BOARD # 258: IUSE: Cohort 1 Results of A Model for Human-Centered Engineering Education

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Dr. Amber Young-Brice is Associate Dean for Academic Affairs and an Assistant Professor in Nursing at Marquette University. She has a master's degree in nursing education, a PhD in nursing, and is a certified nurse educator with 15+ years of teaching experience. Dr. Young-Brice's program of pedagogical research explores the relationship between the influence of non-cognitive factors, such as grit and self-regulated learning, and the successful trajectory of students. Additionally, she studies ways to foster these factors through theoretically derived and evidence-based pedagogical innovations. Her research is grounded in her expertise as an educator and underpinned by theories from nursing, education, cognitive and social sciences.

Dr. Allison Murray, Marquette University

Dr. Allison K. Murray is an assistant professor of mechanical engineering at Marquette University. She holds a BS, MS, and PhD in mechanical engineering from Purdue University. Her research includes inclusive pedagogy and the effects of belonging on student success. She has a active research program in additive manufacturing.

Somesh Roy, Marquette University

Dr. Somesh Roy is an associate professor in Mechanical Engineering at Marquette University. His research focuses on thermal radiation modeling, combustion modeling, and fundamental exploration of combustion-generated pollutants, particularly soot. He also works on community outreach activities on air pollution and air quality in collaboration with art museums and local community organizations. Besides his research on soot, radiation, and combustion, he maintains an active interest in the research on effective and emerging practices for engineering education.

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Background

Despite faculty development initiatives focused on pedagogy, literature reveals descriptions of slow changes in faculty pedagogical transformation [1]. We contend that there is a missing focus on the science of learning and the impact of teacher-student interactions as a reason behind the low efficacy of faculty development activities in changing beliefs and behaviors [2]. To address this gap, this project seeks to broaden engineering teaching with theory-based educational resources (BETTER) through a Caring Science lens [3].

Objectives

Objective 1: Examine the impact over time of a faculty development curriculum grounded in a humanistic-educative framework for promoting a humanizing model to engineering education.

Objective 2: Examine the impact of a Community of Practice (CoP) as a faculty development opportunity to compel faculty to make active efforts to transform their beliefs and attitudes regarding the use of learning theory as part of their teaching practice.

Research Design/Program Description

This project uses a longitudinal, quasi-experimental, explanatory sequential mixed-methods design. The programming intervention is either via a 6-week in-person CoP (treatment group) or via 6-modules of self-paced online learning (SP, control group) that included content regarding key learning theories through a humanistic and Caring Science lens. Participants will be followed and evaluated (pre/post surveys, interviews, artifact collection, and observations) throughout the three years of project funding (NSF IUSE 2236075). This paper presents the preliminary findings of Cohort 1 faculty who participated in programming during summer 2023, including pre/post surveys and interviews.

Results

Guided by the Faculty Learning Outcomes Assessment (FLOA) Framework [4], we applied validated quantitative instruments and qualitative approaches to collect and analyze data aligned with programming outcomes regarding appreciating pedagogy, applying pedagogical reasoning to course design, and utilizing teaching practices that enhance student learning [5].

In our first iteration of the BETTER summer program, with cohort 1 in 2023, data were analyzed via a paired sample t-test to determine whether there was a statistically significant mean difference between General Teaching Scale (GTS) [5] responses from faculty participants (N=19, n=10 CoP, n=9 SP) before and after programming. Statistically significant changes were found in multiple areas of the GTS, such as areas regarding awareness ($p<0.005$), integration

($p<0.000846$), instruction ($p<0.018$), self-knowledge ($p<0.43$), and strategies for student engagement ($p<0.031$).

Qualitatively, faculty reported making adaptations to their teaching and student interactions, including increasing welcoming behavior, trying to get to know students personally, and explaining the reasoning behind their teaching, assessment, and grading practices. A participant Ray stated,

> What they need is for me to guide them on whatever learning path that can help them understand the topic better. And I was finding that a lot of the setup and tear down and these things that I was structuring in a way that made sense to me wasn't actually helping them. And so putting things more open-ended so that they can pick up their own understanding, and then I can kind of guide them towards the correct answer or where I want them to be in the understanding of whatever the topic is ended up being really valuable.

Faculty also reported increasing flexibility toward students' lives outside of class and being willing to listen and demonstrate empathy toward the challenges students face in their personal lives. During the coding process, a humanistic-educative framework was the most frequently applied code, which identified examples when faculty demonstrated humanism, compassion, understanding, human-centered design, universal design, and appreciation of the lived experiences of students. Bobbi stated,

> One thing that I value is the accessibility aspect. I knew, even 8:00 AM, 9:00 AM people probably wouldn't show up as the semester went on. But I'm still gonna record it for those who do need it. And so, it was just an easy thing where I would just click record on Zoom beforehand and they had access to that. And then having everything posted ahead of time and just doing what I can to make those things accessible and trying to be consistent with communication so they knew what to expect.

Faculty reported wanting to change even more, but they cited several barriers to making desired changes, including lack of time for making and implementing course revisions, drastically varied course types, and challenging student characteristics, such as disengagement, absenteeism, and prioritizing grades over learning. Thus, some faculty cited examples of having been forced to keep their instructional practices the same, though they planned to improve them in the future. Min stated,

> I want to ask students for each topic how well they know, like you need to know how much you know […] I think it's one of the teachings in the workshop, is recognize how much you know already. And then you know how to put the effort in, I think. So basically, now you have all the concept map […] you create concept map […] you know this topic and you create it as a homework. I did not do that. I wanted to, but I was rushed to finish the content.

In a theme regarding change, adaptability in instructional style was applied to items coded as demonstrating change in thoughts, actions, and/or beliefs about teaching and student interactions, as well as openness to adapting based on observed student needs. Following the coding process, each faculty member's degree of change was scored as 0=No change, 1=Minimal change, 2=Moderate change, or 3=Substantial change. Additionally, each faculty member's career phase was identified as 0=Beginning, 1=Early, 2=Mid, or 3=Late. Mid-career faculty with 6-19 years of experience tended to report that they had undergone the most substantial changes in their thoughts, actions, and/or beliefs about teaching and student interactions, as well as openness to adapting based on observed student needs. Donald stated,

> I'm entering my mid-career phase where prepping classes is a bit more straightforward. There were two new classes that I was assigned to teach this academic year. I stepped into those classes with the spirit of a complete redesign of both classes using all the knowledge that I've gained over the last few years in my professional development to really identify what the course goals are and backwards design all of the necessary activities so that the instructional design made clear what the objectives were, what the learning activities would be, and what the associated assessment would be.

Early-career faculty with 1-5 years of experience reported moderate or minimal change. Both faculty in the beginning career phase with no experience before the summer program reported no change, while both faculty in the late career phase reported minimal change or no change. As a beginning faculty member, when Harold was asked for feedback on the summer program, Harold stated,

> I think to get the most out of it, I would suggest that people wait until they've taught one year. Just because again, this last year I didn't really get a whole lot of opportunity to really apply it. And then now the next year when I want to, it's not as fresh in my mind. And I think a lot of the material kind of relies on previous experience, which I didn't have a whole lot of.

Of interest when integrating study findings, although there was noted change in awareness and integration, qualitative data analysis revealed difficulty in extrapolating learning theory examples from different fields of study. Some faculty evidenced a lack recall of the learning theories covered in the summer program, as well as a desire to develop a better understanding of the data, evidence, and practical applications, which would support and encourage their use of learning theories in engineering courses. Min stated,

> I wish there's more examples like solutions like Q&A, lots of Q&A, so I can ask questions why this doesn't work, what improvement I could do. You have theory, which is great, but if we can have more commonly seen problems and then we have people chime in different solutions, maybe that would be great.

Thus, future faculty development should provide further assistance in applying theory to practice and ensure that in addition to theory, participants are equipped with numerous concrete examples of instructional strategies that tend to work, particularly in engineering courses.

Conclusion

Our model emphasizes the relationship between learning and teaching, with a focus on the affective domain of teaching by involving dialogue and reflection. Our goal is to transform engineering education through a humanized pedagogy, based on Caring Science. Already from Cohort 1, there is strong evidence that the humanistic-educative framework is the most impactful element of this faculty development program. Our findings provide support for targeting future faculty development toward early- and mid-career faculty, as they may be more likely to gain significant benefits than beginning and late-career faculty.

Future Plans

We are continuing to collect longitudinal data from Cohort 1, including conducting course observations and artifact analysis. Further, we will analyze data between groups (CoP versus SP) for the impact of programming over time. Cohort 2 recently concluded their summer programming in 2024, and data collection is underway.

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References

[1] D. Ebert-May, T.L. Derting, T.P. Henkel, J.M. Maher, J.L. Momsen, B. Arnold, H.A. Passmore, Breaking the cycle: Future faculty begin teaching with learner-centered strategies after professional development, CBE Life Sci. Educ. 14 (2015) 1–12. doi:10.1187/cbe.14-12-0222.

[2] S. Bernstein-Sierra, A. Kezar, Identifying and Overcoming Challenges in STEM Reform: a Study of four National STEM Reform Communities of Practice, Innov. High. Educ. 42 (2017) 407–420. doi:10.1007/s10755-017-9395-x.

[3] C. Cara, M. Hills, J. Watson, An Educator’s Guide to Humanizing Nursing Education, Springer, 2020.

[4] C. Hurney, E. Brantmeier, M. Good, D. Harrison, C. Meixner, The Faculty Learning Outcome Assessment Framework., J. Fac. Dev. 30 (2016) 69–77.

[5] C.A. Hurney, J.D. Troisi, L.H. Leaman, Development of a faculty appreciation of pedagogy scale, To Improv. Acad. 39 (2021) 27–50.