BOARD # 309: What Works in Implementing EBIPs? Faculty Experiences of Contextual Barriers and Strategies to Overcome Them

Dr. Maya Menon, New Jersey Institute of Technology

Maya Menon is a postdoctoral researcher at New Jersey Institute of Technology. She completed her PhD in Engineering Education at Virginia Tech. She has an undergraduate degree in Computer Science from Arizona State University and a graduate degree in Robotics and Automation from Amrita University. Her research focuses on understanding how engineering education can empower young engineers to work toward a sustainable future, including interdisciplinary engineering education and faculty decision-making.

Stephanie Adams, Oregon State University

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.

Dr. Prateek Shekhar, New Jersey Institute of Technology

Dr. 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, National Institutes of Health, and Kern Family Foundation. He has served 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.

Dr. Shane A. Brown P.E., Oregon State University

Shane Brown is an associate professor and Associate School Head in the School of Civil and Environmental Engineering at Oregon State University. His research interests include conceptual change and situated cognition. He received the NSF CAREER award in

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.

IUSE: Facilitating Engineering Faculty's Adoption of Evidence-based Instructional Practices

ABSTRACT

Evidence-based Instructional Practices (EBIPs) are pedagogical approaches grounded in research that enhance student learning, engagement, and retention. These methods, such as active learning, problem-based learning, and peer instruction, have been shown to improve both short- and long-term learning outcomes, particularly in fields like engineering, where students often face complex, abstract concepts and large class sizes. EBIPs help bridge the gap between theoretical knowledge and real-world application, fostering critical thinking and problem-solving skills that are essential in engineering education. Despite their known benefits, many engineering faculty struggle to implement EBIPs due to limited training, time constraints, and a lack of discipline-specific resources.

This NSF-funded project seeks to increase the adoption of EBIPs in undergraduate engineering courses by identifying and addressing the specific contextual barriers and affordances that faculty face during implementation. Faculty often report challenges such as insufficient time for curriculum redesign, a lack of professional development opportunities, and institutional cultures that prioritize research over teaching innovation. To address these challenges, the project focuses on three key activities: (1) investigating the decision-making processes and contextual challenges faculty encounter when implementing EBIPs; (2) co-developing course materials and curriculum to align with EBIP strategies; and (3) creating research-informed resources to support EBIP-based course development.

This project engages faculty from over 40 institutions, including R1 universities, undergraduate-focused colleges, minority-serving institutions, and two-year colleges. By capturing faculty experiences across this diverse range of educational environments, the project aims to develop scalable, adaptable strategies for EBIP implementation. Faculty participants are paired with experienced mentors who provide ongoing, tailored support to address discipline-specific challenges. These mentors assist in curriculum redesign, pedagogical guidance, and troubleshooting barriers, facilitating a deeper understanding of how EBIPs can be integrated effectively.

In this poster, we present key findings from the project, focusing on the contextual barriers faculty encounter during the decision-making process of implementing EBIPs, and the strategies used to overcome these challenges. Case study examples from the participating institutions illustrate both the struggles and successes faculty experience under the scaffolded guidance of a faculty mentor. These case studies offer a window into the process of curriculum transformation, highlighting practical approaches to integrating EBIPs and providing rich, detailed descriptions of the change process.

INTRODUCTION

Engineering education is at a pivotal juncture, requiring innovative teaching strategies to meet the growing demand for graduates who can navigate complex problems and thrive in a rapidly evolving workforce. Evidence-Based Instructional Practices (EBIPs), such as active learning, collaborative learning, and problem-based learning, have consistently demonstrated their ability to enhance student engagement, comprehension, and retention [1], [2]. By shifting away from passive, lecture-centric models, EBIPs empower students to take an active role in their learning, bridging the gap between theoretical knowledge and practical application. Despite their proven benefits, adoption of EBIPs by engineering faculty remains significantly low [3], [4].

The barriers to EBIP adoption are multifaceted, encompassing time constraints, lack of familiarity, insufficient training, and institutional cultures that often prioritize research over teaching innovation [5], [6]. Additionally, the complex and discipline-specific nature of engineering education presents unique challenges that hinder the implementation of these pedagogical strategies [7]. Addressing these barriers requires a more nuanced approach that considers the interplay of contextual factors influencing faculty decision-making and the specific needs of engineering educators.

Mentorship programs have emerged as a promising avenue for facilitating the adoption of EBIPs, providing faculty with targeted, discipline-specific guidance and sustained support [8], [9]. These programs leverage the expertise of experienced educators to assist faculty in overcoming challenges related to curriculum redesign, student engagement, and logistical constraints [10], [11]. By fostering a community of practice, mentorship programs not only enhance faculty confidence and competence but also contribute to the normalization of innovative teaching practices in engineering education [12].

This study investigates the impact of a mentorship program designed to support engineering faculty in implementing EBIPs, focusing on foundational engineering courses such as Mechanics of Materials and Circuits. Using semi-structured interviews with mentees and mentors, this research provides rich insights into the decision-making processes and contextual challenges associated with implementing EBIPs and how mentorship can address the barriers to EBIP adoption and facilitate sustainable instructional change.

By identifying emergent themes and synthesizing strategies for overcoming barriers, this study seeks to contribute to a growing body of knowledge on instructional transformation in engineering education. The findings highlight the potential of mentorship as a scalable and adaptable solution for bridging the gap between evidence-based instructional practices and their classroom adoption, ultimately advancing the quality and efficacy of engineering education.

METHODOLOGY

The context of this research study focuses on the mentorship program, which was implemented over three terms (Spring 2023, Fall 2023, Spring 2024) that supported 28 mentees and 8 mentors from diverse institutional and demographic backgrounds. Participants included faculty from research-intensive (R1, R2), doctoral/professional (R3), and teaching-focused institutions, spanning public and private universities. Recruitment targeted 213 ABET-accredited institutions, focusing on instructors teaching Mechanics of Materials and Fundamentals of Circuits. Outreach efforts included department chairs, professional networks, and a Qualtrics survey, yielding 66 responses and resulting in a diverse cohort of mentees.

Mentors were selected from the research team, professional contacts, and former mentees, ensuring a pool with expertise and teaching experience. This inclusive and strategic approach fostered EBIP adoption across various academic settings, highlighting the program's adaptability and effectiveness in advancing engineering education.

Semi-structured interviews with mentees and mentors in the EBIP mentorship program provided rich, detailed insights into their experiences, aligning with grounded theory principles [13]. This method balanced consistency across interviews with flexibility to explore emerging themes. Interviews, lasting 45–60 minutes, covered motivations, mentorship interactions, EBIP implementation, challenges, and reflections, enabling an in-depth understanding of participants' perspectives. Theoretical sampling within interviews allowed the researcher to adjust questions dynamically, focusing on emerging concepts and supporting iterative data collection and analysis [13], [14]. By incorporating both mentee and mentor viewpoints, the study captured diverse contexts and processes of EBIP adoption in engineering education.

FINDINGS

The NSF-funded project has enabled multiple studies that provide a comprehensive understanding of the process and outcomes of EBIPs in engineering education. These findings highlight the program's iterative, collaborative nature and its impact on faculty development and student learning.

A conceptual model was developed to outline the process by which engineering faculty adopt EBIPs as part of the mentorship program. This model emphasizes a mentor-supported journey that includes:

- Intrinsic Buy-In: Faculty recognize the value of EBIPs and commit to the program.
- EBIP Negotiation: Mentors and mentees collaborate to select appropriate EBIPs.
- Preparation Challenges: Initial barriers, such as time constraints and resource limitations, are addressed with mentor support.
- First Adoption Attempt: Faculty implement an EBIP, leading to either initial success or challenges.
- Reflection and Strategizing: Faculty reflect on challenges, refine strategies with mentors, and may adjust their approach or switch EBIPs.
- Subsequent Adoption Attempts: Continued attempts lead to eventual success, defined by improved student engagement and learning outcomes.
- Sustained Implementation: Faculty carry forward EBIP use and refinement beyond the mentorship program.

This study underscores the cyclical and adaptive nature of EBIP adoption, with mentor-mentee collaboration as a critical factor in overcoming challenges and achieving sustained success.

In addition, an analysis of mentee experiences revealed three mentee-defined areas of success in implementing EBIPs:

- Time Management: Effective allocation and organization of time to support EBIP adoption.
- Facilitation of Course Learning Objectives (CLOs): Aligning EBIP strategies with course goals, whether syllabus-defined or personal teaching objectives.
- Acclimation to EBIPs: Growing comfort and expertise in EBIP use.

From these areas, themes and sub-themes emerged that reflect strategies and challenges in the EBIP adoption process. Key themes include:

- Responsiveness: Adapting EBIPs to classroom dynamics through awareness, adaptive planning, and targeted support.
- Succession: Sustained, varied use of EBIPs, often sequenced for greater impact.
- Guidance: Scaffolding student learning through peer support, collective understanding checks, and clear instructions.
- Organization: Proactive course structuring to support EBIP integration, with flexibility and concise, conceptually focused activities.
- Digression: Leveraging personalization, relatability, and intrigue to connect course material to students' interests and experiences.

CONCLUSION

These studies collectively demonstrate the program's effectiveness in supporting engineering faculty across diverse contexts. The NSF-funded research highlights how mentor-mentee partnerships facilitate the iterative adoption of EBIPs, leading to enhanced teaching practices and student outcomes. By addressing preparation and implementation challenges, fostering reflective practices, and enabling faculty to adapt EBIPs to their unique settings, the mentorship program has made significant strides in advancing engineering education and promoting the widespread adoption of evidence-based practices.

NSF ACKNOWLEDGMENT

This work is supported by the U.S. National Science Foundation through Grant numbers 2111052 and 2111087. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

REFERENCES

[1] S. Freeman et al., "Active learning increases student performance in science, engineering, and mathematics," *Proc. Natl. Acad. Sci. U.S.A.*, vol. 111, no. 23, pp. 8410-8415, 2014.
[2] M. Prince, "Does active learning work? A review of the research," *J. Eng. Educ.*, vol. 93, no. 3, pp. 223-231, 2004.
[3] M. Borrego and C. Henderson, "Increasing the use of evidence-based teaching in STEM higher education: A comparison of instructional change strategies," *J. Res. Sci. Teach.*, vol. 51, no. 5, pp. 552-589, 2014.
[4] J. E. Froyd, P. C. Wankat, and K. A. Smith, "Five major shifts in 100 years of engineering education," *Proc. IEEE*, vol. 100, no. SPP, pp. 1344-1360, 2013.
[5] C. Henderson and M. H. Dancy, "Barriers to the use of research-based instructional strategies: The influence of both individual and situational characteristics," *Phys. Rev. ST Phys. Educ. Res.*, vol. 3, no. 2, p. 020102, 2007.
[6] K. A. Nguyen et al., "Faculty adoption of evidence-based teaching practices in engineering education: A synthesis of the literature," *Int. J. STEM Educ.*, vol. 8, no. 1, pp. 1-21, 2021.
[7] M. Borrego, J. E. Froyd, and T. S. Hall, "Discipline-based education research: A review of the literature," *J. Eng. Educ.*, vol. 103, no. 1, pp. 21-57, 2014.
[8] R. M. Felder, R. Brent, and M. J. Prince, "Engineering instructional development: Programs, best practices, and recommendations," *J. Eng. Educ.*, vol. 103, no. 4, pp. 1-22, 2014.
[9] C. Henderson, A. Beach, and N. Finkelstein, "Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature," *J. Res. Sci. Teach.*, vol. 48, no. 8, pp. 952-984, 2011.
[10] E. Borda et al., "Meeting STEM faculty where they are: Engaging faculty in research-based teaching practices through positive learning experiences and reflection," *CBE Life Sci. Educ.*, vol. 19, no. 2, pp. 1-14, 2020.
[11] M. Borrego, J. C. Stains, S. E. Miller, and M. T. Smith, "Assessing the effectiveness of faculty professional development for transforming STEM education," *J. Higher Educ.*, vol. 89, no. 5, pp. 637-664, 2018.
[12] J. Tomkin et al., "A model of pedagogical change: The case of ENGR 101," *Int. J. Eng. Educ.*, vol. 35, no. 2, pp. 636-647, 2019.
[13] K. Charmaz, *Constructing Grounded Theory*, 2nd ed. London, U.K.: SAGE, 2014.
[14] B. G. Glaser and A. L. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Chicago, IL, USA: Aldine, 1967.