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Reflections on the Process of Growing into Faculty: A Collaborative Experience in Being Apprentices

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Reflections on the Process of Growing into Faculty: A collaborative experience in being apprentices

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INTRODUCTION

Practice makes perfect, yet engineering graduate students rarely have structured teaching experiences beyond acting as a teaching assistant (TA) or substituting for a professor's absence. Teaching is a significant component of faculty responsibilities and many roles within engineering. Yet, few formal TA training opportunities exist to allow graduate students to practice and improve their teaching capabilities while still in graduate school. However, many engineering graduate students do not have a chance to design and implement a course before entering academia. Developing these skills and experiences is necessary for effective teaching.

Many skills are experiential and learned by doing. For example, there is no way to fully understand a design process without executing a design process. Likewise, the complexity of teaching a college-level course is not fully understood until a teaching opportunity arises. Graduate students need a more deliberate structure of scaffolded training to be better prepared for the teaching responsibilities of future academic careers.

There is also an experiential learning component for pedagogical ideas, such as active learning, engaging content, or modes of teaching beyond lectures. Despite the increasing availability of resources and research studies reporting its benefits, active learning has been slowly embraced in core engineering courses. One principal reason is the difficulty of enacting these active learning principles. Because these are skills gained and refined while performing them, without practice, many engineering graduate students do not have the opportunity to acquire them. Further, graduate students are also often deprived of the lessons, experiences, and other productive outcomes gained through teaching.

In this paper, we shared our experiences, reflections, and growth as apprentice faculty at two US R1 institutions. In Fall 2022, we had the opportunity to teach an introductory, core chemical engineering course at our respective institutions as graduate student faculty apprentices. The term faculty apprentice draws on ideas of cognitive apprenticeship, particularly those of peripheral practice; training to enter a space involves learning an area's skills, norms, and culture. A more senior, experienced practitioner of the space facilitates apprentices' training and entry process. We were involved in course design and teaching roles under the guidance and mentorship of our faculty mentors. Our main objective for this exploratory, self-reflective research was to be transparent about our individual experiences as faculty apprentices. In addition, we were motivated to share the lessons we learned with the larger engineering education graduate student community.

We used autoethnography to capture our experience and reflections as a rich data source. Then, we utilized that data to present our lessons learned and the skills we discovered through participating in this process. This exploratory research was designed to leverage our unique

positions to reflect better how being a TA is insufficient preparation for teaching, particularly within a higher education environment. This gap is a systemic issue, but we learned some lessons that can be applied in the short term to better prepare for becoming a faculty or instructor. However, the more significant problem is structural and should be addressed at that level. This study was not intended as an intervention or model solution but to show the problem. Instead, this work was designed to present our experiences, encourage further research to understand this space better and encourage more effective training programs for graduate students with structured, scaffolded experiences. Finally, we provided recommendations for our graduate student peers seeking to become faculty. This research paper will detail our classroom climate, teaching practice, and responsibilities as faculty apprentices. The following questions guided our study:

RQ1: What did we learn about teaching during our apprenticeships?

RQ2: How did our understanding of teaching change by the end of our apprenticeship?

BACKGROUND

A significant component of a faculty experience is the process of teaching. Learning how to teach is a skill learned through teaching experiences. TA experiences are intended to prepare graduate students for teaching and being faculty, but the training programs for this process are often insufficient within engineering. However, student teaching within preservice teacher preparation programs has extensive research, developing many techniques for fostering and enhancing the learning experience while practicing teaching. Scaffolding processes are applicable within these preservice teacher preparatory programs. Some specific methods from preservice teacher training which have been proven to enhance the effectiveness of learning experiences or practicing teaching are reflexive practice and reflective journaling. Such methods can be translated into faculty apprenticeship forms.

Traditional TA training is insufficient preparation for teaching

Unfortunately, a majority of engineering graduate students are not able to gain this practice. Many graduate students serve as TAs. However, this role is more often the execution of pre-designed material, solving problems within discussion sections, leading lab experiments, grading, or other activities which involve little creative control. Further, these roles often receive little to no formal preparatory training [1]–[3]. Some training programs exist, focusing on topics such as pedagogical preparation [4]–[7], accessibility training [8], [9].

Faculty apprenticeship as a form of Student Teaching

Teaching is a skill where much of the learning of enacting the skill occurs in practicing those skills within a highly analogous yet more structured situation. Thus, many preservice teacher training programs emphasize reflection combined with practice [10]–[12]. While these programs aim to prepare teachers for K-12 education, at least within the US, many lessons can be adapted to the academic preparatory process. These programs simulate or enable preservice teachers to

practice or teach within supervised contexts, building their skills and receiving feedback upon those skills before becoming full instructors, with the sole responsibility over their classroom. There is a rich history of using the personal process as a source of research, innovation, and reflection, particularly in autoethnography. This preparation is also accompanied by a rich history of the power of intentional reflection accompanied by practice within preservice teacher training; this is often the core of student teaching.

Student Teaching Effectiveness

Much of learning is made more effective by scaffolding or the temporary use of externally provided structures to assist learning. Such scaffolds, within the context of teaching, can include a mentor [13]–[15], a structured program, opportunities for evaluation or reflection, and the ability to practice skills [16]–[21]. Scaffolding effectively leverages a learner's existing knowledge and enables them to perform tasks or utilize skills outside their capacity without the scaffold. Many preservice teacher programs follow a clear progression of scaffolding within the student-teacher process, informing and supporting the learner, then slowly removing the structure and support to give the learner more autonomy and responsibility as their skills develop. We see many analogies between the process we undertook and student teaching.

Effective Methods for Faculty Apprenticeship from Student Teaching

Some effective strategies from preservice teacher training, which focus mainly on facilitating metacognitive development and personal growth, include reflexive practice and reflective journaling. Reflective journaling is the usage of journals, capturing intentional elements of a process while still experiencing this process. These journals target specific areas of reflection, use distinctive prompts, and facilitate guided reflection upon experiences [22]–[26]. These journals are intended to allow for nearly immediate reflection on events that have just concluded and slightly distanced yet still fresh reflections wherein a holistic view of the events can be taken. In addition, these journals allow for the external presentation of the experiences and a processing tool to help an individual grow and develop.

Reflexive practice is the process of intentionally examining one's practice at distinct times; in the middle of the practice, immediately after the practice has concluded, and some time afterward [27]–[29]. This process is especially effective within educational contexts, where the pacing can be relatively rapid, as there is always more content to cover and students to oversee. Further, this also allows for constant self-evaluation in a structured manner.

CONCEPTUAL AND METHODOLOGICAL BACKGROUND

We did not apply or utilize an explicit theoretical framework for this work. Instead, we drew from several informative ideas for the process and analysis. The idea of the self as both source of and an analyst of data comes from autoethnography. Though this field informed us, we did not explicitly conduct an autoethnography. We were also drawn to the value of self-reflection and

analysis as valuable research sources, leveraging unique situations to explicate learned lessons or discoveries. These perspectives align with the traditions of qualitative research, which view the self as data and reflections as a venue or an avenue for research. We were also inspired by the field of action research, noting that the first step in any action research study is to determine the problem. Here, we unveil an issue within the structure of graduate programs, which enables further work to improve or address such an issue. Finally, we drew from the analogies of preservice teacher training to our apprenticeship. In the US, preservice teachers undergo extensive training, both within their academic certifications and between graduation and professional practice. Within their academic programs, there is a strong focus on structured, scaffolded practice, or student teaching, wherein the student takes on increasingly more responsibility within a public school classroom.

In addition to these theoretical perspectives, our mentoring faculty highly scaffolded our experiences, providing us with significant support, encouragement, advice, and opportunities for practice while leveraging their strengths, experiences, and knowledge.

POSITIONALITY

Below, we make our positionalities visible, recognizing that we are inherently biased as data sources and analysts. Further, our positionality colors every aspect of our experiences, and thus is essential to convey them early on. We take turns and represent the positionality from a first-person viewpoint, enabling our voices to shine more clearly.

Author 1's Positionality:

I come to this work from a place of personal interest. I have always been interested in learning, teaching, and mentoring. I had the opportunity to engage with this process of becoming a professor in a much more structured, scaffolded, and safely strategic environment than is common for engineering faculty. I have a master's in chemical engineering; thus, I feel very confident in my engineering identity, ability to comprehend and communicate the material, and my familiarity with both the difficulty of the learning process and the struggles of being a student through an engineering program. I was co-teaching with my master's advisor, who also taught me several courses during my undergraduate and served as my undergraduate academic advisor. I had a strong positive working relationship with them before the semester started. In addition, I had previously been a TA for several students in the course.

The course I taught was small, comparatively, only having about 50 students in the course. Along with my mentor taking most of the teaching and a TA and a grader handling most of the regular homework assignments, this class size meant that my workload was functionally minimal when I was not teaching. I developed, delivered, and evaluated two full weeks of material, including two lessons, a homework assignment, and a series of example problems for a recitation

section each week. I was involved in the course layout, structure, format, and schedule. I was also responsible for training the TA for the course in delivering the recitation section and then co-facilitating those sessions with the TA.

This process has been incredibly positive and fruitful for me. I will acknowledge in advance that teaching is personally rewarding for me, mentoring is one of my greatest joys in life, and thus I will discuss challenges and frustrations. Still, I will likely be positively painting this experience with the eyes of reflection, already removed from the daily struggles, smoothing out the bumps and enjoying the high moments. I got to experience the joys of teaching. Teaching truly is a difficult yet rewarding experience and process. I was glad to get the affirmation within this process that the rewards for me are a sufficient internal motivation for the challenges and frustrations.

Author 2's Positionality

I was an undergraduate student in this class and a TA in Fall 2020 during the COVID-19 pandemic. I have always been curious about teaching college classes and wanted to explore my interest through this mentored teaching experience. This experience was possible because my advisors sponsored my interest. This opportunity might not be possible for other graduate students due to factors like the departmental interest in core classes and the graduate student-advisor relationship. In addition to teaching, I learned about administrative responsibilities, including creating and grading assessments, managing teaching assistants, using class time effectively, meeting students who were struggling or needed accommodations, and assigning final grades at the end of the semester. Overall, I wanted the students to learn optimally and be consistently evaluated based on the course learning objectives. I believe that the MEB course is a means to an end for students, the "end" is very personal to each student, and I wanted them to achieve my goals and their goals for the course within the given constraints.

I was one of two instructors for the course in Fall 2022 and was responsible for approximately 50% of the course delivery and my weekly help sessions (two in-person and one virtual option). In addition, I met with students on a case-by-case basis throughout the semester as needed. There were 175 students enrolled in the course at the start of the semester. The class met twice a week for 110 minutes, with frequent breaks. During the problem-solving sessions, the instructional team (instructors and the head TA) would walk around to answer questions or guide stuck students. I also created a coursework book to help students organize the content and support active learning in class. In addition, whenever I taught, I utilized classroom assessments to get feedback from students and adjust the content or pace of the course. With the large class size, every time I taught felt like a marathon. However, my best moments were the one-on-one discussions with students and their teams because I was able to make the most impact.

DATA CONSTRUCTION & COLLECTION

We studied our experiences across one semester as faculty apprentices. At the beginning of the semester, we decided to write individual weekly reflections and meet monthly via video conference to co-write joint reflections. In addition, we co-created a list of guiding writing prompts focused on our learning experience and metacognitive reflections.

In our monthly meetings, we discussed and reflected on our experiences. These meetings allowed us to have the unique perspective of a peer who was in the same space. We recorded these Zoom meetings, which served as a primary data source for our holistic analysis. We also met at the end of the semester to reflect on our experiences over the semester.

DATA ANALYSIS & METHODOLOGY

We analyzed the transcripts from the (four) monthly meetings during the semester using an inductive thematic analysis [30]. More specifically, we pursued data analysis via an inductive thematic analysis of the transcripts of our meetings. We followed the protocol detailed by Braun and Clark [30]. In addition, we were guided by our memories, informal notes, and personal reflection journals. We also note here that our thematic analysis process was inductive, though we also draw on the school of autoethnography; we consider the self as both the data source and the data analyst. Thus, our analysis is both more biased and more insightful. We followed Braun and Clark with our initial pass through the data searching for codes already sensitized by our discussion and journals. We coded the transcript data separately to generate the initial codes, focusing on the lessons we learned from our collective experiences. Through this process, we developed ten emergent themes, which we collapsed into the final four themes throughout two meetings. Four of our ten original themes are the existing four, four became the sub-themes within these two, and the last two we combined into themes three and four due to content overlap. We then reviewed the data a final time, seeking any further emergences of these themes to ensure we had accurately understood and captured their definition. Finally, we chose transcript excerpts to explain each theme. We present the final set of themes by describing them and providing representative data excerpts.

RESULTS

We identified four themes that captured our experiences as apprentice faculty and the lessons we learned in this introductory chemical engineering course. These themes emerged over the semester, often surfacing throughout our teaching experience. We arrange our findings under the research question they most clearly align with. We learned much about teaching, and our understanding of the teaching process changed over this experience.

RQ1: What did we learn about teaching during our apprenticeships?

The first theme, "*Unpacking the teaching toolbox*," describes some of the "tools" we recognized as essential for our success were essential for our roles as apprentice instructors. These tools included constantly communicating with and listening to the students in the class, being flexible and adaptable in responding to unpredictable situations, and leveraging the experience of our teaching mentors. "*Putting on a good show*" describes the emotions, effort, and time invested into creating effective lessons. These investments in time and effort were rewarding when we perceived things went well but draining and discouraging when the class did not go as planned.

RQ2: How did our understanding of teaching change by the end of our apprenticeship?

The third theme, "*Dancing behind the curtains*," describes the hidden and surprising aspects of teaching in an introductory (engineering) college course context. Even in our roles as graduate students, we realized that there are many aspects of being a course instructor "hidden behind the curtains" that we are unaware of even as graduate students. Some of these factors were outside of our control. Finally, "*Growing into the persona*" is about extending grace to ourselves as new instructors and learning in a safe environment where mistakes are okay. Over the semester, we were concerned with developing our crafts as instructors and becoming more concerned about the students in our class.

In the following section, we describe each theme in more detail and provide sample quotes from the monthly reflections, which were edited for clarity. Each quote is organized by a number and the author's initials; e.g., 1AA indicates the first quote we present in this paper from Ara.

Theme #1: Unpacking the teaching toolbox

This theme describes the tools we frequently relied on to navigate the challenging experience of being a new instructor. Even after anticipating the pedagogical learning curve, teaching for the first time is a challenging experience for a new instructor due to the challenges of managing the course and students. Through this process, first-time teachers and apprentices need to be sensitive to their learning context, be aware of any biases, and honestly assess their teaching ability, recognizing that there will always be future opportunities for growth. We conceptualized these necessary teaching skills as creating an accessible learning environment, communicating effectively with students, and being flexible and open to surprising and unexpected occurrences during the teaching experience. We found this conceptualization helpful in highlighting core competencies for beginning teachers that will be the foundation for additional future changes.

Accessibility: This sub-theme includes instructional decisions and methods of course delivery implemented by the instructor to facilitate the learning process and deep conceptual understanding and create an inclusive learning environment.

1DM: I think the hardest thing that I have had to try to learn and the thing that has made me the most confident as an engineering educator is rendering my steps visible. I have to go

through every step and I just kind of do them in the back of my head. I forgot that they were not things people just know.

We addressed students' conceptual difficulties by making the learning process visible to students (1DM). In addition, we created an inclusive learning environment by learning students' names, providing active learning opportunities, incorporating technology, and creating environments where students feel comfortable voicing questions and concerns.

Communicating with students: There are multiple dimensions to this sub-theme, including clearly communicating course concepts, values, and instructions to the students to help them focus their attention; fostering respect in the classroom environment through interactions with students; and empathizing with students' emotional reactions to their non-linear learning experience.

1AA: One student (said to me), "Honestly to be fair, I've just been prideful. I thought I could figure it out myself." A lot of these students have been successful with these methods that they're using. What's not working for them now has worked in the past and letting go of that (is hard).

2AA: (Talking about one conversation with a student) The strategy shouldn't be to maximize homework points at the cost of minimizing misunderstanding which affects the exam. Getting students to where it's not really about having the homework done, but (approaching homework as an) opportunity to practice in a very low risk environment, so that (they) can iron out all those (misunderstandings). I don't know that they're always getting that.

2DM: Students (are) just now starting to use office hours, starting to reach out. That might be because we have a built-in recitation section (where) we've already structured (the problem solving guidance) into the process. But I feel your frustration when students do not use the tools we have set up for them and then they're frantically trying to make up for that. It's like we told you at the start that prevention is better than recovery. I just always have to take a second and then engage (in) teacher mode.

Author 1 described a difficult conversation with a student who was not meeting up with their academic expectations halfway into the semester (1AA). Because this student cried during this conversation, she had to be empathic and sensitive while offering advice about changing their academic outcome. Both authors also recalled the challenge of effectively communicating valuable learning objectives to the students through conversations and the types of assessments and structure of the classroom (2AA, 2DM).

Flexibility: This sub-theme describes the instructor's willingness to deviate from set plans and adapt in real-time to unexpected situations.

3DM: The essence of teaching… you do the best you can with what you got, where you are, and then you try to make it better next time.

4DM: Some days just don't go (well), and you just got (to) deal and get the students through as much as you can and then at the end of it, trust that they (hopefully) got enough (to) be fine in the future classes, and they probably will.

3AA: I've introduced these (in-class) conceptual quizzes (which) are exciting and rewarding. I can see their answers, and I'm like, "Okay, we need to spend more time on (this concept)." But it takes time to listen (and respond to the students).

4AA: We've already had two or three students that have lost close friends and family members. It is the start of the semester, and having them freak out about content when it's like, "No, your life is happening, and that's so much more important. Take the time that you need."

5AA: Yeah, I want (them) to ask me questions, and I want to leave space for - not really weird stuff, but not everything (has to) follow this routine. When you (give) students space to think outside the box or ask questions, they're gonna ask questions that you're going to need a moment (to answer). On paper, I'm comfortable with this. I know this (space) is where students are probably engaging more. But practically, I would also just prefer if I could run through my script (especially) with a very large class.

5DM: There are three stages to (systemic issues) recognizing where the issue lies, the scope, and then also your power within it. So, like this, a systemic, generational issue. Okay, Duncan and Ara are not going to be able to fix that in their class. I can't fix the fact that Higher Ed. (model) was (designed) for middle-class white males who don't have to work, have steady income, and are not worried about rent, are taking maybe 4 to 5 classes, 2 of which are electives or (general education courses). I can't fix that. But maybe I can help in some ways. If the issue is in my class, yeah, I can fix that. It's hard to know, and it's hard to think about, and it's hard to do because then that's another thing on your plate of being an equitable instructor alongside everything else.

Being a flexible instructor meant adapting to unsatisfactory and unexpected situations (4AA, 4DM), students' feedback from informal and formal assessments (5AA), and unplanned questions (5AA). It included decisions to revisit a topic because students were confused in a previous class or choosing to end class early since we could not realistically cover all content in the time left. However, we controlled our actions within our spheres of influence. As a result, we realized the need to be flexible and accommodating in response to these disruptive and unexpected events as instructors (3DM and 5DM). This sub-theme also includes creating well-aligned formal and informal assessments that provide instructor feedback about students' conceptual understanding and learning experience and communicate to the students what the instructor cares about.

Leveraging on experience: As we gained teaching experience over the semester, we realized that many aspects of our teaching experience could only improve with intentional practice. Some parts of the teaching experience will improve as we know what to expect. In the meantime, leveraging our prior experiences and experienced teaching mentors is essential.

6DM: I realized now that a lot of skill and teaching comes from just experience. The longer you spend on a course, the better you know it, the more clearly you can prevent misconceptions (and) clarify common sticky points where the hiccups are, and you can stop them preemptively.

We realized that an essential skill in teaching is anticipating where students will experience conceptual difficulties and designing the course proactively to address them, which was hard to do as first-time course instructors (6DM) due to the challenges of managing the course and students. Through this process, first-time teachers and apprentices need to be sensitive to their learning context, be aware of any biases, and honestly assess their teaching ability, recognizing that there will always be future opportunities for growth.

Theme #2: Putting on a good show

Teaching is a complex juggling act. We discovered there were massive affective elements involved in teaching. This environment allowed us to explore these affective experiences within a safe context.

7DM: I am struggling now with knowing that I am planting seeds that may not be realized until they are out of the curriculum. Do the work knowing that it'll pay off someday. But it can be really frustrating doing that and spending five, six minutes on an explanation of why this topic is important, what it is, where you'll use it long term and then they're just looking at me like, "Okay?"

8DM: I was teaching my first recitation yesterday, like the other day, and it was just like, "Oh, my gosh!" Nerves all the time. So many nerves. I made simple mistakes at the beginning. Little administrative things throw you off. Technology is not great. And then you're just out of your groove. But it was also a really validating experience, because I got to have moments of joy where I'm answering students' questions, and I'm engaging with them intellectually, and I'm like the joy and delight I feel right now, I am on the right career path.

6AA: The first week of school when I was teaching, I would be up for like four or five (hours before class) on those days. (Right after class), I'd feel like (I just completed) the last leg of the marathon and after class my body would just shut down.

7AA: I'm not always snarky, but I think it's just the endless work of the semester. I think I'm in

the part of the semester where I just feel like I'm working (constantly). I'm not getting a lot of breaks. And so those moments of frustration I feel a little bit more (intensely).

9DM: I was teaching my first recitation yesterday, like the other day, and it was just like, "Oh, my gosh!" Nerves all the time. So many nerves. I made simple mistakes at the beginning. Little administrative things throw you off. Technology is not great. And then you're just out of your groove. But it was also a really validating experience, because I got to have moments of joy where I'm answering students' questions, and I'm engaging with them intellectually, and I'm like the joy and delight I feel right now, I am on the right career path.

We constantly had to be mindful about sticking to the "script" (5AA), monitor time, remember to unpack our own understanding of concepts (1DM), mitigate misconceptions (6DM), scaffold for future concepts or courses (7DM), assess students' energy and attentiveness, and incorporate active learning as often as possible in real-time. At the same time, we realized that we had a "strong" affective reaction to our evaluations of our teaching experience, especially as we were teaching for the first time. These emotions included positive affect, such as joy or delight after an affirming teaching experience (9DM), and negative responses, such as experiencing nerves before class and feeling physically drained or frustrated afterward (1AA, 6AA, 7AA, 2DM). This environment allowed us to explore these affective experiences within a safe context.

Theme #3: Dancing behind the curtains

This theme describes hidden student, instructor, and administrative factors influencing the teaching-learning dynamic. This theme is intended to evoke images of being backstage at the theater and seeing all the preparation that goes into the act of teaching. These factors are often invisible to the external audience, the learners, or others involved in courses, such as a TA.

10DM: I tried to develop some homework questions for one homework, and I vastly overestimated the amount of knowledge the students had available. So, my co-instructor shut down all of my questions and stuck them in a bank to use later, because and I quote "These would have been hard questions for you when you took this class, and they have taken fewer classes before this class. Always assume they know very little knowledge from previous classes and just a couple of skills. Provide them everything else."

11DM: The essence of teaching… you do the best you can with what you got, where you are, and then you try to make it better next time.

8AA: A lot of times when I teach, my default student is myself. For me, where it can be a (disadvantage) is (when) I would only explain concepts the way I understand them.

We quickly realized there is more to course design, instructional decisions, and content creation than simply creating the materials or making decisions. The students in our courses came from diverse backgrounds, with different prior knowledge, and needing additional accommodations. Ara recognized that some students in her class had unique personal circumstances outside her influence as the course instructor (4AA). How do we decide which students are your target audience, the high achievers or students struggling to grasp the material? How do we effectively curate content and scaffold instruction for your target audience? We unconsciously made assumptions about the learning process and the learners in our classes, influencing our pedagogical decisions (8AA and 10DM). Finally, external factors, including the curriculum, the number of students in the class, the type of classroom, and the timing of the class, additionally influence what happens in the classroom (5DM). Together, all these factors were outside the course instructor's control and added additional complexity to the teaching experience.

Theme #4: Growing into the persona

One of the critical outcomes of this process for us was growing as an educator. The mentorship we received during our apprenticeship gave us a safe, nurturing environment. At the same time, we learned how not to take issues too personally and the importance of intentionally taking moments for self-care.

12DM: There are two competing time scales. It takes me 3 times teaching the course to get it right (and) to start making the innovations I want to make. Cool. That's fine over the course of my career. That's normal. That's okay. But then, for these students that may be the only intersection I have with them….. So, how do I do that? Grappling with knowing that this (class) won't be what I want it to be for 3, 4, 5 times. What about the students in those first 4 - 5 classes? How do I still get them to (have) a good experience and then move past my guilt that I'm not able to give them exactly what I wanted? Because I didn't know how to do the class. That, for me, has just been really hard. That guilt of (feeling) like I'm failing the students. But really I'm not, I'm giving it the best I can. It's just I know it could be better. There's just this built-in learning curve that I am dealing with while teaching.

We eventually recognized that our teaching skills would improve over time and needed to make space for growth and give ourselves grace during this process (11 DM, 12 DM). Interacting with students this semester helped us to realize the urgency and need to drive change and innovation in higher education because it affects students' lives and future opportunities.

Discussion

As mentioned above, we discovered that teaching is a complicated set of skills primarily learned through practicing teaching. We grew and developed in very unexpected ways through this process. We found new things about teaching. We learned about the vast array of skills required for teaching and were able to begin building our teaching toolbox. We learned that teaching was

like performing in the classroom and throughout the semester. Our understanding of teaching evolved with this process. We discovered that teaching involved a lot of work we were unaware of and that even with our existing theoretical knowledge, we were still growing into the teacher we desired to be.

We present our experiences and lessons learned in this process for two reasons. First, to extend our discoveries to the broader graduate student community because we believe these experiences as necessary for learning how to teach before and during any teaching activity. Secondly, we seek to argue that current training systems alone did not adequately prepare us for this process and the skills involved. Therefore, these skills should be taught. Thus, we advocate for a better system and more research in this area to develop methods of scaffolding teaching experiences for graduate students and to create better solutions that easily translate to specific university climates.

Our discoveries echo findings within the literature, as the process we went through for this apprentice faculty process mirrors the student teaching experience of many US educational collegiate programs. This type of practice is an established scaffolding method within cognitive apprenticeship [31]. In addition, situated practice is a form of scaffolding for a more novice practitioner within cognitive apprenticeship models. The activities we engaged in within our faculty apprentice positions fall under these categories due to the nature of scaffolds utilized by our mentoring faculty, such as guiding and supporting our development of course material, meeting with us to discuss how the class was going, explaining their rationale behind choices, or allowing us to execute several sessions of the course alone [32]–[34]. Further, these experiences were well scaffolded, enabling us to grow and learn very effectively [35]–[37], something our prior TA training did not adequately enable.

Our prior TA training programs prepared us for some of the execution, grading, or interactional components of teaching [8], [9], [38], [39]. Still, they did not prepare us fully for all the details of teaching hidden behind the curtains, nor did these training programs prepare us for how much we would grow. Specifically, these training programs did not prepare us for the difficulty in developing material, designing and utilizing active learning, or navigating student emotions. Our experiences included an abrupt learning curve we had to navigate to learn these skills while practicing them. These skills cannot be entirely taught without practice. If we had not engaged in this apprenticeship, we would have encountered these facets of teaching while we were engaging in teaching for the first time. Our experiences and the themes which emerged from that process suggest that more graduate students, particularly those interested in a faculty career in the future, should have the opportunity to teach or have this scaffolded apprentice experience. Our format is not unique, as it echoes other programs which have attempted to do precisely this process [40]–[43]. These programs enabled graduate students to have this scaffolded practice, experience these skills and discover these components of teaching. These programs trained TAs within scaffolded or mentored formats, acclimating them to the teaching process and giving them a chance for a

more authentic practice, which our process also did.

Thus, all of our lessons learned come together to create a cohesive lesson; that teaching is hard. Teaching is a complex skill area, full of unexpected competencies one should have and many necessary component skills. We discovered this and further assert that this process should be provided to more graduate students preparing for faculty careers. We were fortunate to get the chance to do these skills within a mentored, scaffolded, safe, and development-focused environment.

Conclusion

We conclude here with a summary of our lessons learned. Firstly, many skills are involved with the teaching process, many of which are discovered or developed with practice. These include implementing theory or methods, designing activities, enacting active learning, student engagement, classroom management, the iterative process of teaching, and developing or utilizing scaffolds. Secondly, we discovered the cost of teaching and how much it was analogous to a performance. Thirdly, there are many things involved in teaching that are not visible from a student's perspective, which are difficult, time-consuming, and very demanding from our perspectives as first-time course instructors. These range from the time required to develop content, handle student issues, and execute administrative tasks to the added difficulties of teaching others. Finally, we discovered that we were growing into our desired teacher persona within the teaching process. We became the teachers we wanted to be by acting as closely as possible.

We firmly believe that more graduate students should have the opportunity or option to be more involved in teaching design and development rather than simply execution, as is common with TAs. For fellow graduate students, particularly those interested in pedagogy, engineering education broadly, or a future career in academia, we encourage them to take advantage of similar opportunities. However, we recognize that power dynamics exist, many graduate students are already overworked with research, and thus these opportunities may not be available or possible. If you want to teach or gain similar lessons, find a way to model this apprentice faculty; take some portion of a course, help develop and deliver it and get involved with the productive and frustrating skills-building process. Advocate for yourself if no formal mechanism exists for doing things beyond just grading and recitations as a TA. Ask to be involved in developing homework assignments or exam questions. Ask if you can deliver a lecture or help make material for a class session.

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