Preparing Future Engineering Educators through Round-Table Practicum Course Discussions

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Introduction

With good intentions, there has been a push for earlier training of engineering faculty, starting as early as with graduate students aspiring towards faculty positions, in hopes that new faculty are better prepared when asked to teach as primary instructors.[1] The concept of using pre-faculty members as instructors is not novel, however, there are limited reported efforts towards training and supporting the development of future faculty members. Many engineering graduate students experience graduate teaching positions, often being thrown in front of a classroom with limited training or assistance. Graduate teaching assistants (GTAs) are often overwhelmed by the multiple, and at times conflicting responsibilities of graduate students. Recently, efforts have been made to better understand the effects of training programs directed at graduate teaching assistants in STEM fields.[5,12]

This paper describes a semester-long practicum course focused on the development of teaching strategies in GTAs at Virginia Tech's Engineering Education department that acted as a structured forum for GTAs. The course provided a structured environment for GTAs to learn about and discuss various theoretical and practical education topics relevant to engineering educators. The course was designed as a GTA training experience that occurs concurrently with GTAs' classroom teaching experiences. Prior training and previous experience have been shown to improve the self-efficacy of graduating teaching assistants resulting in more effective instructors and improved student performance.[8] This experience provided a sense of scaffolding and guidance for graduate students who are trying to simultaneously balance being researchers-in-training, students, and novice engineering educators. In weekly group discussions, students discussed a variety of topics relating to course development, pedagogies, and classroom experiences. This experience identifies the value of having a space for engineering educators to share teaching experiences.

One thing that should be noted is that the intention for this paper is to provide an example of a positive and effective approach to GTA and future faculty training. It is not the intention for this paper to showcase a rigorous research study, but rather to demonstrate the advantages and potential of a practicum course for future engineering educators.

Background

Research done by Seely and ASEE assert that improving teaching practice is necessary to improve the development of skills required by the Accreditation Board for Engineering and Technology (ABET) and industry.[2,7,11] An emphasis has been made on the importance of innovative teaching strategies, such as active and team-based learning, in the development of future engineers. A 2012 report from the Executive Office of the President's Council of Advisors on Science and Technology recommended such incorporation of active learning in engineering education. As education and engineering education literature has identified, traditional teaching methods do not produce the

necessary creativity or problem solving skills required by engineers.[11] Seely argues that in this need for change, the engineering education field has evolved over time, moving from a focus on STEM and engineering science to an added emphasis in how engineers learn and acquire industry-related skills; this evolution requires the implementation of research-based teaching strategies.[7]

To facilitate the implementation of innovative teaching strategies it is necessary for future faculty members, including engineering educators, to obtain early training, as well as a space to discuss and learn the effectiveness of different pedagogical approaches based on their own experiences, the literature and examples from experienced professors. For example, Prince et al. examined how chemical engineering instructors first learn about new teaching methodologies and how they gain further information after initial exposure. The study suggested that the initial awareness about active learning is through discussions with colleagues. However, the necessary conversations that spark this awareness of active learning does not occur frequent enough.[8] In addition, the study suggested that many instructors gained further information by reading articles and books about various empirically tested teaching methodologies.

For these reasons, it is important to expose prospective engineering faculty to constructive discussions of effective engineering education pedagogy and theory. In the practicum course discussed in this paper, discussions about active learning approaches were supplemented by relevant literature reading assignments. In addition, the GTAs reflected on their teaching practices and experiences to improve student learning. This allowed the GTAs to collaboratively analyze their implemented teaching methodologies with their peers. This form of formative assessment further facilitated modification of various active learning approaches to best fit in individual classroom scenarios. Finally, the classroom environment and rich class discussion allowed inexperienced GTAs to overcome minor issues regarding teaching barriers and common fears by having a group of peer that acted as a supportive group and by obtaining advices from experienced instructors.

Engineering Education Practicum Course in Practice

The engineering education practicum course described in this paper was offered at Virginia Tech as a graduate course for GTAs who were concurrently teaching undergraduate level courses. The course is typically offered during the Fall and Spring semesters, and students are encouraged to take this course during the first semester of which they are teaching undergraduate engineering students. All participating students were engineering graduate students teaching freshman-level engineering students. Teaching experience of the participating students was diverse, ranging from first-time educators to well-experienced educators. In addition the instructor of the class was an experienced and recognized professor who had won several teaching awards.

The engineering education practicum course was a semester-long graduate course, primarily offered to engineering graduate students who were teaching undergraduate engineering courses. The objectives of the engineering education practicum course included:

1. Create organized and rhetorically effective syllabi
2. Articulate correspondences and differences between education theory and education practice
3. Perform peer reviews of other instructors and constructively discuss their performance
4. Productively reflect on your teaching practices to enhance or improve the student learning environment
5. Draw on your classroom experiences to develop useful formative assessments
6. Develop a teaching portfolio that articulates and illustrates your teaching philosophy
7. Develop a workshop class on a specific topic to experience curriculum and assessment design.

The class met weekly for 2 hours and 45 minutes, and was typically a casual round-table environment where GTAs, facilitated by an experienced engineering faculty member (i.e. the practicum course instructor), would discuss 2-3 topics. Class discussions were often supported with relevant engineering education literature. The course instructor prescribed half of the discussion topics, and students chose the other half throughout the semester, but all discussions were primarily student-led, with minimal guidance by the instructor. Students' reflections of their teaching experiences were also discussed weekly, as well as documented in weekly student journals and e-Portfolios. In addition to teaching evaluations conducted by the course instructor, students conducted teaching evaluations of their peers, and self-evaluated video recordings of their own teaching.

The process of continuous and open feedback allowed the GTAs to be able to think and reflect on their teaching experiences, as well as relate to their peers' teaching experiences. This offered opportunities for the GTAs to implement different practices and strategies that were considered useful or effective for their peer GTAs. The feedback process also helped the GTAs to identify weaknesses that had not been identified before and that were relevant to the improvement of their teaching approaches no matter how experienced the GTA was.

Student Feedback on Practicum Course

Formative student feedback was collected throughout and at the end of the practicum course. Feedback was collected via weekly journal entries, individual discussions, and an end-of-semester course evaluation. Based on the student feedback, the practicum course was found to be helpful to graduate students who considered themselves novice engineering educators. GTAs who participated in the practicum course found the experience to be beneficial because the course provided a space for learning through shared experiences. Experienced teachers could also participate in class discussions to share their experience and their teaching approaches to help develop new GTAs for their future professorial careers. Not only did experienced teachers participate to help novice educators, experienced teachers were also able to improve their own teaching strategies based on the continuous feedback and the deep discussions about topics that they previously had not considered. Topics that were more heavily theoretically based, such as

threshold topics, were initially considered irrelevant or impractical to experienced teachers, but were later realized to be highly informative and thought provoking after deep class discussions. Students quickly noticed early semester anxieties were eased by the weekly course discussions and readings that were all considered highly pertinent to common GTA issues and anxieties. Additionally, students felt better equipped throughout the semester to implement small yet innovative pedagogies that were discussed during the practicum course. At the conclusion of the semester, students felt prepared for the different facets of future education careers, including course and syllabi development, classroom management, assessment design, and implementing novel pedagogical approaches.

The effectiveness of this engineering education practicum course indicates that it has potential as an effective approach to GTA training and future engineering faculty training. This course could easily be implemented in other engineering programs that heavily rely on graduate students to be teaching assistants, as well as engineering programs that have a significant population of prospective engineering faculty. Engineering education literature has recommended pre-career preparation for future engineering faculty, and the engineering education practicum course has been identified as an effective approach to guiding engineering graduate students and novice engineering educators into future professorial careers.[1,3,6]

One of the reasons this practicum experience is considered to be so effective in terms of GTA and faculty training is its emphasis on reflection. McAlpine & Weston argue that reflection is a mechanism for the construction of knowledge from experience.[7] By sharing daily experiences in the classroom weekly, the participants were able to develop knowledge regarding effective teaching strategies. This knowledge according to the authors may be considered as tacit, however through the process of internal reflection, sharing experiences, and linking the information to relevant theory provided by the instructor, the participants were able to transform the tacit knowledge into explicit knowledge. In that sense, the students in the practicum course were able to relate current experiences in teaching to future actions and effective application of the knowledge obtained.

In order to be able to enhance student learning, McAlpine and Weston suggest that instructors must be able to know how experienced professors develop knowledge and think about teaching. Additionally, faculty who engage early in their career in collaborative reflection about their teaching practices and communicated their experiences with others through peer-to-peer and professional contexts demonstrated a significant difference in their effectiveness in teaching and the impact on how students learn, in comparison to their peers who did not engaged in those activities.[7] The settings and dynamics of the practicum course provide this early exposure to future engineering educators giving them skills to better adapt to their students' requirements and to succeed as future engineering instructors.

Limitations

Although this course was a generally positive and relatively easy course to offer, there are a few limitations to consider before implementation. As mentioned earlier, all but one of the participating students taught in the first-semester course of the first-year engineering program. The one student who did not teach in the first-year engineering program taught a freshman-level professional development course that was part of a living-and-learning community for engineering students. The lack of course diversity was a limitation of this practicum course since students were not able to discuss how teaching in different courses impacts the way educators approach various courses (e.g. first-year versus junior students, advanced technical courses versus introductory courses). However, since the majority of the students were teaching in very similar environments, students were able to discuss and exchange ideas and teaching strategies, as well, as support each other. Another limitation of the practicum course is its support structure. While this particular experience had a strong support structure, with support from administration, faculty, and GTA supervisors, this might be a limiting factor in other university climates.

Recommendations

The following sections will discuss recommendations for future courses or programs similar to the practicum experience, as well as a model for how this experience could be implemented for other graduate teaching experiences.

General Recommendations

The effectiveness of this engineering education practicum course indicates that it has potential as a useful approach to GTA training and future engineering faculty training. Ground the course in relevant literature establishes the importance of constructing teaching strategies around established research and proven practices. This sentiment is echoed by the *Innovations with Impact* report published by ASEE as an important factor in pushing innovation in engineering education.[2] By instilling this importance during pre-career development, future to be engineering educators can better contribute to the engineering education community by advancing knowledge and better connecting research to practice. In addition, by utilizing a reflection framework established by McAlpine and Weston, course discussions were made more effective by allowing students to relate current experiences to future teaching strategies.[7]

This course could easily be implemented in other engineering departments with graduate students who are prospective engineering professors. Engineering education literature has recommended pre-career preparation for future engineering faculty, and the engineering education practicum course has been identified as an effective approach to guiding engineering graduate students and novice engineering educators into future professional careers.

Model Practicum Course

The following section provides a model of a practicum course that can be used as a reference for similar practicum experiences for GTA and/or faculty development

programs. This model is based on the practicum course described throughout this paper, however displayed in more general terms in order to provide a customizable model that can be implemented in a variety of engineering programs. Recall that this described practicum course was a semester-long course (15 weeks), that met once a week for 2 hours and 45 minutes.

I. Course Objectives:

In particular, having successfully completed the course, students will be able to:

a) Create organized and theoretically effective syllabi
b) Articulate correspondences and differences between education theory and education practice
c) Perform peer reviews of other instructors and constructively discuss their performance
d) Productively reflect on teaching practices to improve student learning and class environment
e) Draw on classroom experiences to develop useful formative assessments
f) Develop a teaching portfolio that articulates and illustrates the student´s teaching philosophy

II. Syllabus:

Following are the possible discussion and reading topics that will be guiding the weekly class discussions throughout the semester. Students are encouraged to suggest additional topics of interest.

Week	Topics
1	Intro, Developing Syllabi + Classroom Climate
2	e-portfolio + Teaching Philosophy
3	Early semester strategies
	Student – TA Relationship + Distressed Student
5	Teaming + Co-operation + Competition
6	Questioning Technique + Threshold Concepts
7	Student centered + Active learning + Cooperative learning
8	Formative Assessment (CATs + Rubric brief)
	Student Evaluations + Good Evaluation Implications
10	Mid semester Slump and nap
11	"Old School" vs "New School" Teaching
12	Technology & Online Learning +Social Networking
3	Research to Practice for Innovative Teaching
14	Projects + Workshop Design
15	Wrap Up
Other possible topics	Threshold Concepts Intrinsic Motivation Engineering & Engineering Education

III. Suggested assignments

a. Development of a Teaching philosophy

b. Construction of an E-portfolio documenting teaching experiences and the student online presence
c. Documentation of weekly journal teaching reflections
d. Critique of assigned readings in preparation for class discussions
e. Performance of peer teaching evaluations
f. Self-evaluation (use 5 minutes video of teaching)
g. Evaluation of an instructor who has received teaching awards

IV. Final project

a) For the final project, students will design and present a mock workshop/class that could be implemented in the course each student is currently teaching. The class should implement strategies and pedagogies discussed throughout the semester.
b) For the final presentation, each student will prepare a 15-20 minute presentation demonstrating how the designed workshop/class would be implemented.
c) Students will also write a report that includes the context of the course the workshop/class is designed for, workshop/class objectives, a workshop/class agenda with estimated timestamps, and potential assessments (student assessments, as well as an assessment of the effectiveness of the workshop/class)

Conclusion

Improvement of engineering education begins with proper training of early engineering educators and faculty members. The graduate level practicum course described in this paper is one effective approach to training graduate students as they develop into skilled engineering educators that are well versed in education theory and practice. Considering the positive experience of participating students, it is our belief that similar practicum courses can be implemented in other engineering programs that heavily rely on graduate teaching assistants and who have a population of engineering graduate students with professorial ambitions. The provided model can be used as a launching point for other institutions to consider implementation of engineering education practicum courses for future engineering educators.

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