

Faculty Apprentice as a Mentorship Model for Engineering Graduate Students interested in Teaching

Rohit Kandakatla
School of Engineering Education
Purdue University
West Lafayette, USA
rkandaka@purdue.edu

Dr. Ruth A. Streveler
School of Engineering Education
Purdue University
West Lafayette, USA
rastreve@purdue.edu

Juan D. Ortega-Alvarez
School of Engineering Education
Purdue University
West Lafayette, USA
jortegaa@purdue.edu

Dr. Karl Smith
School of Engineering Education
Purdue University
West Lafayette, USA
smith511@purdue.edu

Abstract— This paper presents a new model of mentoring engineering graduate students called faculty apprenticeship, which is aimed at helping prepare graduate students to become effective teachers. Engineering education scholars have pointed out that graduate school usually falls short in preparing engineering graduate students for a career as faculty. Moreover, graduate students lack deliberate opportunities to practice and gain genuine teaching experience. Students who are appointed as teaching assistants (TAs) do not always get opportunities to teach and are mostly restricted to supporting the instructor as necessary. With an increasing focus on developing strategies to better prepare graduate students for their teaching role in academia, we address this challenge through the model of faculty apprenticeship.

The faculty apprentice approach was implemented in the school of engineering education at a large Midwestern university. In this paper, we present the rationale of the faculty apprentice approach, which is located within the conceptual frameworks of the mentoring and apprenticeship models. We look at the experiences of two professors and two graduate students who served as instructors and faculty apprentices respectively throughout several semesters. The data is collected in the form of reflections and is examined through a qualitative constructivist lens to inform engineering educators on the mutual benefits of this approach.

The results that emerged from the combined experiences of faculty and students provide a reasonable argument on how the faculty apprentice approach benefits both faculty and students. The results also present the process involved in successfully running the model. We believe the faculty apprentice approach is compatible and complementary with current efforts being taken by engineering colleges towards professional development of graduate students. The intention of this paper is to spark interest among instructors and provide information to transfer this approach from engineering education to other engineering disciplines.

Keywords—*faculty apprentice, teaching, graduate students*

I. INTRODUCTION

Retention of undergraduate students in STEM (Science, Technology, Engineering and Mathematics) continues to be a challenge for universities across the US [1]. While there are multiple reasons that contribute to the attrition of undergraduate students, faculty preparation to teach STEM courses is one of them. However, the undergraduate education system in US has no formal requirements for faculty to get trained to teach in their respective institutions [2]. Faculty who are recruited as tenure-track faculty in research focused universities, often do not have the required training, time and incentives to effectively teach undergraduate STEM courses [3, 4]. Additionally, changing one's instructional techniques takes a significant amount of time [5]. This lack of time and training emphasizes the need for new faculty to have necessary preparation to teach before they get recruited by universities. Also, Browner and Tanner highlight that most PhD programs are designed to make their students demonstrate research competencies with little emphasis on teaching competencies [3]. This makes it important for graduate students who aspire to be future faculty, to look for professional development opportunities at their graduate schools. While most graduate students work as Teaching Assistants (TAs) to gain teaching experience, this paper presents faculty apprenticeship as an alternate model for graduate students to gain the necessary skills to teach STEM courses.

In this paper, two of the co-authors were graduate students who voluntarily served as apprentice faculty for a graduate course at a Purdue University. In the model we are documenting, the apprentice faculty discuss their role in the course with the instructor and how the role can be shaped based on the intended outcomes the apprentice expects to achieve. In this case, the two students had very varied prior teaching experiences, thus making their apprentice experience different. This paper highlights the experience of the two faculty apprentices and the instructors in the course. In detail, we examine the values, outcomes, and

process of this informal professional development experience and address the following research questions: 1. What are the benefits faculty and students perceive from the faculty apprenticeship model as compared to a teaching assistantship? 2. What are the specific strategies faculty can use to leverage the benefits of the faculty apprenticeship model? 3. What are the motivational factors for faculty and students to engage in the faculty apprenticeship? The results from this paper will provide insights to graduate students' and faculty on a different approach to engage in a professional development experience to improve their conceptions, knowledge, and practices of teaching.

II. LITERATURE REVIEW

Graduate education in engineering, as in other STEM fields, usually prepares students to exercise academic research but lags behind in fostering the development of other skills relevant to the faculty job, particularly teaching competencies [6]. Traditionally, formal teaching training happened in-house within the first years of a faculty career, or whenever student evaluations made apparent the need for a change in an instructor's approach to teaching [7]. In the past couple of decades, programs like the National Effective Teaching Institute (NETI) and the Excellence in Civil Engineering Education Teaching Workshop (ExCEED) have supported engineering academic departments and institutions committed to improving the teaching competency of their faculty body [7] [8]. More recently, similar initiatives at the national level have focused on training STEM graduate students and postdoctoral fellows to help them prepare effectively for the multiple responsibilities of a faculty job, particularly teaching [6]. Broad initiatives like the Center for the Integration of Research, Teaching, and Learning (CIRTL) spurred the emergence of institutional programs aimed at easing the transition of prospective faculty into their job functions, while at the same time improving undergraduate education [6] [9]. These programs often encompass a combination of instruction and practice. Furthermore, while some of them focus on socialization as the means to and the goal of preparing graduate students [6] [10], other programs rely more on formal instruction through professional development workshops [9]. Most of these programs have, nevertheless, a component of guided practice, apprenticeship, or mentoring in different capacities—graduate students as either mentees or mentors—as an important factor.

Implementation strategies and affordances of mentorship and apprenticeship models for training prospective faculty are scarce in engineering education literature. On the other hand, the field of pre-service teacher education has seen, in the past few years, the emergence of scholarly literature discussing mentorship and apprenticeship in the training of future teachers. This practice is often referred to as *apprentice teaching* or, at the risk of ambiguity, *co-teaching*. According to Friend and colleagues, "*the goal of apprentice teaching is to address shortcomings in traditional models of student teaching usually characterized by a handoff of responsibility after a period in which the teacher candidate played a very limited role in classroom instruction.*" [11, p. 81]. Fraser and Watson

suggested that the traditional approach to teaching pre-service teachers is outdated, and advocated for three new approaches including mentoring and co-teaching [11]. The latter approach is consistent with Friend's model of apprentice teaching, which "*stresses building a strong professional relationship between the master and apprentice educators, clear communication, collaboration, joint planning, and explicit instruction and practice.*" [11, p. 81]. The faculty apprenticeship model discussed in the present paper is aligned with these characteristics. Moreover, this model is not advanced as a stand-alone strategy, but as a more structured way to leverage the benefits of mentorship in training prospective engineering faculty for their teaching role.

III. METHODS

Data was collected in the form of individual and group reflections from the two faculty, and students who served as faculty apprentices. The instructors developed the course in 2008 and have taught it every year since then. The faculty apprentice model was envisioned by the instructors while developing the course, and they have mentored about 20 apprentices since the inception of the course. The two students served as faculty apprentices under one of the faculty during the fall of 2016, spring of 2017, and fall of 2017. While one of the apprentice had extensive prior teaching experience, the other apprentice had no prior teaching experience. The reflections were collected in a two-step process. In the first step, both the faculty and students individually documented their own reflections and shared it with each other. The research questions were used as reflection prompts to guide the process. During the second step, all individuals met and had a focus group discussion to reflect on their experience with the faculty apprenticeship model. The group discussion was audio-recorded and later transcribed for analysis. A thematic analysis was employed on the individual reflections and the group discussion, to look for emerging themes that will address the three research questions [12].

IV. RESULTS

The results from the thematic analysis is presented below based on the research questions being addressed. Appropriate quotes from the reflections are included to provide additional context.

A. Motivation to engage in faculty apprenticeship

Instructors reported in their reflections that they engaged in the faculty apprentice experience as they believe it to be their responsibility to prepare graduate students in becoming future engineering educators. One faculty member mentioned: "*It was really about preparing engineering educators. I think the idea of how you help people [graduate students] to gain this authentic teaching experience is really important. I think, how do you really give people a seat at the intellectual table*". In the same vein, the other faculty member said: "*I personally see it as a responsibility; I think of all of education as a socialization process and requires an investment. You need to take out time, and train the next generation even though you can do it yourself more quickly.*" This intrinsic motivation and belief is important

to opt for the faculty apprentice model as it increases instructors' time commitment to the course: *"It is important for us all to note that it is more work for the core instructor. The easiest thing is that, you have been teaching this course for 10 years, you have a model that works, you can just teach the course yourself without bringing somebody else in"*. This is a result of the additional time needed for the faculty to mentor the apprentices and help them meet their learning outcomes.

Another motivation for faculty to embrace the faculty apprenticeship model is the opportunity to keep updating the course: *"The motivation for faculty to engage in a faculty apprenticeship could be also the desire or the willingness to keep working on the courses, keep updating them"*. This makes this model valuable to faculty as engineering courses are often critiqued to be outdated and need regular updating.

Both the students in their reflections mentioned that the flexibility available in the faculty apprentice model makes it valuable, as compared to the TA model. In the faculty apprentice model, the instructor and the apprentice discuss on the learning goals that the apprentice wants to achieve, and then tailor the role of apprentice according to that. One student mentioned: *"The good thing about this model is no one is told 'this is what you should do'. We [apprentices] get to set our own goals based on what we want to learn, and that is very valuable because, just between me and Juan [the other apprentice], with him having a lot of teaching experience with me having none, the role we played [as an apprentice] was very different. I was mainly observing the instructor and understanding her role in the classroom, and slowly progressed to having taught 1-2 sessions at the end. I think that is one key part about this model, which is very beneficial to at least upcoming engineering educators"*. This same idea was reiterated by the other apprentice: *"With the faculty apprenticeship model being something versatile, as opposed to having a list of the tasks you're going to assign to that person, you kind of discuss and negotiate with that person, according to their interest and experience, and what they want to do. It's a strategy that leverages the benefits of the faculty apprentice model, and then it comes also as a motivational factor because one of the reasons at least for me as a student to engage in the faculty apprenticeship, is because I know I will be encouraged to exercise and develop what I think I need to develop as an instructor"*. This flexibility provides an intrinsic motivation for the apprentice to engage actively in this experience, as they get to choose the role they want to take in the course.

B. Process followed in the faculty apprentice model

While recruiting the apprentice for the course, the instructor believed it is important for the apprentice to have taken the same course previously: *"one of the things that we probably should point out is that faculty apprentice have taken the class before, and TAs haven't necessarily taken that class at that institution"*. This was important as the apprentice needed to have a personal experience with the course, and know the instructor in general. This is important to the instructor as they now know if they can work well with the apprentice, as they have taught them before. During the first few instances of recruiting a faculty apprentice, the instructors mentioned to have invited students to be a faculty apprentice. However, this has changed more recently as students

themselves reached out to the instructor stating their interest: *"We used to think about it and invite people, and now people come forward and volunteer, and I don't have to invite people anymore"*.

The instructors reported to have followed varied processes with faculty apprentice, which entirely depended on the goals of the apprentice. One of the instructor mentioned: *"my own personal approach now with a faculty apprentice, is that I want it to be meaningful to the student. So, I always ask the faculty apprentice, what do you want to do? And what do you want to learn? How do you want to take part? So, the things that people have done are very different because of that. Individuals have taught the entire section of the course, prepared reading lists for the class and given feedback. One year we had four people, and they each decided what they wanted to do"*.

Both the students in their reflections mentioned about the different roles they played as a faculty apprentice. One of the students (who has no prior teaching experience) said: *"Two weeks before the start of the semester, I met with the instructor to discuss my role as a faculty apprentice and set expectations. The instructor showed great flexibility in letting me decide how I would like to contribute and was open to suggestions about adding content to the course. As a graduate student, this was reassuring to me as I got an opportunity to get involved in decision making for the course. I used this opportunity to suggest some additional readings for the course, which I believed are aligned with the course objectives. During the first half of the semester, my role in the class as a faculty apprentice was observing and making note of the instructor's' actions in the class. I would observe how the instructor is presenting the content and provide my inputs as necessary. As I was spending time observing the class, the instructor let me design and facilitate group activities in the class. Having had the opportunity to observe and learn from the instructor, I could build the confidence and prepare myself for leading the class. During the second half of the semester, I started to lead some classes completely"*. However, the other apprentice (who had a good amount of prior teaching experience) had a different role as he taught multiple class session right from the start, *"Prof. Streveler shared with me the course syllabus and materials well in advance. Moreover, she asked me about my perception of the syllabus, particularly the clarity of the class main assignment, and invited me to contribute ideas based both on my experience as a course taker, and an experienced instructor halfway through earning his Ph.D. in engineering education. Throughout the semester, Prof. Streveler and I met regularly to discuss how to advance the course, introduce changes as needed, and plan my contributions to the class including the sessions I would lead and the pedagogical strategies I would use. Prof. Streveler was open and clear as to what topics she wanted to lead and which ones she rather had me lead, according to the interests and recent experiences of both of us"*. While the experience of both the apprentices varied, the instructors mentioned that they did not allow either of the apprentices to grade the final course project.

Outside of the classroom, the apprentices met with the instructor every week to reflect on the previous class, share

queries with the instructor, and plan for the next class session. Both apprentices mentioned in their reflection that the weekly meetings were an important learning experience: *"One thing that I want to point out about the weekly meeting is, for me it wasn't more like let's meet and have a check-in. It was a chance to reflect on the class, where I would be looking forward to meeting Prof. Streveler, because I got to learn during that meeting by reflecting on what happened in the class, and ask questions that came to me in the class. So, I think that environment, which is setup in the meeting is something that is key. Because apart from the class, that was another learning experience for me every week"*. However, the weekly meetings were not part of a formal structure and were dependent on the learning goals of the students. One of the faculty mentioned: *"It [weekly meetings] varies depending on how much time and effort the person is devoting to it, what is that they want to get out of it. What is it that they're going to contribute? That varies quite a lot"*. Apart from the weekly meetings, the apprentices also scheduled office hours with students as necessary, especially during the weeks before the project submission deadline. However, the frequency and time of office hours was entirely dependent on the apprentice: *"Regarding the contact with the students, Prof. Streveler allowed me to decide how I wanted to interact with them and suggested alternatives ranging from offering office hours, to scheduling one-on-one appointments"*.

It is important to note that both the instructors treated the apprentice as a partner and that greatly defined the process: *"So, I think as the whole the idea of partnership, 'okay, what would you like to get out of this experience, okay cool, that's what we will do'. So, I never approached it as 'I need your help, and you're going to do this'"*. This belief of partnership was followed irrespective of the students' prior teaching experience: *"Sometimes, we treat them as colleagues, as peers, and the range [teaching experience] varies for someone like Juan [apprentice 1], who has a lot of experience. Even though the gap [in teaching experience] is not large for some, and I have always really liked the idea of treating people as emerging scholars, really think about this whole endeavor in scholarly way"*.

C. Benefits of the faculty apprentice model

As the faculty apprentices were students in the course before, they have a much better understanding of the experience in the course as compared to the instructor. One of the instructors mentioned this as a major benefit to the students in the course: *"often these faculty apprentices are nearer in development or stages of expertise to the participants in the course. And the benefit for them, well actually if you talk to apprentice faculty members, my hunch is that it lets them see behind the curtains, and they gain this insider knowledge on what goes inside designing a course, dealing with the tradeoffs, you know you have a limited amount of time, and you have to manage the cognitive load, and you can't do everything, so you need to make some hard decisions. And I hope, they get deeper insights into that or those aspects"*. This aspect of the apprentice being closer to the student also benefits the instructor, especially when they taught the course on multiple occasions: *"faculty become such an expert, that at some point it is harder and harder for you to be closer to what the students are struggling with, what the*

hard parts are and that is something the faculty apprentice can look at much easier, because we have been there not that far ago". One of the faculty mentioned this to be of immense value for them, *"For me, that's a role [helping in understanding what the students are struggling with] in the course that I really search for and welcome, because truly now that, we have started in 2008, and now it's the 10th year. I mean really the stuff is so natural, particularly now that I am teaching it every semester, that will happen. So yeah, that's really become a very important thing that the faculty apprentice is the person that links what the students experience, kind of be a spokesperson. So, for me that's a very important thing"*. Faculty reported that having an apprentice helps them in constantly updating the course as was stated before. Another benefit mentioned by one of the faculty is to regularly plan ahead of the course: *"And it's a good motivation for me to think ahead. To force myself to say, 'Okay, what is going to happen next week. Let's try to get the draft for the slides'. So that's nice"*.

Both the students agree that one of the major benefits of the faculty apprentice model is the tailored learning experience. Apprentices get to build certain skills that they think they lack: *"It's a benefit to the faculty apprentice as it allows them to strengthen and develop that particular facets they feel they need or want to develop"*. The same was reiterated by the other apprentice: *"it gives the apprentice faculty member an opportunity to strengthen something they think they need some development. It also provides them an opportunity to address something that you know they may feel, from having been in the course, that there is room for improvement. You know, they will be able to identify opportunity for improvement, and it rings some ideas for doing it"*. Having an opportunity to revisit the content of the course will help the apprentices in filling the gaps or increasing their understanding of specific concepts in the course (if any), *"There is an enormous evidence that when you teach something, you learn it better yourself. So it's an opportunity to go more deeply into something that you want to understand better"*. The faculty apprentice model provides multiple opportunities to reflect and get mentored by the faculty. This helps the apprentice in developing their teaching philosophy: *"This was a great learning experience as I could reflect on the instructor's teaching strategies and develop my own teaching philosophy"*.

V. DISCUSSION

The results section highlighted the various reasons of motivation for the students and instructors to follow the faculty apprentice model, as compared to the usual TA model. The faculty apprentice model is specifically more motivating for students due to the flexibility it provides them in tailoring their learning experience. It is necessary to note that the motivation for students in this case is intrinsic, as the students do not get paid to become an apprentice. The intrinsic motivation of the apprentice is aligned with the self-determination theory, which states that individuals are likely to be more motivated to do tasks they choose, when compared to the ones that are assigned to them [13]. During their role as a faculty apprentice, both the apprentices mentioned to have had multiple opportunities to reflect on their experience. The reflection helps the apprentice in having a better understanding on the areas where they need to improve. This allows them to use the apprentice experience to

get additional practice and work on the hard parts [14]. The multiple opportunities provided to the apprentice to reflect will aid them in becoming reflective practitioners in their future role as an instructor. This experience will develop the apprentice their ability to reflect, and help them to integrate or modify their teaching skills to achieve the necessary learning goals of the course [15].

The faculty apprentice model provides the benefits of both the teaching apprentice model, and the mentoring model. While the apprentices have multiple opportunities to develop their teaching skills, they also get mentored by the instructor during weekly meetings. This additional aspect of mentoring is not often available in the teaching apprentice model, as the main goal is to address the short comings in the apprentice's teaching [16]. This makes the faculty apprentice model valuable to graduate students who are preparing to teach in future, as they have specific times available to get mentored by the instructor every week. This experience will help the apprentices build their own mentoring skills by observing the instructor [17]. This skill is particularly important to the apprentices, as they will eventually mentor students when they transition to future roles in the academia.

The instructors mentioned that the apprentices often helped them in clarifying, and pointing out topics that were perceived to be difficult by the students in the course. This support is very valuable to students, as instructors often become experts while teaching a specific course on multiple occasions. The expert blind spot makes it challenging for the instructor to know how novice students learn, and they often fail to identify the challenges faced by students [18]. The apprentices tend to have a much better understanding of the difficulties faced by students, as they have taken the course recently and have been students themselves. Having the opportunity to revisit the content and helping students also helps the apprentices in identifying the gaps in their own understanding of the course. This is not unusual as students often confuse familiarity with understanding [14], and will be able to identify the confusion by explaining the concept to others.

VI. LIMITATIONS

One of the limitations of the study is the qualitative nature of the results. While the paper provided an elaborate description of the motivation, process and benefits of the faculty apprentice model, each of the mentioned them could differ in another academic setting and with different instructors. Another limitation is the small number of participants in the study. The participants were limited to a single course as the faculty apprentice model was an innovative model introduced by the course instructors. It is also important to note that the model presented in this paper is limited to the course Content Assessment and Pedagogy (CAP), which is offered by the School of Engineering Education at Purdue University. While other faculty in the school may use the term faculty apprentice, the experience of the apprentice is entirely dependent on the lead instructor.

VII. CONCLUSION AND FUTURE WORK

The results in this paper present an alternate model to help prepare graduate students in developing their teaching

competencies as opposed to the TA model. Graduate students can serve as an apprentice under an instructor to have a much closer experience of designing, and teaching the course. The flexibility allowed in the faculty apprentice model makes it beneficial for graduate students as they can now tailor their role in the course based on the learning needs. The apprentice model provides students with multiple opportunities to reflect and build their teaching skills. While having an apprentice increases to instructors time commitment to the course, it also provides multiple benefits to the instructor. We hope that higher education faculty could use this model to provide valuable teaching experience to graduate students, who aspire to become future engineering educators.

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