This statement for promotion to the rank of Teaching Professor presents evidence of the various ways in which I have met the required criteria for promotion. Since my appointment to Associate Teaching Professor in May 2016, I have shown continual excellence in teaching, educational research, and service to the University and the chemical engineering community. My broad teaching and research topics focus on effective hands-on pedagogy to create pathways to student success and thriving with a specific focus on methodologies that are shown to create more inclusive classrooms. As this narrative will show, I have successfully worked with the undergraduate students to further both their professional goals and my own.

TEACHING

My teaching philosophy centers on pedagogies of engagement and application of student learning through class projects, hands-on experiments, and learner-driven design. Students are most likely to learn (and retain) new information and understand connections between concepts through active learning experiences. In the paper, *Pedagogies of Engagement: Classroom-Based Practices*[1], collaborative learning environments and problem/project based learning are emphasized as best practices. Therefore, all of my courses require group work and hands-on learning experiences as core components. Additionally, I aim to use these approaches to increase student self-efficacy at all points in their educational development. As described in *Learner-Centered Teaching*, novice learners require teaching skills that involve direct work from teachers. In learner-centered activities, teachers "must be able to give constructive feedback, be patient…and celebrate accomplishments, even small ones"[2].

These general principles have proven effective in many different teaching experiences, as exhibited by receiving the following three awards:

- Thomas P. Madden Award for Teaching of First-Year Students (2016)
- Catherine F. Pieronek Women in Engineering Impact Award (2017)
- Rev. Edmund P. Joyce, C.S.C., Award for Excellence in Undergraduate Teaching (2020)

In the following sections, I will outline specific applications of this teaching philosophy to the courses I have taught since 2016.

Chemical Engineering Lab I & II

I act as the course coordinator for CBE 31358 and CBE 41459, regularly referred to as Junior Lab and Senior Lab, respectively. In that role, I am responsible for all general coordination of student groups, schedules, and experiments. I work with 4-6 faculty members on each course to create a hands-on, small group experience with significant faculty interactions.

Students regularly rate these lab courses as being intellectually challenging, in large part because they are doing a kind of work that requires retrieval from many classes. Through Course Instructor Feedback, students generally rate my teaching in those courses very well. CIF's can be

1. Smith KA, Sheppard SD, Johnson DW, Johnson RT. *Pedagogies of Engagements: Classroom-Based Practices*, Journal of Engineering Education, (2005), pp 87 – 101.
2. Weimer, M. *Learner-Centered Teaching*, Jossey-Bass, (2013), pp 124.

difficult to parse in the lab course, because students are asked to rate all faculty members in lab, regardless of whether or not they complete that faculty members specific experiment. Therefore, there is greater movement in CIF scores between sections or across semesters. Despite this fact, I have regularly received very high CIF scores, as shown in Figure 1, with an average Composite Median Score across all sections in the 4 semesters shown of 4.8.

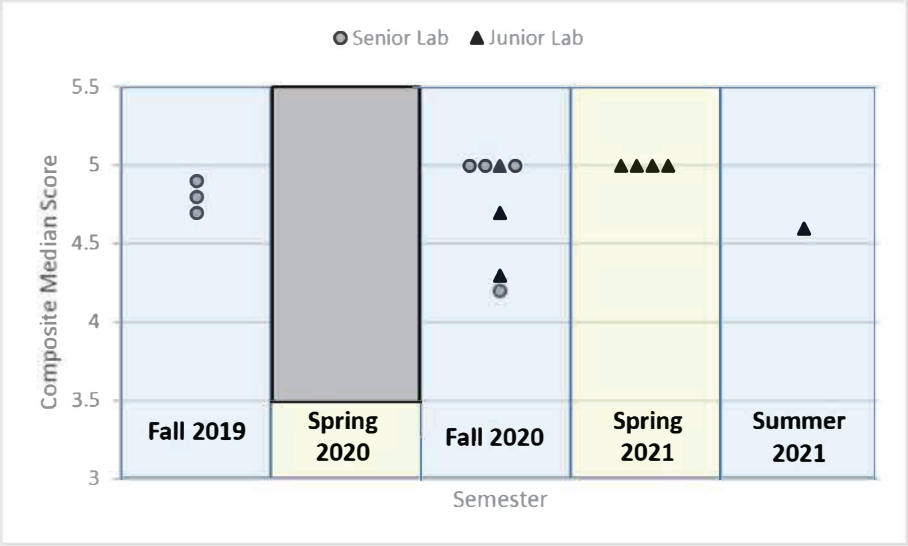

Figure 1. *CIF scores for Junior and Senior Lab indicating broad student satisfaction. Each section in a given semester is represented by a circle (Senior Lab) or triangle (Junior Lab).*

In addition to the ongoing running of Junior and Senior Lab, I have spearheaded a number of initiatives to improve the course. First, I instituted several new safety measures that align more clearly with industry standards. All groups now complete a Job Safety Assessment (JSA) when entering lab and enhanced online safety training. This requires that students consider any safety concerns and possible measures they will take to minimize risk for the particular experiment they are running that week. In addition, students go through general safety checks of eyewash stations, fire extinguishers, and other safety equipment. Feedback from students has been positive with several connecting these activities directly to internship practices. In addition, the engineering advisory council members consistently praise these methods as industry standard and incredibly important learning objectives for all engineers going into industry.

In addition, the Junior Lab course has adapted to more clearly meet a number of students' formal academic requirements. First, the Junior Lab course was offered in multiple off-sequence options for students who had interrupted schedules due to COVID related changes, including disruptions to study abroad programs. While these courses run on the same experiments as the regular course, the materials and expectations were adapted to meet the students where they were in the curriculum. This included creating new lectures with background material and many additional hours of student meetings to help students succeed.

Second, with the change to the Core Curriculum at the University, many engineering students needed new types of courses to fulfill all requirements for graduation. Specifically, students need a writing intensive course, but they may not have many chances to earn that credit within the packed chemical engineering curriculum. Therefore, I adapted the writing assignments of the Junior Lab course so that all chemical engineering students would be able to gain this writing intensive credit without additional courses. To my knowledge, this was the first engineering course to count for the writing intensive requirement. Changes to the class included more targeted and specific writing instruction for all students, librarian-guided exercises on using appropriate resources, individual writing assignments, and required rewrites of faculty reviewed work. These additions were balanced with changes to the students' laboratory schedule in order to ensure the course demands were still appropriate for a 3 credit hour course.

Finally, part of the on-going operation of the laboratory requires consistent improvements to the experiments that students complete. Since taking over the lab coordination position, I have on-boarded four new experiments: Fault Finding in Controls, Gas Absorption, Heat Exchanger Network, and Reverse Osmosis. These represent an approximately $250,000 investment in the laboratory. Each experiment fills a gap in our current hands-on experiences for students. For example, CBE students learn heat transfer and the basics of heat exchanger theory in the transport course sequence. Many students, however, have not seen a heat exchanger and do not understand the how to compare different types. In the past, we had a unit that did not work consistently and included only one heat exchanger type that is not heavily used in industry. The new experiment requires that students run multiple heat exchangers, compare the behavior between exchanger types, and suggest use case scenarios for five heat exchangers included in the unit. Students now see equipment closer to real-life scenarios, and they are required to use higher order Bloom's Taxonomy skills to analyze and evaluate the equipment. Each new unit brought into the lab augments the theoretical framework introduced in core chemical engineering courses in order to complement and extend lessons across multiple semesters.

CBE 10115: Chemical Engineering and Food Design

In the 2020-2021 academic year, the first-year engineering course sequence was adapted to create spring semester first-year courses delivered by each department. Because these courses should not have specific Advanced Placement requirements and must have a project-based component, none of the current CBE courses fulfilled this new role. Therefore, I created a new CBE course, Chemical Engineering and Food Design. This course focused on chemical engineering in everyday life through the lens of food. Topics included large-scale manufacturing and process engineering to chemical process happening in every household kitchen.

The course presented some challenges to meeting student needs at this particular time. First, some students were taking both this course and the Introduction to Chemical Engineering (CBE 20255) course during this semester. Other students would be taking CBE 20255 in the fall with students who would not have the benefit of exposure to topics from the Food Design course.

Therefore, I focused on chemical engineering phenomenon that would not advantage these ahead of schedule students who then took CBE 20255 in the fall semester. However, I did have to balance keeping up engagement for the students who were already in that course and had advanced knowledge and interest in chemical engineering topics. I focused on hands-on experiences that would allow students to adjust the difficulty and theoretical connections dependent on where they were in the curriculum. Overall, I believe this worked well as there were challenging topics brought to the students, but they often connected to coursework further into the chemical engineering curriculum.

A major goal of this course was to help students understand chemical engineering and make an informed decision about their major selection. In order to better understand how this course met that goal, the students were surveyed at the start and end of the semester. All 24 students from the course completed both surveys. In addition, 5 first-year students that did not take CBE 10115 but did take CBE 20255 were included in the pre-survey. Because the survey was not given during class time for those five additional students, none of them chose to complete the final survey. The results of the pre- and post- survey can be found in Table 1, below.

Table 1*.Student responses for "To what degree do you agree with the following statements" for each of the learning goals listed.*

	Start of Semester (n=29)						End of Semester (n=24)					
	Strongly Agree (5)	4	3	2	Strongly disagree (1)	Average Score	Strongly Agree (5)	4	3	2	Strongly disagree (1)	Average Score
I understand what chemical engineers do	4	20	4	1	0	3.93	9	15	0	0	0	4.38
I can name modern societal issues that chemical engineers address	5	21	3	0	0	4.07	12	11	1	0	0	4.46
I am aware of the areas of chemical engineering in which I may specialize	5	19	4	0	1	3.93	14	9	1	0	0	4.54
I understand the connection between food science and larger chemical engineering industries.	4	16	6	3	0	3.72	17	6	1	0	0	4.67
I am certain that I will major in chemical engineering.	16	10	2	1	0	4.41	15	5	2	0	2	4.29
I am certain that I am capable of completing a chemical engineering degree.	19	8	2	0	0	4.59	15	6	1	1	1	4.38

For the first four goals described above, students indicated improved understanding of chemical engineering and their options with a chemical engineering degree. As shown in the final two statements, there was a slight decrease in student certainty in engineering and their own capabilities. However, this change is small and could be accounted for by the lack of CBE 20255 students in the end of semester survey. In addition, at least one student decided not to pursue chemical engineering after this semester, which we also take as a successful use of the course as informed major choice is a primary goal of the first-year experience.

While meeting the more general learning goals, students also learned about real chemical engineering topics. For instance, in a measurement of a highly processed food, the students were

able to practice data analysis and connect back to factory requirements for quality assurance. An activity on food preservation through dehydration introduced students to the thermodynamic concept of water activity and ways to reduce water activity to preserve foods. This was then connected to processed food by explaining how salt and sugar reduce the water activity in most prepared foods. By grounding the thermodynamic property in food spoilage, students were more easily able to connect the concept to topics where they were already comfortable. In the end, students responded very positively to the course, with a Median Composite Score of 4.6 and 94% of respondents rating the course "Excellent" or "Very Good". Anecdotally, students commented on how much fun they had doing the activities in class, and they regularly made connections to their own experiences cooking (or a parent cooking).

In the spring semester, this course will be re-tooled for upper-class CBE students. I expect that it will be similarly interesting to the students, but much more technically rigorous than what was described above. In future years, I hope this course could be adapted to act as a more general Core Curriculum course and even reach outside of the College of Engineering.

Special Projects

In accordance with my Statement of Duties, I dedicate a portion of my time towards special projects for the department. Each year there are number of these that come up, so I will focus on some of the larger projects that represent the typical project types. First, I often work with faculty and students on general Scholarship of Teaching and Learning research to improve student experience. For several years, I worked with Dr. Alex Dowling to understand longitudinal learning objectives between Numerical and Statistical Analysis and Junior Lab. As Dr. Dowling made changes to his course, I tracked students' ability to answer several simple statistics problems at the start and end of the Junior Lab semester. The data was then brought back to Dr. Dowling so that he could make continued improvements to his class.

A more typical special project is providing space and expertise for students doing hands on work in the lab environment. When Dr. Jeremiah Zartman wanted to add a microcontroller design experience to his Biotransport class in 2018, I was able to help order and arrange materials as well as provide the space and timing needed for student success. In summer 2021, when Notre Dame collaborated with H.B. Fuller as a new partner to the Engineering Innovation Hub, I helped deliver their project to the CBE students. Because the EIH has no space for wet chemistry, students used the undergraduate chemical engineering lab space to complete a number of experiments for H.B. Fuller. In addition, I arranged and attended a field trip for the students to an H.B. Fuller facility to view the industry-sized example of the unit we were recreating in the lab. The students are continuing the project in the fall semester, and we are prototyping an H.B. Fuller mixing experiment to be used in future offerings of Senior Lab. With the success of this project, I will chair a faculty committee to outline our vision of an expanded student-focused space for similar projects across the undergraduate and graduate curriculum.

PROFESSIONAL DEVELOPMENT

In addition to teaching, I continue to grow in my professional development in both teaching and research. I am an active member of the American Society of Engineering Education, American Institute of Chemical Engineers, and the Society of Women Engineers. In addition to acting as a conference reviewer and session moderator, I have served as the Secretary/Treasurer for the Chemical Engineering Division of ASEE for the last 3 years. I also regularly publish papers in both the First Year Engineering division and the Women in Engineering Division at the yearly annual ASEE conference, as shown in my curriculum vitae.

Research

Currently I have three focuses for my research: (1) understanding the role of classroom pedagogy, (2) exploring the experiences of women in engineering, and (3) probing the role of Advanced Placement credit on student achievement. Classroom pedagogy is largely focused on my own courses or the first-year course in collaboration with Kerry Meyers and Andrew Bartolini. These focus heavily on student major selection, confidence, and self-efficacy when starting the engineering curriculum.

In addition, I have worked on several research projects with Kerry Meyers centered on the experience of women students while at Notre Dame. Last year, we published a paper on the experience of students attending an engineering field trip. This year we have two papers in preparation. The first is looking at the impact of engineering placement residence halls on student satisfaction and persistence over the last 15 years. The second is a qualitative study of changes to female graduate students' career goals over the course of their Ph.D. experience. In both studies, results underpin how we can best support our female students.

Over the last 2 years, I have been working with Leo McWilliams on the correlation between student demographics and preparation and their academic performance. Through this work we have noted strong correlations between student Advanced Placement credit and term-by-term GPA, especially in their first two years in engineering. This finding, coupled with the understanding that AP credit creates more student curricular choices, has led us to champion curricular changes that meet the students where they are in an equitable fashion. I am happy to say that the College of Engineering has picked up that charge and moved forward with several initiatives to address inequitable academic opportunities. This work has been well received outside of the university as well, especially in groups focused on inclusive classrooms.

Continued Trainings

My teaching is continually evolving as I learn more about the best way to support our students. In summer 2021, I completed the edX course, The Inclusive STEM Teaching Project. This focused specifically on creating and enhancing inclusive classrooms for STEM faculty. In addition, I have attended Kaneb Center events and organized reading groups to learn about new

pedagogical techniques and discuss them with colleagues from throughout the university. Due to my continued engagement and my teaching awards, I was asked to become a Kaneb Faculty Fellow in Fall 2020 which has allowed me to pass on some of my best practices to other faculty on campus through workshops and faculty mentorship.

SERVICE

In my last 6 years, I have continued to expand my service to my academic community. In some cases, I have already described these in sections above where they most clearly fit with my other goals. In addition, I have found many ways to serve all levels of the university.

Within the CBE department, I serve on the Undergraduate Committee, the Safety Committee, and act as the academic advisor to a number sophomore and junior students. Over the years, the majority of my department level service has focused on improving undergraduate education and holistic growth of all students. This includes many hours of informal mentoring of both undergraduate and graduate students. While it is hard to quantify the impact or amount of time dedicated to informal mentorship, I consider it one of the most rewarding and meaningful parts of my position.

At the College of Engineering level, I have served on College Council, the Implementation Committee for First Year Engineering Courses, and the Diversity, Equity, and Inclusion Task Force. With the DEI Task Force, I was able to bring my ongoing research to the committee and advocate for recommendations that would ensure equitable experiences for all students. I also serve the College as the advisor to the Society of Women Engineers. This is the largest engineering club on campus, with multiple events most weeks.

Finally, I have served the University through multiple committees centered on academic technology. First as a member of the Learning Management Guidance Council, then as a member of the University Committee on Academic Technology, and finally as part of the succession committee and as a pilot participant for the new Learning Management System. In this role, I bring an intimate knowledge of student experience using technology and my own expertise in pedagogical development. With connections as a Faculty Fellow of the Kaneb Center and a Fellow of the Institute for Educational Initiatives, I have been able to leverage campus wide feedback as the university continues to adapt to new technology needs.

CONCLUSION

As this statement demonstrates, I have met the stated department and university criteria for promotion to Teaching Professor as they relate to my Statement of Duties. I believe I have shown growth in my teaching breadth and expertise while continuing to implement student focused research and service.

Internal Letters of Recommendation

Not applicable