Board 395: Supporting STEM Faculty in Adopting and Adapting Writing Pedagogies

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Supporting STEM faculty in adopting and adapting writing pedagogies

Abstract

While the importance of communication skills is widely recognized in engineering professions and included in accreditation standards, developing such skills is challenging. Evidence-based best practices have been identified in writing studies but are not well known among faculty in science, technology, engineering, and mathematics (STEM). Many of these best practices have been developed in courses capped at 15 to 30 students and do not scale well, which presents additional challenges for STEM faculty teaching large classes. Our Writing Across Engineering and Science team has taken a transdisciplinary action research approach to this problem, engaging across engineering, science, and writing studies to iteratively develop, implement, and assess collaborative solutions. The program we co-created includes a faculty learning community and individualized mentoring, both facilitated by transdisciplinary teams, to support STEM faculty as they adopt and adapt new writing pedagogies. Our analysis of program effectiveness is based primarily on faculty surveys, mentoring records, interviews, and analysis of course materials. In one case, we are also investigating the effects of pedagogical changes on student writing. To date, 54 faculty from 15 different STEM departments at our university have participated. Most participated only in the faculty learning community. Thirteen have participated in both the faculty learning community and the individual mentoring, while 7 participated only as mentees. Data are available for 12 of the faculty who participated only in the faculty learning community; 11 of these faculty reported making pedagogical changes. Of the 20 mentees, we have documented pedagogical changes from all 20. The examples provided illustrate both the types of pedagogical changes participants are making and the concepts that seem to be more difficult to implement. Overall, our analysis suggests that this program effectively promotes pedagogical change and innovation around writing in STEM classes.

Introduction

The ability of engineers and scientists to communicate effectively and persuasively is a critical competency that has been emphasized by the National Academies and included in accreditation standards [1]–[3], yet remains challenging to develop [4]. Our local needs analysis confirmed widespread recognition of this need across our engineering college [5], [6]. Reave's 2004 report [4] documents two common approaches (requiring a technical communication course or integrating communication instruction into engineering course(s) by incorporating a co-instructor with expertise in communication) and concludes with a call for comprehensive and integrated communication instruction in engineering programs. A technical communication course cannot by itself cannot achieve key goals [7], [8] and could contribute to a misconception, already widespread among our students, that writing is not something important to the practice of engineering. The co-instruction model, when authentically integrated [4], can be effective (e.g., [9], [10]). However, the financial resources and personnel needed to apply this model at the scale of our college were not available to us.

We chose instead to develop a support system for STEM faculty as they learn, adopt, and adapt new writing pedagogies [6], [11]. Our Writing Across Engineering and Science (WAES) support system now includes a semester-long faculty learning community (FLC), individualized

mentoring, and professional development and courses for STEM teaching assistants and graduate students. Working as a team that includes engineering, science, and writing studies faculty, academic professionals, and graduate students, we approach the problem using a transdisciplinary action research (TDAR) framework [12], [13], simultaneously trying new interventions and researching their effectiveness. Our interventions are co-designed and co-delivered. Our research is similarly transdisciplinary, from the data collection and analysis through synthesis into manuscripts and future interventions.

One current project examines the effectiveness of this support system at promoting pedagogical change and improving student writing. Here, we report on faculty participation and presence or absence of pedagogical changes as basic metrics of program effectiveness. We also reflect on what types of changes are being made and which writing studies concepts have appeared to be more difficult to take up and/or incorporate into STEM classes. In keeping with the iterative and intertwined TDAR approach, these results continually feed into our on-going interventions.

Data collection and analysis

Collected data include video- and audio-recording of mentoring sessions, course materials over the course of mentoring, texts from workshops (e.g., field notes of discussions, free writing exercises, chalkboard writing), observations of classes and course staff meetings, and faculty surveys and interviews. Pedagogical change was noted in surveys through self-reported changes as well as documented through changing course materials during mentoring meetings. Data on degree of change are based on all participants who completed a survey in 2021 (earlier surveys did not include this question, and instead only asked whether or not there was pedagogical change). Preliminary observations about which concepts are being taken up are based on mentoring cases, for which more information is available about the specific changes being made.

Results

Participation

While originally envisioned as a sequential support system with an initial one-semester FLC followed by individualized mentoring (one or more semesters), faculty participating in the WAES program have followed a variety of pathways. The three main pathways are Faculty Learning Community only, Faculty Learning Community and Mentoring, and Mentoring Only (Figure 1). In addition, STEM faculty on our project team also participated in the faculty learning community, and some participated in mentoring as well. A few faculty have begun with mentoring and then elected to participate in a faculty learning community later. Others might participate in a faculty learning community and then elect to participate in mentoring in a later year. Participation is voluntary. Stipends were provided only for the 2022 cohort of faculty in the FLC.

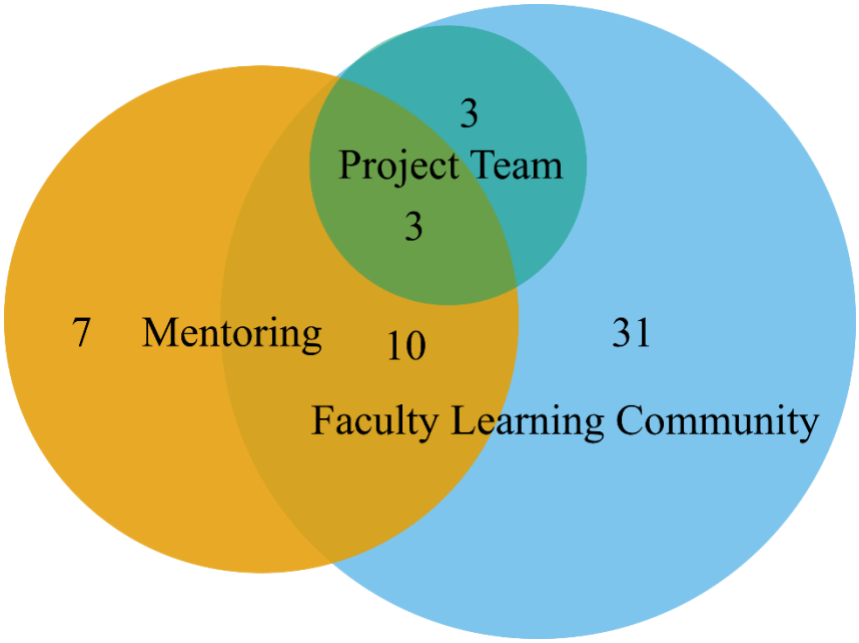

Figure 1. Participation in WAES programs. Number of STEM faculty and academic staff participants from 2016-2023, with the Faculty Learning Community (FLC) offered in 2017, 2018, 2020, and 2022. A total of 54 faculty participated in WAES, with 34 participating only in the FLC, 13 participating in both the FLC and mentoring, and 7 participating only in mentoring.

Effectiveness

The results of this project thus far are encouraging and suggest that the WAES program is highly effective in promoting pedagogical change. The majority of faculty across each pathway engaged in pedagogical change (90% of FLC-only faculty and 100% of mentoring-only faculty and FLC and mentoring faculty). One limitation is that we have data from only 35% of FLC-only faculty. While this is a relatively high response rate for a survey, especially one that is distributed at least a year after participation in the FLC, work is on-going to increase coverage of the FLC-only participants. Because we are able to observe changes directly while working with mentees, data on pedagogical changes are available for all of those participants and are typically more comprehensive with respect to the types of changes made. All 20 of the FLC and mentoring faculty and mentoring-only faculty implemented pedagogical change. The voluntary nature of the program (no incentives except for a stipend provided for the 2022 FLC cohort) likely contributes to this high rate of change. However, our research has found that the longitudinal nature of the program and the support that mentoring provides during implementation also contribute to its effectiveness [5], [14], [15].

Considering the depth of changes based on our most recent faculty survey, faculty reported a range from slight changes to complete course revisions (Figure 2). The one faculty member who reported no change was FLC only. Of the five faculty members reporting slight changes, four were FLC only and one was FLC and mentoring. For the faculty reporting moderate changes, two were FLC only, one was mentoring only, and two were FLC and mentoring. The two faculty members who reported a complete revision were both FLC and mentoring. We provide two examples below to illustrate some of the types of changes taking place.

Our current analysis examines which writing studies concepts are being adopted and how they are being adapted for STEM contexts. We have noticed so far that many faculty have implemented changes regarding process orientation and global, prioritized response. Fewer changes seem to be taking place regarding genre awareness and writing-to-learn, and very few faculty have made conceptual changes regarding source use in their classes. For more information about these concepts, see the following references: process orientation [14], [16]–[18]; global, prioritized response [17]; genre awareness and flexibility [19]–[22]; writing-to-learn [23]–[26]; and source use [27]–[32].

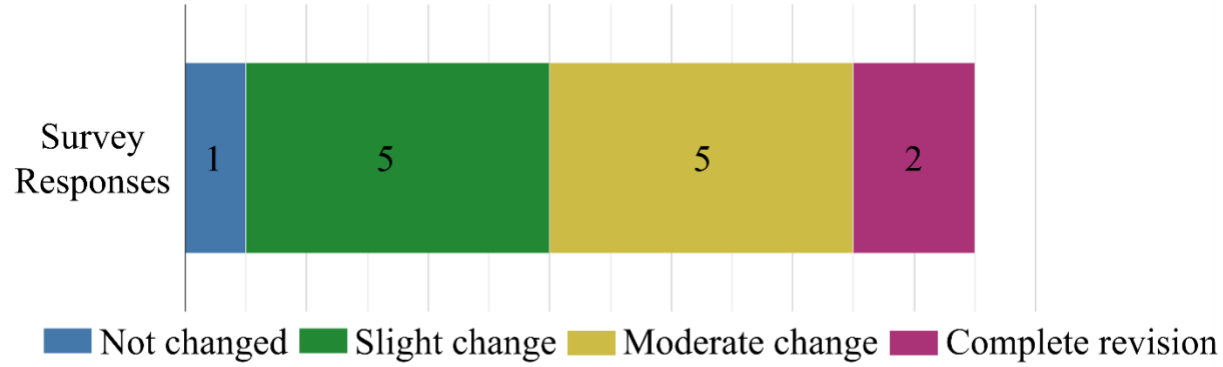

Figure 2. Degree of changes in pedagogical approach to writing and writing instruction after participation in the WAES program. Data on degree of change are self-reported and based on all participants who completed a survey in 2021.

Example of Moderate Change

The first example comes from a project-based learning course in Civil and Environmental Engineering, team-taught and led by Dr. Jeffrey Roesler.[1] Over the course of the semester, teams of first-year students collaboratively define, study, and propose sustainable solutions to a range of engineering problems on campus. Students work together to craft professional reports that outline their proposed solution in addition to presenting at a poster session evaluated by local engineers and professionals at the end of the semester. Dr. Roesler participated in the first WAES cohort in 2017 and again in 2022. Mentoring took place over the Fall 2019 semester. At that time, the course already took up a process orientation [14] to report writing, with students completing various milestones throughout the semester that represented various sections of the report (e.g., executive summary, objectives, methodology). Dr. Roesler was interested in additional methods of providing feedback to students before milestone drafts were assessed by graduate teaching assistants.

Over the course of the Fall 2019 semester, WAES team members John Popovics, Bruce Kovanen, and Gail Scott worked with Dr. Roesler to develop a framework for peer review. In this case, peer review was implemented during class time and framed as an opportunity for students to explore alternative organizational structures for the report and to improve their own. For example, when assessing the project scope, students evaluated whether the report

[1] Faculty participants granted permission for their real names to be used in reports of the research.

successfully divided the project into concrete tasks and provided details on how individual tasks would be executed. The peer assessment form also asked that students connect their feedback to course goals and assignment requirements outlined in the course's communication manual. In this way, peer review became another avenue to emphasize the importance of various sections of the report and their connection to professional civil engineering practices, such as providing measurable deliverables.

Example of comprehensive change

The second example comes from *Behavior of Materials* (CEE 300), an advanced composition and laboratory course offered by the Civil and Environmental Engineering Department that introduces students to a variety of engineering materials (metals, ceramics, and polymers) used in civil engineering construction projects. Each semester, the course has an enrollment of around 100 students. One of the course instructors, John Popovics, has participated as a member of the WAES team since its origin, including in the first WAES cohort in 2017, and has worked with other members of the team to iteratively implement comprehensive changes in the course's writing pedagogies. These changes include an overall decrease in the number of reports students complete, allowing a more process-oriented assignment design as well as a transition from collaborative reports to individual student submissions, which has been reported on by our team previously [33]. Another major change to the course has been the incorporation of language units from the Civil Engineering (CE) Writing project that Susan Conrad led at Portland State and that investigated differences in writing practices of professional engineers and students and developed educational modules specifically targeting characteristics of practicing civil engineers' writing [34], [35], [36].

The CE Writing Project language units offered opportunities for students to connect course materials to professional engineering practices by employing discrete, focused exercises [35]. Incorporation of the CE Writing Project language units into CEE 300 also helped to address issues of scale. Given that CEE 300 is a large lecture course comprising several smaller lab sections, one of the central issues around pedagogical change and writing instruction was how changes could be implemented in a large class without undue workload burdens on the instructor and graduate teaching assistants. CE Writing Project language units were incorporated into course writing assignments at various stages, for example by asking students to review the unit on reverse outlining, reverse outline their draft lab report, and reflect on how it is organized and how to improve the organization. A central contribution of incorporating CE Writing Project language units was a stronger connection between the coursework of CEE 300 and the work of professional engineers, again without overburdening instructors with additional grading labor. To prompt further reflection on the language units and genre differences between school and professional writing, other assignments prompt student reflection on disciplinary writing practices of professionals.

Conclusions

To date, the evidence suggests that the WAES program has been effective at promoting pedagogical change around writing in STEM courses. Our research and experience suggest the effectiveness of this project has been a result of close transdisciplinary work over the course of several years. In each facet of the support system, faculty and graduate students across disciplines co-facilitate workshops, mentor faculty, and work across disciplines in team meetings

every week. For universities seeking to implement faculty development regarding writing instruction, we encourage models that promote long-term, transdisciplinary engagement. As a writing-across-the-curriculum project, our work highlights the importance of longer-term interactions and sustained mentoring to assist faculty as they implement pedagogical change [15], [37]. One important question not yet addressed in our research is how these pedagogical changes are affecting both students' conceptions of writing and their ability to write in ways that their disciplines value.

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