Graduate Teaching Assistant Certification as a Requirement for First-Time TAs in the Cockrell School of Engineering at The University of Texas

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Dr. Connolly has been leading the development and implementation of the TA Certification Program in the Cockrell School of Engineering since its inception in the Fall of 2013. Before he joined Cockrell School, he worked at the Charles A. Dana Center for Mathematics and Science Education at UT Austin, originally in conjunction with The Carnegie Foundation for the Advancement of Teaching, on the development of mathematics course pathways to improve student success and degree completion. During this time, he oversaw course development and was responsible for developing faculty supports and professional learning opportunities. Dr. Connolly served for ten years as a faculty member in the Mechanical Engineering departments at Penn State University in Erie and The University of Texas at San Antonio, where he was the Principal Investigator for several engineering education research programs under the auspices of the National Science Foundation. These programs focused on remotely accessible collaborative experimentation and the merging of theory-based learning and laboratory-course activities using mobile computing technology to improve undergraduate engineering education. Prior to his academic career, Dr. Connolly worked as a systems integration engineer on the Space Station and Space Shuttle programs at the NASA Johnson Space Center, and as a reliability engineer on the B-2 Stealth Bomber program for the Department of Defense. Dr. Connolly earned a B.E. in Mechanical Engineering from the State University of New York at Stony Brook, an M.S.E. in Aerospace Engineering, and Ph.D. in Mechanical Engineering, both from UT Austin. He served as a graduate teaching assistant for six years during his graduate studies.
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Abstract

The Engineering Teaching Assistant Certification Program in the Cockrell School of Engineering is part of a larger engineering graduate student professional development program whose main goals are to increase success and retention rates of undergraduate engineering students, and to professionally develop engineering graduate students to be successful in their teaching and careers. All TAs are required to be certified during the first semester in which they are appointed. The TA certification workshop is based on research and best practices in education – it takes a hands-on and interactive approach in covering the following topics: understanding undergraduate students and the culture of higher education in the United States, principles of student success, fundamentals of pedagogy, student learning styles, questioning strategies to increase student engagement, and managing the practical aspects of a TA position, such as working with faculty, grading, office hours, and resolving student issues. TAs are either observed during their classroom/laboratory session or are required to participate in a teaching practicum session, where they are evaluated by their peers. These are followed by a debrief to provide constructive feedback for improving teaching effectiveness. TAs are required to conduct two surveys during first semester in which they are appointed. The Early Semester Survey (ESS) enables students to provide critical early feedback so that TAs can make adjustments to their teaching practices. At the end of the semester, the TA version of the university’s Course Instructor Survey (CIS) is conducted. This paper presents an overview of the program with a focus on the certification curriculum, data analyses of the effectiveness of the TA Certification Program, along with lessons learned and plans for further development of the program.

Program Motivation and Objectives

The development of the Engineering TA Certification Program was motivated by a college-wide initiative to increase student retention in all engineering majors and a university-wide initiative to decrease the average number of semesters it takes for students to complete their degrees. This program was also developed in response to a call from faculty across the Cockrell School to provide professional learning opportunities for graduate students to develop their teaching and communications skills. While we seek to help all TAs and all students, we place an emphasis on
serving students in introductory engineering courses, especially those that have traditionally low success rates, given that one of our primary goals is to increase student retention. In addition, given that approximately half of our graduate TAs are international students, we place an emphasis on helping them better understand cultural aspects associated with American educational system that impact interactions with students, faculty, and staff.

Based on advice from faculty and the college- and university-wide initiatives cited above, we developed specific objectives upon which the certification program was built. Before learning about how to better teach their students, we recognized that TAs, particularly international TAs, should have a solid understanding of the broad experiences and mindsets of our undergraduate students and the culture of higher education in the United States. Similarly, we recognized that TAs should be able to model and provide supports for students to develop the characteristics of successful engineering students, as well as understand and mitigate the mindsets, attitudes, and beliefs that can be obstacles to student success.

From the standpoint of teaching, we recognized that TAs should understand the fundamentals of pedagogy as they apply to engineering education, the principles of working with adult learners, adapting to different student learning styles, and how to actively engage students by developing effective questions and questioning strategies. Lastly, we recognized that TAs should be coached in managing the day-to-day aspects of a TA position, such as working with faculty and staff, grading student work, conducting office hours, and using learning management systems.

Overview of the TA Certification Program

All new TAs are required to be certified during the first semester in which they are appointed as a TA, regardless of their assigned duties and level of student contact. To become certified, TAs are required to participate in the certification workshop, be observed in the classroom or participate in a teaching practicum, and conduct early- and end-of-semester surveys of student ratings of teaching effectiveness. Each of these requirements will be described in detail in the following sections.

TA Certification Workshop

Workshop Design Principles

The TA certification workshop is an all-day workshop that is held prior to the start of classes in fall semesters and a week and a half after the start of classes in spring semesters. The workshop was developed under the guidance of the following design principles:

- The workshop should entail approximately six hours of professional learning time
- Facilitators should include experts, practitioners, and seasoned TAs
- Participants should work in table groups of approximately eight people
- Sessions should make use of a diverse set of delivery modes, such as individual reflection and planning, small-group collaboration, and whole-group discussions
- Sessions should model what effective learning environments look like
- Participants’ experience and expertise should be acknowledged and leveraged
- Content should be based on research and proven educational practices
- A majority of the activities should be interactive
- Content should be presented from an engineering education perspective as much as possible
- Actual engineering materials, e.g., problems, lab procedures, etc., should be used in activities as much as possible

The objectives, approaches, and content of each session of the workshop are described in detail in the following sections.

**Session 1: Understanding the Undergraduate Engineering Student Body and the Culture of Higher Education in the United States**

The objectives of this session are for TAs to develop a stronger understanding of the cultural norms of higher education in the United States, to develop a sense of the types of issues that arise when working with students, and to learn about college- and campus-wide resources to which students can be referred for assistance with academic and personal issues.

The session begins with a brief interactive presentation that covers (1) the results of studies that address college student mindsets and attitudes towards higher education in general and (2) American cultural attitudes regarding time and personal interactions, especially those between students and faculty, and their impact on the educational environment.

The main part of the session comprises an activity where the participants are presented with scenarios that describe real-world difficult or awkward situations that they are likely to encounter when working with students, faculty, and staff. Examples of such scenarios include:

- You’re speaking with an American student or colleague who speaks English very quickly or has a strong regional accent. You’re having difficulty understanding him.
- A student comes to your office outside of your office hours. You’re very busy preparing for an exam you have tomorrow and you do not have time to help her, but it’s clear that she really needs help.
- You are suspicious of students cheating or have evidence of such. Consider different instances of cheating: homework, lab report, or computer assignment; exam or quiz; major project report (plagiarism.)
- A student who is not doing well in your class speaks to you about his progress in your class. During the conversation, he divulges details about some difficulties he’s facing in his personal life and becomes very upset and emotional.

The participants are first asked to individually think about what they would do (or not do) in that particular situation and then are given a few minutes and jot down their ideas. Next, the participants form groups of two or three people and share their responses such that they can recognize common threads and discuss differences. During this time, facilitators circulate the
room to listen in on group discussions and provide additional direction or prompting as required. The session culminates with the lead facilitator asking individuals to share with the whole group what they discussed in their small groups and to moderate the ensuing discussion.

Session 2: Principles of Student Success

The objectives of this session are for TAs to develop an expanded view of what it means to be a successful engineering student, increase awareness of the variety of self-beliefs that engineering students may possess about their own academic abilities, and develop strategies that TAs can use to encourage productive behaviors and beliefs in a variety of student scenarios they are likely to encounter, especially when working with struggling students.

The session begins with large group discussion question: *What are the qualities of successful engineering students?* Participants are first asked to reflect on this question and then provide their responses via an online polling tool using their smartphones or other mobile devices. These qualities are then sorted into two categories: visible qualities, such as math and reasoning skills, critical thinking, time management, class participation, etc., and underlying mindsets, attitudes, and beliefs, such as seeing oneself as an engineering learner, having a clear and purposeful reason for majoring in engineering, seeing oneself as part of a learning community, etc. The conversation continues by helping TAs build their awareness of how student mindsets and beliefs can affect academic behaviors by presenting recent research findings from educational psychology. In particular, the malleability of intelligence and how students can develop a “growth mindset”, versus a fixed mindset, in the context of their academic endeavors.

The session continues with a small group activity where TAs are presented with scenarios that describe situations where students, either individually or as a group, encounter academic situations that challenge their self-image as a successful engineering student. Examples of such scenarios include:

- **You have returned the first exam and, as is normal for this second-year “weed out” course, students performed poorly overall. The class average was 45%. Your students are really frustrated and discouraged. They feel that the exam content wasn’t “fair” based on what was covered in class and on the homework assignments.**

- **A student visits you during office hours and she tells you that she is studying and putting a lot of time in on assignments, but feels like she is “spinning her wheels”. She spends hours on one homework problem and has little to show for it. She is beginning to think that she isn’t cut out to be an engineer. Struggle is a normal part of learning, but “spinning your wheels” isn’t productive.**

- **A third year student who has earned high B’s in all of his previous engineering courses comes to talk to you about his performance in the class. He is earning similar grades in your course and is frustrated that his exam performance in your class not “high enough”. He feels that because he does most of the practice problems, he should be getting an A in your course.**
Participants form groups of two or three people and discuss strategies to encourage these students to persist and develop a growth mindset. During this time, facilitators circulate the room to listen in on group discussions and provide additional direction or prompting as required. The session culminates with the lead facilitator asking individuals to share with the whole group what they discussed in their small groups and to moderate the ensuing discussion.

Session 3: Fundamentals of Engineering Education

This is the longest session in the workshop, and takes about twice as much time as any of the other sessions. The objectives of this session for TAs to learn about the characteristics and needs of different types of learners, to investigate successive levels of learning as outlined using Bloom’s Taxonomy, to develop a systematic approach for developing engaging questions for students at various levels of understanding, to understand how fostering an environment of “productive struggle” increases knowledge retention and deep understanding of engineering concepts, and to understand basic elements of lesson planning.

The session begins with an interactive presentation that covers the following: (1) learning-style models such as VARK and the experiential learning cycle, (2) developing strategies for increasing student-centered learning, (3) Bloom’s Taxonomy of educational objectives, (4) the concept of scaffolding questions to increase student engagement and allowing students to struggle with engineering content, (5) lesson planning, and (6) grading.

The session continues with breaking TAs into small groups of 2 or 3 people and presenting them with a problem from their specific engineering discipline that most students would find moderately difficult. The groups are presented with a scenario in which they are working individually with a student or with a group of students in a classroom setting on the problem. The groups are asked to develop a questioning strategy where the TA facilitates as the students work through the solution by asking scaffolded questions, as opposed to the TA simply providing the solution to the problem in an expository manner. Lastly, the group is asked to couch this strategy into a wider lesson plan by answering the following questions:

- What is the overarching engineering concept being explored in this lesson?
- What are the student learning objectives for this lesson?
- What pre-requisite knowledge to students need for this lesson?
- Where might students have difficulties? Which misconceptions may appear?
- What guiding questions can you ask to facilitate student learning, without simply giving the solution away?

The groups are required to write their strategies and lesson plan outlines on poster paper. While the groups work on this activity, facilitators circulate the room to listen in on group discussions and provide additional direction or prompting as required. The session culminates with a “gallery walk”, where all of the groups walk around the room and review and critique the strategies and lesson plans that other groups developed.
Session 4: Effective Use of Learning Management Systems

The objectives of this session are for TAs to become familiar with the features and capabilities of the Canvas learning management system and to learn how to get further training and support in using Canvas to manage TA responsibilities and work more effectively with students and faculty.

This session entails a live demonstration of the Canvas learning management system, with a focus on the features that TAs are mostly likely to use, such as communicating with students, organizing online course materials and assignments, administering online quizzes, grading student work, scheduling meetings, and entering grades. This session is facilitated by the training and outreach coordinator from the campus-wide information technology group. TAs are encouraged to ask questions and bring up concerns during the demonstration to make the discussion more interactive.

Classroom Observation and Teaching Practicum

Depending on their assigned duties, TAs are observed during their classroom or laboratory session or they participate in a teaching practicum.

Classroom or laboratory observations are conducted by the director of TA certification. The observation protocol calls for a 30 – 45 minute observation of teaching practices, with a focus on the following aspects:

- projecting authority and confidence; building a rapport with students
- clearly stating learning objectives for the session
- speaking volume, pace, and clarity
- effective use of educational technology
- quality of “board work”, e.g., legible writing, clear and effective diagrams/graphs, etc.
- quality of technical communication
- checking for student understanding
- asking effective questions to promote critical thinking and engagement
- ensuring broad participation from students; not engaging the same students all of the time
- checking in with students about their perceptions of the difficulty of assignments and exams; reminding students about office hours; demonstrating that they are effectively communicating with faculty

Observations are followed by a debrief meeting with the TA to provide constructive feedback for improving teaching effectiveness.

Teaching practicum sessions provide TAs with the opportunity to demonstrate their teaching skills via short problem-solving sessions attended by the director for teaching assistant certification and fellow first-time TAs. A standard evaluation form is used to rate the TA in the following areas:

- statement of the problem and learning objective(s)
discussion of relevant equations or overarching engineering concepts
indication of common misconceptions or sticking points
questions that are used to assess student understanding
clarity and effectiveness of teaching
verbal communication: pace, volume, and clarity
graphical communication: clear handwriting/organized slides; diagrams

All evaluators are required to provide constructive feedback on what was done well and what needs improvement. TAs who demonstrate significant deficiencies in either the observation or teaching practicum session are required to meet with the director of teaching assistant certification to discuss strategies for improvement, after which the TA is observed again in the classroom or participates in a second teaching practicum session.

**Student Surveys**

TAs are required to solicit student feedback early in the semester and at the end of the semester to monitor their teaching effectiveness. The early semester survey (ESS) is conducted during the third week of the semester and plays an important role in evaluating the instructional effectiveness of new TAs and flagging struggling TAs for intervention. Each TA sends this anonymous survey electronically to his/her students and consists of the following questions.

- Two open-response questions:
  - *Describe what your TA is doing well, along with any additional comments you wish to provide*
  - *Describe how your TA could improve his/her teaching effectiveness. Provide as much constructive feedback as possible.*

- Six multiple choice questions, scored on a 1 – 5 Likert scale (strongly disagree to strongly agree), which are directly connected to the TA certification program outcomes:
  - *My TA evaluates my work – such as assignments, quizzes, exams and reports – consistently and fairly.*
  - *My TA exhibits flexibility and adaptability in meeting students’ needs when explaining concepts and procedures.*
  - *My TA engages me during class, lab, and/or office hours by asking good questions and getting me to think, rather than simply going over problems or procedures.*
  - *My TA is concerned about students’ academic success by offering advice and/or constructive feedback on assignments, test preparation, etc.*
  - *My TA carries out his/her assigned duties in a professional and timely manner.*
  - *My TA serves as an effective liaison between faculty and students.*

- One multiple choice question, scored on a 1 – 5 Likert scale (very unsatisfactory to excellent), which solicits an overall rating of the TA:
  - *Based on other TAs I have had, I would rate my TA as...*
Program Evaluation and Results

Since the inception of the program in Fall 2013, it has undergone both changes in content and delivery to reach its current form. Changes to the program were made as the result of workshop evaluation surveys, which helped us to make changes in delivery modes and scheduling of workshops. At the end of each semester, focus groups were conducted to get a better idea of the topics that TAs felt would have been most helpful in a workshop that prepared them to enter the teaching environment – after having gone through a full semester of serving as a TA.

We feel that the best way to evaluate the effectiveness of the TA Certification program is to collect TA evaluation data from students. The graph shown in Figure 1 represents data from the early semester survey from Fall 2015, in which TAs are rated on statements based on certification program outcomes. The last column of the graph represents the overall TA rating. The indicated ratings are average values of all student surveys ($N = 1218$ students, $n = 86$ TAs.)

While we were pleased with these results, we decided to look more closely at the individual overall ratings for each of the TAs, as represented by the histogram in Figure 2. Any TA whose overall score was less than 3.75 was flagged for intervention to improve teaching effectiveness. The data revealed that 18 out of 86 new TAs, about 22%, required interventions such as coaching, additional teaching practice sessions, follow-up classroom observations, and/or more structured instructional planning.
Figure 1: Results of Early-Semester Survey of Students – Statements Based on Certification Program Outcomes – Fall 2015
Figure 2: Distribution of Overall TA Ratings by Students – Fall 2015
Longitudinal Data: Fall 2013 to Fall 2015

During first two semesters of the program, the workshop comprised several sessions that stretched out over the first 5 - 6 weeks of the semester. The reasoning was that new TAs could bring in their experiences of being a new TA into the discussions and activities for each workshop, which would enhance its effectiveness. While this generally turned out to be beneficial, the fact that the training was stretched out over a relatively long period of time – and further into the semester – resulted in significant decreases in attendance which prevented many TAs from successfully completing certification.

Starting in Fall 2014, the workshop was held as a one-day event prior to the beginning of classes, which significantly increased workshop attendance and subsequent completion of certification. In addition, this had a significant impact on early-semester student ratings of TAs. The histograms below show the distribution of overall TA ratings on a scale of 1 to 5, where a score below a 3.75 is considered a flag for intervention to help a TA improve teaching effectiveness.
Figure 3: Longitudinal Study of Overall TA Ratings by Students – Fall 2013 to Fall 2015
These data show a significant drop in the percentage of TAs requiring intervention to improve teaching effectiveness. Prior to switching to a pre-semester workshop model, approximately 50% of new TAs were flagged for intervention in Fall 2013 and Spring 2014. From Fall 2014 onwards, the number of TAs requiring intervention was cut in half.

From Fall 2014 onwards, we noticed that the percentage of TAs requiring interventions has remained almost constant: 24%, 26%, and 22%, respectively. As part of our ongoing work, we are interested in determining how further changes to the workshop or follow-up activities can further decrease this percentage.

**Ongoing Work**

While we are pleased with our results to date, we recognize that there is still room for improvement, based on feedback from TAs, students, and faculty. The most pressing issue identified by faculty and TAs is that they would prefer differentiated workshop sessions that better align with individually assigned TA responsibilities, e.g., a special session for TAs who will primarily be working with students in experimental lab courses, a special session for TAs whose responsibilities involve office hours and grading only, etc. We are currently exploring ways that we can offer such options within the one-day TA certification workshop without putting undue pressure on TAs to spend additional time on professional development activities.

The most salient issue we have seen from student feedback is that some students feel that their TAs are over explaining engineering concepts or spending too much time on less challenging content, while other students feel that their TAs are not spending enough time explaining engineering concepts and are rushing through curricular materials. We feel that this can be addressed by creating workshop activities that guide TAs in the development of creative strategies to help them meet the needs of less academically prepared students while ensuring that they are engaging students who are seeking greater academic challenges.

From the standpoint of evaluating program effectiveness and its impact on retention, we have embarked upon an ambitious data-analysis effort involving direct comparisons of early- and end-of-semester student ratings of TAs, and completion rates and class averages for courses that have traditionally lower levels of student success.

**Implications of this Initiative**

Based on the preliminary results of the TA certification program, we believe that this program has demonstrated significant potential to increase student success and retention, while providing relevant professional learning opportunities for TAs that will serve them beyond their roles as engineering educators.
Although this program was developed for graduate TAs at a research-intensive university, we believe that its core design principles will enable it to be adapted for use in engineering programs at a wide variety of institutions whose programs and student populations differ from those at the University of Texas at Austin. It is our hope that this paper will serve to open up a conversation in the engineering education community on how we can best serve our TAs to ensure that all of our undergraduate students are provided opportunities to achieve academic success.

**Bibliography**


