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Innovation through Propagation: Learning In and Out of the Classroom

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Work in Progress – Innovation through Propagation: Learning In and Out of Class

Introduction

Extensive research and development have identified teaching approaches, in and out of the classroom, to improve student learning. Multiple evaluation studies, both individual and synthetic (e.g., meta-analysis), have concluded that evidence-based teaching approaches can improve student learning when compared to traditional lecture. The following quote summarizes that compelling body of research supporting evidence-based approaches to teaching:

> *If the experiments analyzed here had been conducted as randomized controlled trials of medical interventions, they may have been stopped for benefit—meaning that enrolling patients in the control condition might be discontinued because the treatment [evidence-based teaching approaches] being tested was clearly more beneficial*[1].

Research has shown that engineering faculty members are aware of evidence-based teaching approaches to improve student learning in and out of the classroom[2-4]; however, despite persuasive evidence about their efficacy, multiple national reports have expressed further concern about the extent to which these approaches are currently being used and the rate at which they are being adapted by individual faculty members, engineering departments, engineering colleges, and institutions[5,6]. Multiple systematic changes are required to address these concerns, but such changes will not be catalyzed by affecting one or two things in the complex system of practice in engineering education. There is no silver bullet which will result in adaptation of evidence-based teaching practices and will improve student learning in and out of the classroom. Further, there are no five or fewer silver bullets. Systemic change requires change across numerous elements in the system. Recommendations presented in two ASEE reports[7,8] addressed *who* and *what* needs to change, and now it is critical that the engineering education research community conduct research to support change agents as they develop effective plans to make these changes. The purpose of our work-in-progress paper is to offer sample research questions to illustrate potentially productive research directions for improving adaptation of evidence-based teaching approaches to improve student learning, which could be addressed by the engineering education community. Based on results of a Delphi study, we offer a framework for organizing the research which includes four issues: (a) changing the culture; (b) catalyzing conversations about learning outcomes; (c) promoting adaptation; and (d) improving faculty development. In the following sections, we rationalize our choice of these four issues and offer sample research questions related to each one.

Changing the Culture

Frequently, papers or talks promoting adaptation of evidence-based teaching approaches call for changing the culture[7,8]. However, the term “culture” is too often used as a catchall term for numerous things that need to be changed. Further, there are few useful descriptions of culture in academic settings and few specifics about what *aspects* of the culture should be changed. As a result calls to *change the culture* tend not to promote change.

For example, the reward system is often identified as an important lever for promoting culture change[9]; however, there are multiple reward systems at each institution and interrelationships between reward systems at different institutions is downplayed. In considering job changes, faculty members often expect that achieving tenure at one institution implies that tenure would be transferable to another institution. As a result, changing just one aspect of culture (i.e., the reward system) is much more complex than calls to "change the reward system" imply. Thus, we believe that a critical first step to characterizing research about changing the culture is developing a common understanding and shared description of "culture."

Here, we use Schein's definition of organizational culture[10] to establish that first step. Specifically, Schein offers this definition: "A pattern of shared basic assumptions learned by a group as it solved its problems of external adaptation and internal integration (…) A product of joint learning." Readers interested in Schein's work on organization culture are referred to[10,11] that explore the three levels: artifacts, espoused values, and shared basic assumptions.

Using Schein's definition and based on the Delphi studies described previously, we propose sample research questions to illustrate work that the engineering research community can undertake to support propagating evidence-based approaches to improve student learning in and out of the classroom:

- How do the artifacts, espoused values, and shared basic assumptions that are inherent in institutional culture vary across institution type?
- How do the artifacts, espoused values, and shared basic assumptions that are inherent in institutional culture influence adaptation decisions regarding teaching approaches?

In this work in progress, these sample questions are only intended to highlight some of the potentially productive research directions.

Catalyzing Conversations about Learning Outcomes

Successfully propagating evidence-based approaches to improve student learning requires manifold conversations about how to best facilitate student learning (i.e., teach). But these conversations should be informed by and inform conversations about how to identify outcomes associated with student learning and about how to assess those outcomes. There is an extensive literature base and a large collection of effective teaching approaches, but teaching continues to be a private activity [12]. On the other hand, though there has been some research about student outcomes (mostly limited to ABET engineering accreditation criteria), there is considerably less research about effective assessment approaches, and faculty have even fewer conversations about what students should learn and about how to evaluate student learning. With the possible exception of efforts to assess conceptual understanding[13], student learning is assessed mostly with locally developed, one-time use classroom examinations.

Faculty need to talk more openly about teaching, and these conversations should include discussions about learning outcomes and assessment. This observation is consistent with design research which has demonstrated that it is critical to define the design requirements before generating alternative designs, and it is consistent with the principle of "backwards design"[14]. When applied to student learning, this means curriculum design should follow a process whereby learning outcomes are first articulated, then approaches to assess those outcomes are developed, and finally teaching approaches are selected.

As an example, recent literature has identified multiple attributes that one or more stakeholders in engineering education assert should be more broadly integrated into the undergraduate engineering curricula, e.g., systems thinking, computational thinking, innovation, entrepreneurship, and leadership. In response to these calls for action, most papers that address these issues tend to focus on the programming aspects of achieving the attributes (e.g., teaching practices or co-curricular activities), rather than provide explicit, in-depth descriptions of how acquisition of one or more of these attributes would be recognized and/or evaluated.

To address these issues, we again offer sample research questions:

- Why do most efforts to affect the undergraduate curriculum primarily focus on teaching practices, rather than student outcomes or assessment?
- What out of class learning outcomes can faculty influence, and how can these be assessed?

Promoting Adaptation

As we noted previously, questions about the efficacy of evidence-based teaching approaches have already been answered in a compelling manner: evidence-based teaching approaches can improve student learning with respect to traditional (lecture-based) teaching. But still, faculty often have misconceptions about teaching, such as holding the belief that good teachers are most frequently good researchers or using student-centered teaching means it is no longer possible to cover the content. Though there is some evidence that these beliefs are indeed misconceptions, there is a need for more research to provide concrete evidence for faculty. Further, little is known about out-of-class student learning and, consequently, about faculty teaching practices outside of the classroom that can improve student learning. Thus, to improve student learning both inside and outside of the classroom, we first need more research about students' out-of-class learning.

However, the mere existence of research about approaches to improve student learning will not be enough to produce significant changes in faculty teaching practices. We know, for instance, that although 72% try a research-based instructional strategy, only 49% report sustained use[6]. And we also know that there are multiple factors that influence faculty adaptation of evidence-based teaching approaches[2,3,15], including classroom time and content coverage, preparation time, student resistance, and the institutional reward structures. But we need to learn more about faculty decisions to adopt (or discontinue use of) evidence-based teaching approaches, about the relationship between factors that promote and barriers that hinder adoption of those approaches, and about faculty at different stages of the adoption/innovation cycle.

To address this issues, we again offer a brief sample of research questions:

- How do faculty develop beliefs and values about teaching approaches, in general, about lecture, and about evidence-based teaching?
- What assumptions and misconceptions do faculty have about efficacy of existing evidence-based teaching approaches and what is the validity of those?

Improving Faculty Development

Faculty members make conscious and subconscious decisions about their teaching, decisions that often affect teaching decisions of their colleagues. Faculty members considering a change in

their teaching style, like anyone planning to make a change, benefit from support. Research also shows availability of faculty professional development support can influence both decisions to adapt news new teaching approaches as well as decisions to continue[6,15]. Institutions can support faculty decisions about teaching with formal organizational units and structure, or they can rely on more informal approaches, and national trends suggest that formal structures are becoming more pervasive[7,8]. However, issues about organizational structures for the faculty development issue remain, as do other questions about effective implementation strategies. Following the pattern of this work in progress, we offer two illustrative research questions:

- How should the function of faculty development be addressed at different institutional levels, e.g., departmental, college, institutional, national, and international?
- How are faculty engagement with and responses to formal faculty development initiatives characterized, and how might these characteristics, patterns, etc. inform future faculty development initiatives?

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