WIP: Centering Marginalized Students' Voices During the Development of a Faculty Toolkit for Inclusive Excellence in Engineering Education

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Alain Mota is the Program Manager at the Caruth Institute for Engineering Education. In this role, he works across projects supporting the research and implementation goals of several efforts at the institute. Specifically, the Thrive Scholars mentorship program which is focused on supporting and developing first year and transfer undergraduate underrepresented students in Engineering and Computer Science throughout the first academic year. His main area of support comes from direct one on one meetings with undergraduate students (mentee's) that serve as an official connection with the School of Engineering. He synthesizes information through the program systems and triangulates interventions for struggling students through support of the mentors that serve as direct point of contact for the first-year students. He co-coordinates programming in the form of seminars that are focused on supporting student holistically. Alain also serves as the lead program manager of the Summer Engineering Camps an effort that is centered on development of the engineering identity through direct experiences with Engineering fields and design challenges in the informal STEM learning space. Finally, he manages and supports research and development of new and innovative approaches to exposing Pk-12 students to active learning frameworks such as Maker Sprints and Project Based Learning. Alain has a Master of Science in Interdisciplinary Environmental Studies from the University of Texas at El Paso and a Master of Arts in Design and Innovation from Southern Methodist University. As part of his goals to contribute across the University Alain also supports Engineering and Science undergraduate students as they serve as camp counselors in his work at the Caruth Institute for Engineering Education. He directly manages the deployment of STEM integrated activities that surface Engineering to Middle and High School students in the Dallas area in an informal learning environment through the Hammon Engineering camps. He is also engaged in outreach programs that are seeking to serve underrepresented populations in Engineering. In his program manager role at the Institute, he contributes in fostering relationships and developing STEM activities for Voices of Hope and Jubilee Park. He is also part of the Maker Education project as his previous experiences developing teachers at the STEM academy leveraged the SMU MakerTruck as part of the training and outreach, one of the major goals to make Engineering accessible for the institute.

Before joining the University Alain worked at the Dallas Independent School District as both a mathematics and science instructional coach for elementary and middle schools. He served as the inaugural STEM department head for the Barack Obama Male Leadership Academy and was a science campus coordinator for Henry B. Gonzalez Elementary. Prior to becoming an Educator Alain worked in Environmental consulting. In this space his experiences ranged from aquaculture management and research for an aquatic toxicology firm to doing statistical analysis for the nutrient criteria standards at the Texas Commission of Environmental Quality. Alain has a Master of Science in Interdisciplinary Environmental Studies with a focus on Environmental Engineering, Geophysics and Public Health. His research doing microbial risk assessment of import products from Mexico is published on the Journal of Food Safety. He is currently enrolled in the Master of Arts in Design and Innovation at Lyle.

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Introduction

The purpose of this WIP research paper is to describe the development of an inclusive teaching toolkit for engineering faculty that centers the voices and experiences of traditionally underrepresented undergraduate students in engineering. Approaching the toolkit's design in a way that elevates student narratives is intended to enhance instructors' awareness related to the influence that they have on the student experience. Through this awareness, as well as clear and actionable strategies that are provided within the toolkit, faculty should feel more informed to make intentionally inclusive decisions within their instructional practices. The proposed toolkit will promote potential shifts in educational enacted practices grounded in evidence-based strategies and student narratives.

Faculty classroom teaching preparation in STEM fields, particularly within engineering, is often severely lacking [1]. Due to the research-emphasis within many doctoral programs, faculty have limited training as it relates to high impact teaching practices and fostering inclusive learning environments [2]. Once in the professoriate, faculty reward structures often prioritize research productivity over teaching, leaving little incentive for faculty to hone their instructional skills [3]. While a lack of effective teaching practices is problematic for all undergraduates, there are disproportionately negative impacts for traditionally underrepresented students (i.e., Black, Hispanic, and Native American and/or Alaska Native individuals [4]) who often experience additional challenges that threaten their persistence and completion of their engineering degree. Representation issues within STEM and the associated challenges for students of color are often further exacerbated within predominantly white institutions (PWIs) [5], [6].

Despite the fact that faculty are often more invested in scholarship than teaching [7], quality instruction is critical for the successful transfer of knowledge and achievement of student learning outcomes, degree completion, and a career in the profession. While engineering education scholarship offers numerous empirically grounded pedagogical practices, few faculty seek out these resources to improve their instruction [8]. For those faculty who are interested in enhancing their teaching, there is a need to provide resources informed by the perspective of students who have been historically marginalized in STEM education. The toolkit described in this paper is being developed by a team of practitioners whose work focuses on creating equitable and inclusive environments within the school of engineering at a private, PWI. An ongoing feature of this toolkit is that the authors are intentional about drawing upon the experiences of racially minoritized undergraduate students in engineering. A current undergraduate student, who identifies as a Black female, is serving as a co-author on this paper and collaborator during the development of this toolkit to ensure that our recommendations acknowledge, encompass, and address the experiences that she and other minoritized groups have had during their engineering education. The toolkit is in its nascent stages, but we aim to use this WIP as an opportunity to amplify a student's voice and foster discussions around inclusive pedagogy within engineering education. Our work is driven by the research question, "what happens when institutional recommendations, established best practices, and the perspectives of a student come together?"

Literature Review

Common instructional practices within engineering education, and the lack thereof, represent a barrier to broadening participation in engineering [9]. Engineering faculty receive limited pedagogical training during their academic preparation, and they are even less likely to have exposure to inclusive teaching practices [10]. Faculty play a critical role in fostering minoritized students' sense of belonging within engineering culture [11], [12], which has important implications for student success [13]. When instructors do not reflect on the impact of their positionality on the student experience, they may inadvertently perpetuate systemic biases and injustices through their academic policies, teaching strategies, and assessment practices [14].

Marginalization within engineering education is further impacted by faculty mindsets related to student learning [15]. When faculty possess fixed mindsets, such as the belief that not every student can become an engineer and that the ability to understand engineering content is an innate skill, they may limit the effort that they invest in their teaching practices [15]. The belief that deficits in student learning are the result of student inaction, and not related to instructors' approach to teaching, perpetuates already existing equity gaps [16]. The deference of the responsibility of learning to the student and not to the instructor represents a form of gatekeeping within the profession [17], which is detrimental to diversifying the field in ways that are critical for innovation and advancement. Conversely, when instructors have a growth mindset, they may be more likely to embrace student-centered approaches to teaching and create inclusive learning environments that facilitate student learning. This type of stewardship is not only essential for fostering improved student outcomes [16], but as our undergraduate co-author will describe, can have long-term impacts related to participation and diversity within the engineering profession.

Method

This WIP describes the early stages of data collection and analysis related to the development of an inclusive teaching toolkit for engineering faculty at a private, four-year PWI. Our long-term plans include a mixed-methods approach to data collection, qualitative sources, such as student narratives and faculty focus groups, and quantitative data, such as student performance outcomes, to gain a better understanding of faculty approaches to teaching within the school of engineering and the related impacts on student learning. We also plan to consult faculty throughout the toolkit development process to co-design a readily adoptable product. We share our approach as a methodological contribution to toolkit design by aligning espoused advice, best practices, and perspectives from the lived experience of students who are minoritized in the system.

For the first stage of developing an inclusive teaching toolkit, the authors obtained copies of an institutional instructor's guide that is distributed annually to all engineering faculty. We reviewed the existing guidelines and contrasted them against high-impact practices related to inclusive teaching [18]. In alignment with our commitment to centering underrepresented students' voices throughout the development of the toolkit, we employed a participatory research approach [19] throughout this process by collaborating with a current undergraduate student in the school of engineering who identifies as a Black female. The recommendations shared in this paper feature her perspective to improve the learning experiences of those who follow in her

footsteps. Her participation in this project is of critical importance given her direct experience as an underrepresented female in the school of engineering. She reviewed the existing instructional guidelines and developed recommendations as an integral member of the research team, while also offering a personalized lens on how instructional practices impacted her journey.

The positionalities of the faculty and staff research team members further underscore the importance of centering our student co-author's voice. The remaining co-authors identify as a white female faculty member in the school of engineering who was trained in a non-engineering STEM discipline and now studies equity issues within higher education, a Latinx male with a multidisciplinary graduate degree that includes environmental engineering, geophysics, and public health focused with research focused in water quality and a PK-12 STEM certified educator, and a Black female senior staff member, Assistant Dean, with a graduate degree in higher education leadership and policy and certifications in executive coaching, cultural intelligence, diversity, equity, and inclusion. Before sharing our recommendations in the following section, the undergraduate member of our team will provide additional context on her engineering education experience.

As a young Black woman attending a PWI, my relationship with the engineering school is multifaceted. The lack of representation of both women and Black students is a large source of frustration for me, as being a part of the minority influences some insecurities that I possess regarding my competence as an engineering student. Even so, I still recognize the institution's role in providing unique opportunities for academic, professional, and leadership growth, particularly related to affinity groups that focus on community building within engineering. The nuances of my experiences inside and outside of the classroom over the course of my four years at this university inform my following recommendations and speak to the impact of positive and negative teaching experiences encountered during my educational journey.

Preliminary Findings and Recommendations

Our analysis of the instructors' guide revealed that several policies have been implemented with the intent of supporting student learning, but their impact falls short in terms of aligning with high-impact teaching practices and fostering inclusive learning environments. Syllabus language was the first item addressed in the instructors' guide, with the following recommendations standing out to us: 1) "Each course must have a syllabus that includes a description of how grading will be done, with the relative importance of homework, exams, projects, etc.," and 2) "Syllabi should also include any specific additional items for which you plan to hold the students accountable (attendance requirements, etc.)." These recommendations are strong examples of policies where small modifications can result in inclusive learning environments. When addressing attendance requirements, for example, instructors should be encouraged to emphasize a tone that reflects a highly structured student learning experience [18]. Instructors can promote student engagement by underscoring that attending class is necessary to gather a conceptual understanding of the course content, as well as teacher and peer interactions.

Student perspective on syllabi: Giving students access to a thorough syllabus allows professors to manage expectations with the students, but providing this syllabus prior to beginning the class is of equal importance as it influences a student's decision-making process for course enrollment.

On few occasions, I enrolled in courses without viewing the syllabus and needed to withdraw from the course because my expectations did not align with the scope of the coursework. Such inconsistencies are problematic because the lack of insight manifests as a disruption to my four-year plan, resulting in additional semesters to graduate and an unexpected financial burden.

Existing recommendations related to grading represent the area where a fixed mindset and professional gatekeeping were the most apparent. Two policies stood out to us as needing to be addressed: 1) "If you assess that a student is failing a class, talk to the student as early as possible, suggesting the possibility of dropping the course," and 2) "Some departments have adopted guidelines on grade distribution in each course. Check with your department to find out if it has such guidelines. If a large class (e.g., more than 10 students) 6 gives an unreasonably high number of A's (e.g., more than 50%), the Department Chair may be asked to investigate the situation. Excessive number of A's is a flag that either the grades are given away, or the students are not challenged enough." Rather than penalizing students for mastering content or scoring them against each other, we recommend developing grading schemes that compare students against standards of proficiency. Another approach to assessing student learning is the adoption of backward design, where desired student learning outcomes are identified, acceptable evidence of student learning is determined, and activities that reach those goals are then employed [18]. Rather than grading students on a curve, faculty should develop grading schemes that incorporate a growth mindset. Examples of this include allowing a cumulative final exam score to replace a previous exam grade so that students can demonstrate learning, reducing the weight of assessments from early in the semester so that students have an opportunity to learn from their mistakes, and allowing students to drop or retake quizzes or exams [18].

Student perspective on grading: The current guidelines and some grading practices, like grading on a curve, communicate to me that failure in an engineering course is the expectation and that the students are not expected to succeed. This mentality communicates doubt in the students' abilities and a sense that professors do not expect students to succeed. In my experience, when professors frame challenging coursework as a learning opportunity, the classroom environment reflects a culture of understanding that encourages students to ask questions and emphasizes the importance of learning from mistakes. For me, this shift is extremely necessary in a discipline that is notoriously difficult with typically cumulative coursework because it conveys the message that engineering possesses challenges, but they can be overcome. As someone who experiences imposter syndrome related to my intersecting underrepresented identities within engineering, having professors that instead have a "weed-out" mentality has caused me to question my own competence in my pursuit of an engineering degree (*continued in next paragraph).*

A professor's influence on their students is vast given their stature; thus, their opinions about topics related to their area of expertise carry great weight with students. I experienced a lack of support from a faculty member teaching an introductory major course that continues to be a point of reflection for me. During a conversation regarding internships with the professor, I was met with skepticism and discouragement from engaging in the job search at that stage of my education. I interpreted the doubt the professor communicated as doubt in my abilities as a student and in my potential for success in the field. In internalizing the professor's words, I invalidated my own motivations for pursuing an internship and potentially derailed my career growth. The implications of this conversation extend beyond an individual basis, especially

given the context of being a Black woman in the male-dominated field of engineering. I consistently feel as though I need to prove myself in my major, and lack of support from faculty only further compounds this sentiment. Although this experience is not directly related to the teaching strategies of this particular professor, it speaks to the impact of faculty interactions.

Discussion and Conclusion

As our preliminary work demonstrates, seemingly straightforward and objective policies can have significant and deep impacts on undergraduate students, particularly those who identify as underrepresented minorities. It is important for engineering faculty to not only invest in their instructional skills, but to have an inclusive mindset when doing so. The instructional toolkit that is the focal point of this paper is in the early stages of data collection, but given the population of undergraduate students that the authors work with, we remain committed to incorporating the stories and experiences of traditionally underrepresented students as we review, develop, and recommend teaching strategies for faculty in the school of engineering.

At this time, we are in the early stages of triangulating espoused advice, our student's narrative, and established best practices into well-defined teaching recommendations. Over the next year, we plan to gather and analyze additional student narratives, as well as partner with faculty to co-design content that is best suited for each engineering discipline. Specific recommendations that we plan to provide include explicit instructions related to syllabus content, revised guidance related to grade distributions, and specific examples of student-centered teaching practices that instructors can adopt in the classroom. When the toolkit develops into a formalized teaching resource, we hope to share it with junior and adjunct faculty during their onboarding process. We further intend to share our content within departmental meetings, followed by opportunities for interested faculty to participate in toolkit workshops. The concept of a "toolkit" implies practicality and application. We envision that the toolkit will bring inclusive teaching concepts and frameworks into engineering and computer science classes. Furthermore, focusing on practices that address minoritized students' experiences can promote equitable outcomes. Faculty are more likely to engage in this type of work when they see their peers doing so [20], thus we hope to use a snowball approach as an informal method of dissemination and implementation.

While our toolkit represents an attempt to improve educational practices within the school of engineering at a PWI, structural supports and systemic change related to effective teaching should be enacted in engineering education [21]. We recognize the impact that academic reward structures play in how faculty invest their time in terms of research or professional teaching development. While we are unlikely to restructure promotion criteria within our institution, we hope that by amplifying the voices of current students who can speak to the effects of instructors' actions – or inactions – on their undergraduate engineering education, we will generate an awareness among faculty of the power they possess and the impact of their work, not only in research settings, but in the classroom, too.

References

[1] S. Ambrose and M. Norman, "Preparing engineering faculty as educators.," *Natl. Acad. Eng.*, vol. 36, no. 2, p. 25, 2006.

[2] S. Baum and M. McPherson, "Improving teaching: Strengthening the college learning experience," *Daedalus*, vol. 148, no. 4, pp. 5–13, Oct. 2019, doi: 10.1162/daed_e_01757.

[3] D. M. Riley, V. Henry, and L. C. Leighton, "What makes faculty adopt or resist change in engineering education?," presented at the 2013 ASEE Annual Conference & Exposition, Jun. 2013, p. 23.1367.1-23.1367.20. Accessed: Jan. 16, 2024. [Online]. Available: https://peer.asee.org/what-makes-faculty-adopt-or-resist-change-in-engineering-education

[4] NCSES, "Diversity and STEM: Women, minorities, and persons with disabilities," National Center for Science and Engineering Statistics, Alexandria, VA, NSF 23-315, 2023. [Online]. Available: https://ncses.nsf.gov/wmpd

[5] D. Solorzano, M. Ceja, and T. Yosso, "Critical Race Theory, racial microaggressions, and campus racial climate: The experiences of African American college students," *J. Negro Educ.*, vol. 69, no. 1/2, pp. 60–73, 2000.

[6] M. Berger *et al.*, "A tale of two universities: An intersectional approach to examining microaggressions among undergraduate engineering students at an HBCU and a PWI," in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, ASEE Conferences, Jun. 2020, p. 34072. doi: 10.18260/1-2--34072.

[7] J. S. Fairweather, "Faculty reward structures: Toward institutional and professional homogenization," *Res. High. Educ.*, vol. 34, no. 5, pp. 603–623, 1993, doi: 10.1007/BF00991922.

[8] M. Borrego, J. E. Froyd, and T. S. Hall, "Diffusion of engineering education innovations: A survey of awareness and adoption rates in U.S. engineering departments," *J. Eng. Educ.*, vol. 99, no. 3, pp. 185–207, 2010, doi: 10.1002/j.2168-9830.2010.tb01056.x.

[9] R. M. Marra, K. A. Rodgers, D. Shen, and B. Bogue, "Leaving engineering: A multi-year single institution study," *J. Eng. Educ.*, vol. 101, no. 1, pp. 6–27, 2012, doi: 10.1002/j.2168-9830.2012.tb00039.x.

[10] L. R. Lattuca, I. Bergom, and D. B. Knight, "Professional development, departmental contexts, and use of instructional strategies," *J. Eng. Educ.*, vol. 103, no. 4, pp. 549–572, 2014, doi: 10.1002/jee.20055.

[11] L. J. Sax, J. M. Blaney, K. J. Lehman, S. L. Rodriguez, K. L. George, and C. Zavala, "Sense of belonging in computing: The role of introductory courses for women and underrepresented minority students," *Soc. Sci.*, vol. 7, no. 8, Art. no. 8, Aug. 2018, doi: 10.3390/socsci7080122.

[12] C. Vignola, N. Flowers, and B. C. Coley, "Engineering a new reality: Using virtual reality to cultivate inclusive mindsets among engineering faculty," presented at the Collaborative Network for Engineering and Computing Diversity, Crystal City, VA: American Society for Engineering Education, Apr. 2019, p. 12. Accessed: Jan. 16, 2024. [Online]. Available: https://peer.asee.org/engineering-a-new-reality-using-virtual-reality-to-cultivate-inclusive-mindsets-among-engineering-faculty

[13] D. R. Johnson, "Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors," *J. Coll. Stud. Dev.*, vol. 53, no. 2, pp. 336–346, 2012.

[14] M. L. Miles, A. J. Brockman, and D. E. Naphan-Kingery, “Invalidated identities: The disconfirming effects of racial microaggressions on Black doctoral students in STEM,” *J. Res. Sci. Teach.*, vol. 57, no. 10, pp. 1608–1631, 2020, doi: 10.1002/tea.21646.
[15] F. Brown and K. Cross, “Engineering faculty’s mindset: An analysis of instructional practice, learning environment, and teacher authenticity,” in *2019 IEEE Frontiers in Education Conference (FIE)*, 2019, pp. 1–4. doi: 10.1109/FIE43999.2019.9028524.
[16] T. McNair, E. M. Bensimon, and L. Malcom-Piqueux, *From equity talk to equity walk: Expanding practitioner knowledge for racial justice in higher education*. Hoboken, NJ: Jossey-Bass, 2020. Accessed: Feb. 08, 2024. [Online]. Available: https://www.aacu.org/publication/from-equity-talk-to-equity-walk-expanding-practitioner-knowledge-for-racial-justice-in-higher-education
[17] D. Witteveen and P. Attewell, “The STEM grading penalty: An alternative to the ‘leaky pipeline’ hypothesis,” *Sci. Educ.*, vol. 104, no. 4, pp. 714–735, 2020, doi: 10.1002/sce.21580.
[18] K. Hogan and V. Sathy, *Inclusive teaching: Strategies for promoting equity in the college classroom*. West Virginia University Press, 2022. Accessed: Feb. 08, 2024. [Online]. Available: http://wvupressonline.com/inclusive-teaching
[19] L. M. Vaughn and F. Jacquez, “Participatory research methods: Choice points in the research process,” *J. Particip. Res. Methods*, vol. 1, no. 1, Jul. 2020, doi: 10.35844/001c.13244.
[20] A. Kezar, S. Gehrke, and S. Elrod, “Implicit theories of change as a barrier to change on college campuses: An examination of STEM reform,” *Rev. High. Educ.*, vol. 38, no. 4, pp. 479–506, 2015.
[21] L. Jamieson and J. Lohmann, “Innovation with impact: Creating a culture for scholarly and systematic innovation in engineering education,” American Society for Engineering Education, Washington DC, 2012. Accessed: Jan. 16, 2024. [Online]. Available: https://www.asee.org/publications/asee-publications/asee-reports/innovation-with-impact