Board 230: Contextualized Scaffolding for Engineering Faculty to Facilitate the Adoption of EBIPs

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Prateek Shekhar is an Assistant Professor – Engineering Education in the School of Applied Engineering and Technology at the New Jersey Institute of Technology. He holds a PhD in Mechanical Engineering from the University of Texas - Austin, an MS in Electrical Engineering from the University of Southern California, and a BS in Electronics and Communication Engineering from India. Dr. Shekhar also holds a Graduate Certificate in Engineering Education from Virginia Tech. Prior to his current appointment, he worked as a Postdoctoral Researcher and Assistant Research Scientist at the University of Michigan. He is the recipient of the 2018 Outstanding Postdoctoral Researcher Award at the University of Michigan; and serves as a PI/Co-PI on multiple projects funded by the National Science Foundation. He currently serves in editorial capacity for the Journal of Women and Minorities in Science and Engineering, International Journal of Mechanical Engineering Education, and Journal of International Engineering Education.

Jeff Knowles, Oregon State University

Dr. Jeff Knowles is an engineering instructor at Oregon State University who began teaching courses in 2015. His current pedagogical research is related to barriers associated with implementing Evidence-Based Instructional Practices (EBIPs) in STEM-related courses and determining what affordances can be granted to overcome such contextual obstacles. Jeff's interests also include the numerical modeling of nonlinear wave phenomena.

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Stephanie Adams is currently enrolled as a doctoral student at Oregon State University, where she is working towards her PhD in Civil Engineering with a concentration in Engineering Education. Her current research focuses on the adoption of evidence-based instructional practices (EBIPs) among engineering faculty members. Additionally, she is investigating the identity development of engineering students in capstone courses.

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Abstract

The benefits of Evidence-Based Instructional Practices (EBIPs) are well-supported in the existing literature and have been demonstrated to play an impactful role in improving student learning and retention rates. Despite these benefits, a majority of engineering faculty have not transitioned to the use of EBIPs in their undergraduate classrooms. There are several overarching factors which prevent instructors from embracing non-traditional styles of teaching (i.e., time, preparation, student resistance, etc.) which have been explored at a holistic level. This project includes three primary efforts. The first is understanding the contextual barriers which stand in the way of successful EBIP-implementation. We identified instructors who were knowledgeable of EBIPs but faced challenges in implementation through a screening survey. Approximately 70 instructor survey respondents have shared their personal experience and perceptions around non-traditional modes of teaching over a series of three semi-structured interviews. Specifically, participants were prompted to reflect on contextual barriers and affordances that impact their decision-making processes around active student engagement in the classroom. The second effort consists of a mentoring component in which participating faculty are continuously engaged in the innovation and development processes tied to EBIP-implementation in the classroom. This collaborative development has created a supportive space in which faculty are encouraged to test new EBIPs in their courses and reflect on the challenges and successes they encounter. In response to participant feedback, members of the research team provide appropriate scaffolding for instructors in the form of active-learning exercises or hands-on demonstrations which circumnavigate local barriers faced by engineering faculty. The third effort is to evaluate the efficacy of the mentoring program. Qualitative data is collected through field notes and video recordings of the conversations, which are transcribed to discern emerging themes uncovered by various coding methods. Specific insights and results from our efforts are shared in this paper.

Project Goals

This project seeks to understand and provide scaffolding to local barriers encountered by engineering faculty who teach mechanics of materials and fundamentals of electrical circuits courses. The study consists of three primary phases: (1) a screening survey, (2) interviews with faculty about adoption, (3) a mentoring program, and (4) development of a conceptual model using all data sources which describes the decision-making processes of instructors around EBIP-implementation or abandonment.

Major Activities and Accomplishments

The screening survey collected data on participant experience with EBIP-implementation, current use, and abandonment for typical student-focused pedagogical approaches (such as active learning, collaborative learning, case-based teaching, peer instruction, etc.). Demographic information was also gathered about the survey respondents along with their interest regarding future participation in the project. Participants who had indicated prior experience and abandonment of EBIPs were prioritized in the interview recruitment process. From here, 69 interviews (an average of 45 minutes long) were conducted with instructors to understand the contextual barriers engineering instructors had encountered which led to their abandonment of the EBIP. Thematic coding analysis of the transcribed interviews revealed that commonly reported barriers, such as time limitations, student resistance, and logistical difficulties shared similar emergent themes associated with cultural pressures prevalent in their institutions and/or departments. Interview results suggest the existence of a commonly held maxim within engineering departments which prioritizes quantity of content covered over engagement with the material. Several instructors indicated that this pedagogical philosophy has a tendency to influence student perceptions about what a typical engineering class should look like (i.e., a traditional, passive, lecture-based course). Concerns about diverging from the status quo were apparent deterrent factors in decision-making processes around EBIP-implementation. More so, some instructors who reported regular active learning in the classroom faced criticism or a lack of support from colleagues. Instructors also expressed concern about students being inadequately prepared for their future academic and professional careers if certain course topics were to be omitted, often in stark contrast with the value of student engagement to learning and preparation for the workplace. It is noteworthy to point out that the validity of this concern hinges upon the assumption that the material presented during lecture has a direct impact on the success of the student's career path. This suggests that both advocates of traditional and active learning hold reservations towards EBIPs because they place greater value on the specific topics rather than student engagement with engineering problem solving in general. On the other hand, interviews revealed that successful implementation of EBIPs often involved elements such as competition, gamification, clear instructions, adequate background knowledge, a supportive classroom environment, instructional autonomy, and creative time-management strategies for assessment and preparation outside the classroom.

The third phase of the project consists of a mentor intervention where a group of faculty mentees work collaboratively over the term with project team members to strategize methods for EBIP implementation, provide scaffolding (i.e., hands-on activities, group worksheets, ranking tasks, relevant peer-reviewed literature, etc.) and to reflect on barriers that prevented or hindered successful EBIP-implementation. Mentors, which initially consisted of the original members of the research team, typically met with mentees on a weekly basis. Meetings often alternate between brainstorming sessions for EBIP-implementation and reflection on the execution details the following week. One of the successes observed with this phase of the project is witnessing participants who were originally interviewees and mentees in phases (2) and (3) of the project transition to mentors during subsequent rounds of the mentoring process. Thus far, four of the faculty, who started as mentees in the project currently hold mentor positions, and several others have expressed interest in becoming a mentor for future terms. Two or three mentors have also been referred to the research team by the original members through professional contacts. There has been growing interest in this project within the engineering education community. A handful of faculty from across the nation have contacted members of the research team directly, inquiring about how they could contribute to the project (i.e., mentee, mentor, providing active learning materials they had developed for previous courses, etc.). This broadened awareness of the project seems to have been stimulated by a number of factors, including colleague recommendations by previous mentees and mentors, talks and poster presentations at conferences, flyers, and publications [1], [2], [3], [4]. In terms of quantitative success, thus far, there have been nine mentors and 27 mentees and there are 11 more mentees lined up for future terms. Ten of the 27 mentees identify as female and one of these participants identifies as black. We have made significant efforts to recruit diverse mentees through contact with faculty and administrators at HBCUs and personal contacts of the project team. We anticipate a much more diverse group of mentees in future years. Qualitatively speaking, mentees have expressed in follow-up interviews that the mentoring process has provided them with a forum in which they feel supported and safe in sharing their pedagogical philosophies about traditional and alternative styles of teaching. Furthermore, many mentees emphasized the value of having a mentor who had taught their specific course, providing material-specific advice and recommendations that greatly enhanced their teaching approach. Additionally, participants have reported having a greater awareness of the student perspective and how to tailor their classes in a manner which is not only more palatable to the student, but also more effective and meaningful.

We have developed and collected a large collection of curricular materials for circuits and mechanics of materials. We are working on a searchable web-based database that would allow faculty to search for and access these materials in an efficient manner. We anticipate a functioning version of this by summer of 2024.

Summary

Our project efforts have provided a space for engineering faculty to attempt new instructional devices, share encountered barriers, and receive appropriate scaffolding with the objective of realizing a more engaging learning environment for students. Ultimately, the data gathered from this work will be geared towards the development of a conceptual model on instructor decision-making processes around EBIP-implementation. We hope that this model will facilitate more effective mentoring and training programs.

References

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