Annual Conference & Exposition, Vancouver, BC, Canada.
14. Nowack, K.M. (1999). "360-Degree Feedback." Intervention Resource Guide: 50 Performance Improvement Tools, D.G. Langdon, K.S. Whiteside, and M.M. McKenna, eds., Pfeiffer, San Francisco, CA.
15. Trumbo, D.A. (1961). "Individual and Group Correlates of Attitudes Toward Work-Related Change." Journal of Applied Psychology, 45(5), 338-344.
16. De Meuse, K.P. and K.K. McDaris. (1994). "An Exercise in Managing Change." Training and Development Journal, 48(2), 55-57.
17. Malouff, J.M. and N.S. Schutte. (1986). "Irrational Belief Scale." Sourcebook of Adult Assessment Strategies (1995), N.S. Schutte and J.M. Malouff, eds., Plenum Press, New York, 432-435.