A Graduate Student Pedagogy Seminar in Chemical Engineering

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Introduction

Teaching is an important but often challenging activity for graduate students. In the role of graduate teaching assistants (GTA), they impact the learning experience of undergraduate students, but they also gain a set of knowledge and skills beyond what they learn in class or through research. Typical duties for GTAs vary and can range from conducting problem solving sessions, creating homework solutions, grading, and holding office hours. GTAs may also find themselves working within pedagogically sophisticated learning environments such as working with small groups of students in a Studio setting, as we have recently reported [1, 2]. Within these spaces GTAs are asked to "facilitate" student learning. By "facilitate" we mean that they are encouraged to shift activity, as much as possible, away from directly showing students how to do their work to asking students questions, eliciting their thinking, and encouraging group interactions.

As such pedagogical strategies become more complex, the professional development of GTAs becomes critical. While graduate students are familiar with negotiating a course as a student, they do not have experience with facilitating student learning and typically lack the proper pedagogical preparation prior to entering the classroom to be effective. There is significant work regarding graduate student development across higher education [3, 4]. In physics, Goertzen and colleagues studied how graduate students think about and facilitate Physics Tutorials in order to improve professional development for graduate students [5, 6, 7]. Speer focused on providing a framework for understanding the connection between beliefs and practice of graduate students in mathematics [8. 9]. Chemical engineering educators have published reports on courses devoted to developing graduate students' skills as researchers and writers [10, 11, 12], voluntary graduate certificates [13], but there is limited information on the creation and implementation of pedagogical development of graduate student teachers in engineering. In an ongoing effort to prepare incoming graduate students to be a facilitator in Studio, researchers on an National Science Foundation (NSF) Widening Implementation and Demonstration of Evidence Based Reforms (WIDER) grant integrated pedagogical development content into a new professional development seminar in the School of Chemical, Biological, and Environmental Engineering (CBEE) at Oregon State University during the 2016-2017 academic year. This paper describes the creation, implementation, and reception of the seminar, and offers suggestions for those who hope to create or implement a similar seminar in their programs.

History of CBEE Pedagogical Development Seminar

This study was part of an NSF WIDER grant, titled Enhancing STEM Education at Oregon State University (ESTEME@OSU). ESTEME@OSU focused on improving instructional practices within five STEM units (CBEE, biology, chemistry, mathematics, and physics) and

understanding the impact of evidence-based instructional practices (EBIPs) in the classroom on performance and attitudes of students. The primary EBIPs of interest on this grant were interactive engagement in lecture and cooperative learning in Studio-type environments. GTAs within the five STEM units often serve as facilitators in these cooperative learning Studio environments. In the five units, we found a wide range of pedagogical development opportunities to prepare them for complex teaching practices.

Table 1 provides an outline of the major activities and products that eventually resulted in the integration of pedagogical development into the year-long seminar for first year graduate students. During the 2014-2015 academic year, researchers attended and characterized professional development opportunities provided to graduate students in CBEE, biology, chemistry, mathematics, and physics to understand how graduate students are being prepared for the implementation of EBIPs within small group learning environments. Opportunities for pedagogical professional development for graduate students ranged from pre-term orientations, weekly seminars, teaching planning meetings, reflective practice meetings, and involvement with curriculum and assessment development. Biology, chemistry, physics, and mathematics all included pedagogical development opportunities in seminars that were part of the core graduate curriculum. In CBEE, GTAs were asked to attend bi-weekly meetings that focused on creating a community that reflected on problems of teaching practice in Studio and discussed alternative ways of approaching practice. These bi-weekly meetings were voluntary and organic in nature, such that topics differed week to week and generally were directed by issues the GTAs were currently facing.

Table 1. Details of the major activities and progression for pedagogical development in CBEE

Timeframe	Activity	What we learned or accomplished
2014-2015 academic year	Characterization of current pedagogical development provided to GTAs in five units	Need for a structured pedagogical development for GTAs in CBEE
2015-2016 academic year	Interviews and observations of GTAs in CBEE	CBEE GTAs: • were unprepared to facilitate in Studios • used pedagogical language but not necessarily adapting/adopting practices • wanted opportunities to practice communication with students • did not fully understand how to interpret the nuances of student responses and questions
Summer 2016	Attended the NSF sponsored CoMInDs workshop	How to design and implement pedagogical development for graduate students using existing resources, frameworks, and structures
	Convened a meeting of community members interested in pedagogical development within CBEE, College of Science, and the Graduate School for input on goals and direction	Revised goals and received input on important skills graduate students need

2016-2017 academic year	First iteration of pedagogical development seminar sessions embedded in a professional development seminar series	• Devote significant effort into pedagogical development that is integrated into pre-year activity and into the graduate seminar • Focus on the topics of facilitating group work, metacognition, feedback, and the diversity of students • Create engineering specific pedagogical instructional videos

Through the 2015-2016 academic year, researchers interviewed, observed, and recorded graduate students in CBEE, mathematics, and physics to understand the beliefs that GTAs have about teaching and learning and how they enact teaching practices in the classroom. One purpose of this research was to design a structured, integrated pedagogical development specifically for GTAs in CBEE that addressed specific learning goals, which will be discussed below. An initial analysis of the interviews and recordings showed that GTAs felt: underprepared to facilitate in Studios, were using pedagogical language but not necessarily adapting/adopting practices, wanted opportunities to practice communication with students, and did not fully understand how to interpret the nuances of student responses and questions. We determined that further pedagogical preparation for GTAs to facilitate Studios was needed in CBEE to attend to these initial findings.

In June 2016, two of the authors attended the three-day NSF-funded College Mathematics Instructor Development Source (CoMInDS) workshop. The purpose of attending this workshop was to prepare for and build on current frameworks for pedagogical development. The workshop focused on how to design, improve, and implement a graduate student pedagogical development program. While at the workshop, we developed goals for the pedagogical development for graduate students in CBEE. These goals aligned with the concerns brought up in the interview and video research, but we also wanted further input from members of the community and others who had expertise in pedagogical development in other departments.

We then hosted a four-hour community working meeting specific to instituting a pedagogical development seminar in CBEE. The intent was to include key players within CBEE as well as those with valuable experience and perspective from across campus to engage in a conversation around the needs that graduate students have as facilitators. Fifteen participants attended including: faculty members in CBEE who were in charge of graduate student development, faculty who taught CBEE Studio courses, the CBEE graduate student coordinator, current CBEE graduate students, the CBEE School Head. Also in attendance were faculty members from the College of Science who had experience designing and implementing graduate student pedagogical development, department chairs from these units, as well as a member of the graduate school including the Director of Graduate and Postdoctoral Teaching Development in the Graduate School. This group contributed ideas to pedagogical development goals and what

pedagogical and professional skills they believed were important for graduate students to acquire while going through the CBEE program.

This workshop provided key community buy-in, and resulted in the following goals for the pedagogical development for graduate students in CBEE. Graduate students would:

1. Develop an identity as part of the CBEE and teaching community
2. Identify and explain different ways of how people learn
3. Identify and explain aspects of teaching practice
4. Explain how to handle the 'logistical' aspects of practice such as planning for the first day
5. Translate knowledge/skills for teaching into knowledge/skills for research and industry

Seminar Content and Implementation

All incoming CBEE graduate students are required to attend a multi-day pre-Fall orientation to help situate them in the school. One result of the community workshop was a four-hour workshop devoted to pedagogical development for incoming GTAs only. The four-hour workshop was a new addition to the CBEE orientation during the 2016-2017 year and provided sixteen incoming GTAs the opportunity to meet one another, create a GTA community, and indicate to new GTAs that CBEE valued and was dedicated to improving pedagogical practice. During this workshop incoming GTAs were introduced to what it meant to be a CBEE GTA, an introduction to Studio pedagogy [1], metacognition [14], fixed vs. growth mindset [15], and learning theory [16]. Topics in the workshop were chosen based on topics covered in the University of Colorado Boulder's Learning Assistant Program [17], which focuses on pedagogical development for undergraduate learning assistants who are in similar roles as GTAs in CBEE. Topics were also chosen to address past issues that GTAs expressed in regards to feeling unprepared to facilitate in Studio and using language of reform based practices but not fully understanding the theory behind them.

New to the 2016-2017 academic year, all incoming graduate students were required to take a 1-credit, 50-minute-per-week professional development seminar each term of their first year (each term is 10 weeks). The seminar was designed to help graduate students become accustomed to graduate expectations in CBEE (e.g. laboratory rotations, finding an advisor, thesis/dissertation resources, required paperwork) and prepare them for future professional careers (e.g. writing a CV or cover letter). After the community workshop, we worked with the professional development seminar coordinator to determine when time would be devoted to pedagogical development. Originally pedagogical development was not part of the professional development seminar series but the developers of the seminar series were open to providing some guidance on teaching and learning practices for all graduate students, regardless if they were a GTA. We designed and facilitated each pedagogical development session and chose topics that addressed the issues that emerged from the interviewed and observed GTAs, as well as those that addressed

the desired learning goals for the pedagogical development. Table 2 provides a description of pedagogical topics covered, the associated learning goals, resources used, and the primary activities implemented.

Table 2. Timetable of pedagogical development seminar topics, main resources, and activities

Term	Week	Topic(s)	Goal(s)	Resource(s)	Activities
Pre-Fall Orientation	0	Studio pedagogy Metacognition Fixed vs. growth mindset Learning theory	1, 2, 3, 4, 5	Koretsky, 2015 [1]; Tanner, 2012 [14]; Dweck, 2007 [15]; Handelsman, Miller, & Pfund, 2007 [16]	Whole class discussion Read article Small group discussion
Fall	3	Facilitating group work	1, 3, 4	Hauk, Speer, Kung, Tsay, & Hsu, 2013 [18]	Instructional video and worksheet
	5	Feedback Self-explanations Mental models	1, 2, 3	Gilbuena et al., 2015 [19]; Durkin, 2011 [20]; Rankin, 2017 [21]; Redish, 1994 [22]	Whole class discussion Working with a partner
	7	Imposter syndrome	1	Senior CE graduate students Director, Academic Student Success Center	Guest speakers
	9	Professional skills - teaching, learning, and research	1, 5	Feldon et al., 2011 [23]; Flaherty, 2016 [24]	Individual reflection Small group discussion Whole class discussion Read article
Winter	4	What is knowledge and knowing? (epistemology)	1, 5	Hofer & Pintrich, 1997 [25]; Hammer & Elby, 2002 [26]	Case studies Small group discussions Whole class discussion
	5	Relevance and creating space for equity and inclusion in engineering	1, 3	Bothwell & McGuire, 2007 [27]	Out of class reading Individual reflection in class Whole class discussion Case studies Small group discussions
	7	Stereotype threat	1, 2, 3	Steel & Aronson, 1995 [28]; Cohn-Vargas, 2015 [29]; Vogt, n.d.[30]; Paige, 2016 [31]; Dweck, 2007 [15]	Small group discussions Whole class discussion
Spring	3	Systems engineering thinking	1, 5	Graduate student doing systems engineering thinking research	Guest speaker Whole class discussion
	5	Systems engineering thinking in action	1, 5	Faculty member who has practice with systems engineering thinking	Guest speaker

For each seminar session, we used Backwards Design [32] to align our desired goals with topics and activities. Students learn more effectively when they are interacting with others and content [33] so we put emphasis on facilitating activities that applied the topics to a CBEE specific context. Typically each seminar started with a brief introduction to the topic with a reflection

question or whole class discussion following. The second half of the seminar focused on the application of the topic to a CBEE specific context. Graduate students were either asked to reflect on or identify situations in which they had encountered topic content or were given case studies that were created from experiences of the facilitator in CBEE. For example, for the seminar topic of "What is knowledge and knowing?" the first half included a short lecture on epistemology models and a whole class discussion around where graduate students typically look for information (e.g. Google, textbooks, other people). The second half of the seminar focused on small group work. Each group was given one case study asking them to reflect on different roles they might encounter: a GTA, a procurement quality engineer, graduate research assistant, or an incoming graduate student from a different discipline (e.g. chemistry). Table 3 provides an example of a case study and discussion questions.

Table 3. Example of a case study and discussion questions for "What is knowledge and knowing?"

Case: You are a graduate teaching assistant in a studio for Thermodynamics. Each week you get together with the other GTAs and instructor and go over possible solution paths for the studio. This week is a particularly difficult studio and in your meeting, your group comes up with multiple ways to solve the problem. Before studio, you've decided your goal is to try and help students understand different ways to complete the studio. As you are walking around you are noticing that students are really struggling with the concepts and worksheet. Finally, in frustration a student asks you "Just tell me if this is right or wrong, I just want to finish."
Discussion questions: What knowledge is being valued? How would you negotiate this space to move in a productive direction? What are possible solution paths? What questions might you ask to make those involved more reflective for future practice?

The winter term sessions integrated into a quarter-wide theme on equity and inclusion. A group of interested students and faculty designed and facilitated topics with the course coordinator. Topics for the term included creating space for equity and inclusion in engineering, the danger of a single story/stereotyping, and bridging institutional power structures. During this term, students were put into assigned groups for the entire term. The instructional designers thought it would better serve the graduate students if they worked with the same group members throughout the term to build trust and community. Group formation attended to gender and domestic status to ensure that students felt supported [34], [35].

Methods and Results

Overall reflections

After each seminar, the first author wrote reflections on the facilitation, the activity, engagement of the graduate students, and improvements for future iterations. These reflections were used to

summarize challenges faced in the seminar and areas that graduate students expressed an interest for future discussion. A summary of the reflections is below.

Student grouping and physical space made a difference in facilitation and engagement. Winter term was the only term in which the graduate students were put into assigned groups of three and there was an observable increase in student engagement with their group and the discussions that followed. While walking around and facilitating discussion, the first author noticed that students who were quiet the term before were actively participating in the group discussion. By the end of term, students who normally did not speak out during whole group discussions also felt comfortable enough to participate. Fall and Winter seminars were in a room with movable desks while Spring term was in a room with stadium seating. With stadium seating, students would often spread out across the rows, which not only removed a sense of community but also impacted how they engaged with group activities.

Not all of the graduate students in any given term were GTAs, so it was important to emphasize how pedagogy and learning theory translate to current or future professional situations. In order to support non-GTAs, we included case studies outside of facilitating learning environments (e.g. scenarios in research labs or industry) and discussions at the end of the session included how topics discussed could be applied in different professional contexts. However, consistently addressing how topics transferred across contexts was sometimes difficult to achieve.

Having the pedagogical development sessions interspersed throughout the professional development seminar did not allow for continuity or for content to build week after week. There was an activation energy associated with each pedagogical development session because the instructor had to reorient students to the pedagogical topics. Reiterating the importance of the pedagogical topics impacted how the graduate students engaged with the content and discussions. Students who were GTAs would dominate many of the whole class discussions, which indicated that the graduate students who were GTAs needed a venue to talk about practice. Graduate students who were GTAs facilitating Studios picked up on the nuances and constraints of the course and department structure. For example during a discussion on the importance of asking students questions and acknowledging there is not always a right answer, the graduate students stated it was difficult to enforce or approach facilitating in this way because the undergraduate students were assessed based on right or wrong answers. They wanted to know more about how to mitigate the factors out of their control, which we did not have the time to address. Time was a factor in the type and depth of discussions we were able to achieve. Taking time at the beginning of the seminar to explain the importance of the topics took time away from productive discussions.

Survey

We administered a five-section survey to assess the impact of the pedagogical development seminar series at the end of the year. A forced-choice four point Likert scale was used. Topics within the survey included: how the graduate seminar contributed to achieving the pedagogical development goals, how effective different activities were for student learning, the level of knowledge and importance of seminar topics, and demographic information. The survey was piloted with a small group of researchers and graduate students and modified based on feedback. The survey was administered the last week of Spring term. Participation was voluntary and informed consent was achieved as approved by the university IRB. The overall response rate was 76% (n=30). For analysis, we divided responses between graduate students who had reported GTA experience (n=20) and those who had no GTA experience (n=10). We used an independent t-test assuming equal variances to compare differences between groups and a point biserial correlation to determine the effect size of statistically significant differences [36].

To evaluate the effectiveness of the seminar in helping graduate student to develop pedagogical thinking, we used the needs assessment (NA) model [37]. This model provides a way to rank topics in order of priority by comparing *what is* to *what should be* in order to help improve the seminar. For this study, *what is* was the graduate students' level of knowledge on each topic covered, and *what should be* was what was perceived as important to them now and in the future.

One limitation to the survey was the graduate students' ability to recall topics and activities of previous terms. We tried to mitigate this limitation as much as possible by asking about general effectiveness of activities. There was also the possibility that graduate students reflected on the whole professional seminar rather than just the pedagogical development sessions. For future assessment, these limitations would be taken into account by administering the survey after each semester covering the topics for that semester.

Table 4 summarizes how students believed that the graduate seminar contributed to each pedagogical development goal. On average, graduate students with GTA experience thought that the graduate seminar contributed most to "I can identify connections between teaching skills and industry skills" (M=3.10; 1= no contribution to 4= strongly contributed) and contributed the least to "I can explain the logistical aspects of teaching practice" (M=2.10). On average graduate students with no GTA experience thought that the graduate seminar contributed most to "I can explain the logistical aspects of teaching practice" (M=3.10) and contributed the least to "I see myself as a teacher" (M=2.00).

When comparing the responses for the two groups, students with GTA experiences and students without, there were statistical differences between the statements "I can identify connections between teaching skills and industry skills" (t= -2.17, r_{pb}=0.38, p= 0.04), "I see myself as a teacher" (t= -2.24, r_{pb}=0.39, p= 0.03), and "I can explain the logistical aspects of teaching

practice" (t= 3.83, r_{pb}=0.59, p<0.01). The point-biserial correlation effect sizes, r_{pb}, all indicate that the strength of these relationships were "substantial [36]."

Graduate students with no classroom experience believed the seminar contributed to their ability to explain the logistics of practice more than graduate students with GTA experience. While it is important to discuss the theory behind practice, GTAs "in the trenches" realize they need competence in logistical aspects of practice such as creating a rubric or using an online management system, which could explain the difference between the two groups. This was not a focus of the current pedagogical seminar because we wanted to address topics that all graduate students, regardless if they were a GTA, could use immediately and in the future. Ideally, we need to modify delivery for some specific logistical training, e.g., use one term of the seminar series specifically for this aspect of practice. With the mixed (GTA and non-GTA) cohort, this balance needs to be considered.

Table 4. Graduate student perceptions of contribution to seminar goals

*Please indicate how participating in the graduate seminar **contributed** to the following statements:*
1= no contribution to 4= strongly contributed

Statement	GTA experience (n=20) Mean	No GTA experience (n=10) Mean
I can identify connections between teaching skills and industry skills*	3.10	2.50
I feel like I belong in the school of CBEE	2.90	3.00
I can identify connections between teaching skills and research skills	2.85	2.90
I am aware of multiple components of teaching practice	2.85	2.60
I can identify different ways of how people learn	2.80	3.00
I see myself as a teacher**	2.70	2.00
I am confident in my teaching	2.70	2.40
I know best-practices for teaching	2.25	2.60
I can explain the logistical aspects of teaching practice***	2.10	3.10

** p=0.04, ** p=0.03, ***p<0.01*

Table 5 shows the results to the question regarding graduate students perceptions of how effective each activity in the seminar was to their own learning. The highest average for both groups was "Listening to a guest speaker" (M= 3.10 for GTA experiences, M= 3.30 for no GTA experience) with the least being "Reading articles in class" (M=2.35) for graduate students with GTA experience and "Watching instructional videos" (M= 2.30) for students without GTA experience (1= ineffective to 4= very effective).

Over the course of the year, there were three sessions that were designed around guest speakers: imposter syndrome and both systems engineering thinking sessions. Within each session there was a more passive listening component followed by questions or an activity. The graduate students were asked to watch an instructional video on facilitating group work which showed two examples of mathematics instructors' enacted practice, which was part of a scaffolded

activity worksheet [18]. The mismatch in content (mathematics vs. chemical engineering) may have impacted perceptions of effectiveness as well as the engagement of the graduate students in class. Although teaching practices span content, it would be beneficial to create engineering specific instructional videos to reduce cognitive load and increase interest from engineering graduate students. Overall, graduate students on average thought interacting with other students was effective for their learning.

Table 5. Graduate student perceptions of seminar activities

*Below is a list of activities used during the graduate seminar. Please circle the response that best describes **how effective** each of the following activities are to **your own learning***

1= ineffective to 4= very effective

Seminar Activity	GTA experience (n=20) Mean	No GTA experience (n=10) Mean
Listening to a guest speaker	3.10	3.30
Writing reflections on topics in class	2.80	2.50
Working with a partner	2.79[a]	3.20
Individual reflection in class	2.75	2.70
Whole class discussions	2.68[a]	2.70
Small group discussions	2.60	3.20
Reading articles outside of class	2.55	2.70
Working through case studies with a small group	2.45	3.00
Watching instructional videos	2.45	2.30
Reading articles in class	2.35	2.60

[a]n = 19

We used Equation 1 to calculate the weighted rank for both what the graduate students perceived as important now and in the future [37].

$$NA = (Perceived\ importance - perceived\ knowledge) \times average\ perceived\ importance \quad (1)$$

Table 6 shows the NA mean ranks for graduate students with and without GTA experience. According to the needs assessment (NA) for both groups, future delivery of the pedagogical development seminar series should focus on addressing facilitating group work, metacognition, and providing feedback.

Table 6. Needs assessment (NA) mean ranking for graduate students with and without GTA experience

	GTA experience		No GTA experience	
	NA now (n=20)	NA future (n=20)	NA now (n=10)	NA future (n=10)
Seminar Topic	Mean rank	Mean rank	Mean rank	Mean rank
Facilitating group work	2.01	2.65	1.34	2.47
Metacognition – awareness of your thought process	1.70	2.75	0.62	2.06
Provide Feedback	1.17	2.21	-0.33	1.48
Your own teaching style	0.85*	1.77	-1.42*	0.32
The diversity of students at your institution	0.77*	1.21	-2.48*	-0.35
Mental models	0.66	1.29	-0.27	1.15
Fixed vs. growth mindset	0.47	1.56	-0.63	0.35
Stereotype threat	0.45	0.78	-0.90	-0.31
What counts as knowledge and knowing	0.42**	-0.26	-1.94**	-1.85
Systems engineering thinking	0.32	0.33	-0.65	-0.65
Learning theory	-0.12	0.70	-1.20	0.28
Imposter syndrome	-1.08	-1.67	0.93	-0.83

*$p=0.02$, **$p=0.03$

We also compared the NA differences between graduate students who indicated they had been a GTA and those who had no GTA teaching experience. There was a significant difference between students who do have GTA experience (M= 0.85) and students who do not (M=-1.42) for the NA mean rank for "teaching style" (t= -2.40, r_{pb}= 0.41, p= 0.02); between students who do (M=0.77) and students who do not (M= -2.48) for the NA mean rank for "the diversity of students at your institution" (t= -2.56, r_{pb}= 0.44, p = 0.02), and between students who do (M=*0.42*) and students who do not (M=-1.94) for the NA mean rank for "what counts as knowledge and knowing" (t= -2.25, r_{pb}= 0.39, p= 0.03) regarding importance now. The point-biserial correlation effect sizes suggesting that the strength of these relationships among NA mean ranks was "substantial [36]." The effect size indicates that graduate students who have some GTA experience believed that "teaching style," "diversity of students," and "what counts as knowledge and knowing" were important topics to talk about and understand in their current situation compared to those without GTA experience. These topics could be better connected to other aspects of future practice to increase relevance for all.

At the end of the survey the graduate students were given the opportunity to offer any improvements they would like to see. Eleven students responded with suggestions with themes including: bring in guest speakers to talk about academic/industry careers, accommodate for students who are not GTAs, demonstrate exemplary teaching methods including how to "deliver

effective lectures," and more interactive activities to mitigate the domination of certain voices. One student recommendation to make activities more interactive was instead of watching an instructional video of practice and discussing in small groups, asking the graduate students to act out common student characteristics and how to facilitate.

Conclusions and Recommendations

As part of an institutional change initiative, we conducted initial observations and interviews with graduate teaching assistants (GTAs) in chemical engineering at a large research university and determined that there was a need for pedagogical development to help better prepare them to facilitate Studio workshops. As a result we created goals for and embedded topics related to pedagogy into a first-year graduate student professional development seminar. After the pilot pedagogical development seminar series and analysis of observations and survey data, we have the following recommendations for graduate student pedagogical development:

- Establish goals and buy-in with department community members. Participation from members of other departments and elsewhere in the university can provide useful perspectives and help with buy-in.
- Dedicate an entire term to pedagogical development to allow continuity and allow content to build constructively.
- Assign graduate students into groups for the entire term to create a community and build relationships.
- Focus on the topics of facilitating group work, metacognition, and providing feedback along with helping GTAs better understand their teaching style, diversity of students, and epistemology at the institution within a pedagogical development seminar.
- With mixed GTA and non-GTA cohorts, provide additional opportunities for the GTAs to develop teaching-specific practical logistical skills.
- Create engineering specific pedagogical instructional videos.

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