AC 2012-4109: UTILIZING UNDERGRADUATE TEACHING ASSISTANTS IN ACTIVE LEARNING ENVIRONMENTS

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Utilizing Undergraduate Teaching Assistants in Active Learning Environments

Introduction

Engineering schools must strive to evolve a new paradigm for undergraduate education that recognizes the evolution of the skills and learning styles of its incoming students and prepares them to tackle society's grand challenges of the future, while at the same time increases the probability of their success in their chosen engineering program. Most researchers and experts in the field agree on some basic tenants of retention[1,2,3], which include developing community amongst freshmen, creating connections for freshmen through meaningful interactions with returning students and faculty, engaging freshmen in active learning environments, helping freshmen understand and internalize the vision and mission of the school, and assisting freshmen to develop a personal identity as an Engineer. This paper will describe our experiences with developing and evolving an Undergraduate Teaching Assistant Program (UGTA Program) at Arizona State University that utilizes several of these pillars to improve retention rates in engineering.

Context of the UGTA Program

Many institutions utilize undergraduate students in a variety of ways to assist with the instruction and grading of undergraduate classes. Colleges and universities across the country, including the Ira A. Fulton Schools of Engineering at Arizona State University (ASU), manage supplemental instruction or study group programs to facilitate structured study sessions led by undergraduate students who have successfully completed the course. Similar to tutoring, these students are trained in learning strategies, but work exclusively out of the classroom to serve as a resource for students who need additional assistance with class content. The University of Colorado hires and trains undergraduate students as Learning Assistants (LAs) to facilitate small-group interaction through in-class discussion groups or recitation sections for courses with a large enrollment. LAs lead learning teams of approximately 20 students through physics, astronomy, chemistry, biology, geology, and math classes. Though one goal of the program is to improve the quality of science education for undergraduate students, the experience of the LAs is specifically designed to recruit students to careers in teaching.[4]

UGTAs at other institutions, like Carnegie Mellon University, are utilized in departments and classes across campus. In programs like engineering, UGTAs are often used as graders and lab assistants and are paid an hourly rate[5]. While these institutions usually outline the different roles, policies, and expectations of the UGTAs in relation to graduate teaching assistants, oversight is left to specific departments and students do not receive any common training or preparation. In some programs, like the department of sociology at Penn State University, undergraduate students must be invited by an instructor to serve as an undergraduate teaching assistant[6]. As described in further detail throughout this paper, our UGTA Program utilizes undergraduate students to facilitate active learning in engineering classes, provides consistent academic training across all programs in the Ira A. Fulton Schools of Engineering at ASU, recruits a diverse pool of undergraduate students, and holds UGTAs accountable to the program

goals through enrollment in common course and payment of a nominal stipend at the end of the semester.

UGTA Program in Engineering at ASU

The primary objective of the UGTA Program in the Ira A. Fulton Schools of Engineering at ASU is to improve the educational experience of freshmen in their engineering classes by providing assistance with facilitating team-based activities in the classroom. Faculty who teach Introduction to Engineering and other first-year classes are encouraged to engage students in exploratory and collaborative learning activities. Active learning environments transcend the traditional lecture model and allow students to discover, process, and apply the information they learn in the classroom. Active learning focuses on developing students' skills, rather than merely transferring information, and fosters higher-order thinking skills that involve analysis, synthesis, and evaluation. Recent research shows that courses taught using active learning techniques increase student attendance, lead to higher engagement by students in class, and improve students' understanding and learning of the course material[7]. Not only do active learning strategies emulate many processes of scientific inquiry, but they also accommodate a variety of learning styles and interests, which can be helpful in attracting and maintaining females and underrepresented ethnic minorities in science, technology, engineering, and math[8]. The exploratory activities utilized in our first-year classrooms enable students to collaborate with each other to advance their understanding of engineering.

With the success of the UGTA Program in freshman classrooms, many faculty members who teach 200, 300, and 400-level classes have also begun to embrace collaborative learning techniques and now utilize UGTAs inside and outside of the classroom. UGTAs bring their knowledge and personal experiences from the perspective of a peer-level undergraduate student who has recently taken the class. In addition to having fresh exposure to the course content, the UGTAs' energy and excitement for their major and course material makes them an ideal conduit to promote the benefits and provide advice for the challenges that await students as they progress through the academic career.

Since the program's inception in fall 2009, more than 120 students have worked with over 50 faculty members, and feedback from students and faculty has been overwhelmingly positive. Over the last three years, with guidance from faculty and students, the program has evolved from a volunteer opportunity that provided little training and guidance for UGTAs to a paid experience with built-in oversight and deliberate efforts to improve teaching, learning, and skill development. The program has become increasingly institutionalized within the Ira A. Fulton Schools of Engineering, and visibility of the program increases with each semester.

UGTAs are sophomore and upper-division undergraduate students in good academic standing who spend about three to five hours each week working with an engineering class. UGTAs meet with their faculty instructor to prepare for activities, assist their faculty in facilitating classroom active learning projects, and may hold office hours or review sessions throughout the semester. Through their presence in the classroom, UGTAs:

- Promote more effective learning and achievement through peer mentoring

- Act as a cultural bridge to transition from high school to the university environment
- Help students to navigate the institution
- Promote self-confidence and self-reliance by promoting available resources
- Act as role models who demonstrate personal and academic success.

UGTA applications and selection

Each fall and spring semesters, the Engineering Office of Academic and Student Affairs and the engineering faculty recruit UGTA applicants. The UGTA Program launches an online application through which students provide their scheduled availability, classes for which they would like to serve as a UGTA, an explanation of why they would like to be a UGTA, and a summary of their qualifications. The executive coordinator who administers the program reviews the applications, verifies applicant grades, and emails qualified applications to faculty instructors for their review. In many cases, faculty members solicit their own UGTA applicants from students who have previously taken the class and exceeded expectations. Both methods of encouraging applicants are effective, as students who have been pursued by a faculty member feel a sense of achievement and a personal connection with that professor, while an open call for applications allows any students to show initiative in their own involvement.

The UGTA Program received 136 completed applications for the fall 2011 semester to fill 57 positions, and 81 completed applications for spring 2012 to fill approximately 46 positions. Of the 57 UGTAs in fall 2011, 25 students reapplied to the UGTA Program for the spring 2012 semester. A variety of factors are considered when offering UGTA positions, including scheduled availability, prior performance in the course, overall GPA, and application responses. The following table provides a brief summary of characteristics of the UGTAs employed this academic year.

FALL 2011			**SPRING 2012**		
Average cum GPA	3.52		Average cum GPA	3.62	
White	35	61.4%	White	33	71.7%
Asian	8	14.0%	Asian	6	13.0%
Hispanic/Latino	10	17.5%	Hispanic/Latino	5	10.9%
Not Available	1	1.8%	Not Available	1	2.2%
Two or More Races	3	5.3%	Two or More Races	1	2.2%
	57	100%		46	100%
Female	22	38.6%	Female	16	34.8%
Male	35	61.4%	Male	30	65.2%
	57	100%		46	100%

We have been particularly pleased with the number of female participants in the program, which exceeds our overall female population of about 25%. Given the important peer-mentoring role, the Ira A. Fulton Schools of Engineering will place more emphasis on selecting a diverse UGTA pool in the future. Though more ethnic diversity is needed, female students have been well represented in the UGTA program, creating a stronger peer-modeling environment. One UGTA even noted in her final reflection paper, "my favorite part of this experience was to be able to show these freshmen that a girl can be just as successful as a guy in the computer engineering field."

UGTA training and preparation

Unlike programs in many other places, our recognition of the UGTAs multifaceted role in learning, mentoring, and role modeling has lead to the recognition that formalized training is needed. To prepare UGTAs, students attend a training session at the beginning of each semester and enroll in a one-credit online class aimed at developing their leadership, communication, and teamwork skills. Because the UGTA course is taught online, the beginning-of-semester training is especially important for UGTAs to get to know one another and build community. This in-person opportunity allows new UGTAs to hear about the experiences of and gain advice from previous UGTAs, to establish rapport with the executive coordinator who manages the program, and to clarify the expectations of students who participate in the UGTA Program.

All UGTAs are also enrolled in a one-credit FSE 294 course called "Engineering Undergraduate Learning Assistant." The class is facilitated online by the executive coordinator and is offered for credit without a grade. From a logistical standpoint, enrolling all UGTAs in one course improves communication between the UGTAs and the Engineering Office of Academic and Student Affairs, provides a communication forum in which all UGTAs can contribute and interact with each other, and increases accountability of the UGTAs through the semester. Course assignments help to develop the students' soft skills, promote reflection on their growth through the semester, and provide a setting in which they are asked to articulate the real-world experiences in which they have utilized their skills.

In the fall 2011 semester, FSE 294 students were assigned to read:

> Trowbridge, L. W., Bybee, R. W., & Carlson-Powell, J. (2000). Questioning and discussion. *Teaching Secondary School Science: Strategies for Developing Scientific Literacy.* Prentice Hall, pp. 183-193.
>
> Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). Cooperative learning returns to college: What evidence is there that it works? *Change*, *30*(4), pp. 26-35.

For both readings, students were asked to post to a Blackboard discussion forum and provide an example of the reading's applicability to their UGTA role, discuss the merits or weaknesses of the article, and outline a plan for implementing what they learned from the article in their UGTA classroom. Similarly, students were asked to review the university's academic integrity website and create a discussion post that addressed why it is important for students to understand the

policies, processes, and sanctions and how UGTAs can utilize their knowledge of academic dishonesty in their roles.

These assignments helped to prepare UGTAs for their roles inside and outside of the classroom. Students who volunteered as UGTAs in a prior iteration of the program (before the FSE 294 class was required), discussed the difficulty of assessing students' knowledge and understanding, and then knowing how to guide students through using the course principles and formulas, rather than simply telling students the answers. The "Questioning and Discussion" piece helps students to understand basic pedagogical tenants when leading a class discussion or helping with small group projects. Similarly, the cooperative learning piece not only helps UGTAs to understand the value of team-based activities in their own learning, but also leads them to recognize some of the key characteristics of effective teams so that they can cultivate these qualities among the teams of students in their classes.

The last two assignments of the FSE 294 class provided insight for engineering administrators and helped the UGTAs to market their experience. Students were asked to submit a copy of their resume with the UGTA experience and to write a 2-3 page reflection paper that addressed the value of collaborative activities in learning engineering concepts, explained how serving as a UGTA impacted their ability to become a successful engineer, and provided feedback about their experiences in the UGTA Program. These assignments required students to consider all of their experiences throughout the semester and to articulate the skills and qualifications they were able to hone in preparation for internship and job interviews.

UGTA responsibilities

UGTAs and their faculty members work together to determine the specific roles and responsibilities for each course. The only limitations enforced by UGTA Program administrators are: (1) UGTAs must work approximately five hours per week, and (2) UGTAs may not be used for grading. In our school other undergraduate students are typically hired specifically as graders with virtually no student contact. Setting clear expectations and boundaries for the roles of UGTAs is important for the success of the students and the program. Undergraduate students have had less academic experience and, in most cases, less life experience than graduate teaching assistants. Because UGTAs are integrated into in a classroom of their peers, excluding them from grading reduces the potential for conflict and eliminates an uneven power dynamic that threatens the intent of peer mentoring.

With the primary purpose of maximizing peer-to-peer contact, UGTAs have a wide variety of functions inside and out of the classroom. The majority of UGTAs spend their time preparing for and assisting with in-class activities that may include answering questions about hands-on projects, proctoring exams, providing guidance for teams working on problem sets, demonstrating proper usage of machinery or equipment, managing lab supplies, or live-coding in front of the class. Several UGTAs have lectured on content-based topics like pneumatic devices or the design process, while other UGTAs have prepared presentations that develop the students' abilities to use programs like Excel, MATLAB, or AutoCAD. According to the end-of-semester assessment, about half of all UGTAs held regular office hours and exam review sessions outside of class, while others provided email support to students with homework questions.

Through the course and their experience in this program, UGTAs are able to further develop the skills that are necessary to succeed in today's economy, revisit course material to fortify the UGTA's knowledge of engineering concepts, develop a working relationship with a faculty member in their major, and earn valuable experience for their resume. In addition to the course credit and notation on their transcript, UGTAs also earn a modest stipend each semester and recognition on the website and at an appreciation event each semester. While these formal benefits of the program provide substantial reward for the students, many UGTAs have also received informal privileges. For example, some UGTAs have been able to enjoy personal lunches with the engineering deans and have attended football games as guests in the dean's suite.

Program budget

An executive coordinator in the Engineering Office of Academic & Student Affairs is responsible for advertising the program to students, coordinating the application process, working with engineering faculty to match applicants with classes, facilitating the hiring process, managing the training, teaching class for UGTAs, and evaluating the effectiveness of the program. These UGTA responsibilities are cyclical throughout the academic year and consume approximately 30% of her FTE.

The costs of the program include UGTA stipends, polo shirts for the UGTAs, and meal costs for recognition events. UGTAs are awarded one $500 stipend at the end of the semester once they have fulfilled their obligations to the course for which they served as a UGTA and have completed all assignments associated with the EULA course. We employ 50-60 UGTAs per semester, so the stipend budget for both semesters is approximately $55,000 per academic year.

Each semester, the UGTA Program provides polo shirts for all UGTAs and hosts an appreciation and recognition event at which breakfast or lunch is served. Shirts and meals account for approximately $5,000 of the budget each year and provide a number of benefits to the program. Students enjoy receiving "free" shirts, which boosts morale and increases community among the UGTAs. Additionally, distinctive polo shirts help to give authority to UGTAs in the classroom, while advertising the program to their peers. The recognition event at the end of each semester serves as an opportunity for engineering administrators to recognize the efforts of our faculty members who engage in active and collaborative teaching methods, express appreciation for the dedication of the UGTAs throughout the semester, and enables faculty and students to interact outside of the classroom.

Program evaluation

Data were collected by surveying students enrolled in classes with UGTAs, surveying faculty teaching courses with UGTAs, asking UGTAs to write a reflection paper of their experiences, and examining course evaluations. Feedback throughout the program has been used to modify aspects of the program and improve the structure.

Feedback from Students

Feedback from students enrolled in classes with UGTAs was overwhelmingly positive. Approximately 1,600 students were enrolled in one or more courses that utilized a UGTA. One-hundred seventy-six students completed the online survey and results are shown in the following table.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	N/A
My UGTA was prepared for in-class activities.	40%	36%	11%	4%	3%	6%
My UGTA helped me to understand the course material.	37%	29%	17%	6%	3%	8%
My UGTA provided help outside of the classroom.	29%	21%	18%	6%	2%	24%
My UGTA provided resources to help me succeed.	30%	27%	19%	6%	4%	14%
My UGTA encouraged collaborative learning with my peers.	33%	26%	20%	6%	3%	11%

Responses to open-ended questions in the survey allude that high response rates for "Neither agree nor disagree" and "Not applicable" may be attributed to students choosing not to utilize the UGTA as a resource or confusion about the roles of the UGTA and graduate teaching assistant.

In response to the question, "What are the benefits of having a UGTA?" three main advantages emerged. First, students appreciated that UGTAs are more relatable to other students and less intimidating than the professor or graduate TA. Second, UGTAs were able to reach beyond the classroom to assist students with adjusting to college life and providing advice about their major. And finally, UGTAs served as another resource in the classroom, which led to an increased ability to address student questions and a more efficient use of class time. A sample of student responses are presented below.

> A UGTA is someone who is at times easier to talk to than a professor. They are less intimidating.
>
> The UGTA Is another resource that we can utilize in class. It is nice to get help with some of the topics from people our own age who have recently learned the material, so they can explain it in words we understand. Also having a UGTA encourages in-class activities which I think are very beneficial to learning the material.
>
> The main benefit was hearing opinions and information on future classes in our major.
>
> They helped me with everything that I needed. They also helped me adjust to the ways college is.

> The UGTA's are like "proxy professors," and I enjoyed the increased access and different perspectives from having the UGTA's in the class.
>
> I like having a peer who recently went through the class as a student and had tips on what they might have done differently if they were now taking the class with the knowledge they gained, course wise.
>
> The wait time between help is a lot shorter, so less time is wasted.
>
> In large classes the professor can't get to everyone that has questions. With a UGTA it's much easier to receive the help needed.

In addition to the benefits, some students also noted areas for improving the UGTA Program. Most suggestions for improvement focused on encouraging the UGTAs to hold accessible office hours, providing more training for the UGTAs on complex course material, and better integrating the role of the UGTA within the course. Several students also noted that they did not interact with the UGTA because they did not have difficulties with the course content.

Feedback from UGTAs

Feedback collected from the UGTAs through their final reflection papers provided valuable insight about the rewards and challenges faced in the position. While a variety of the benefits experienced by the UGTAs were expected, many students also profited in unanticipated areas. Most students cited the opportunity for skill building that will assist them in graduate studies and in industry careers. These skills included increased proficiency in team leadership, public speaking, one-on-one and small group communication. Several UGTAs also discussed a newfound understanding of the importance of listening and appreciation of the perspective of others. Not only did the UGTAs recognize this skill development, but so did industry recruiters. One UGTA noted, "This semester I had the opportunity to interview with leading technical and investment banking companies in the US, and they were very interested to learn more about my role as a UGTA."

UGTAs also cited their excitement to interact and build connections with other students, graduate teaching assistants, and faculty members in their major. For example, one student explained:

> I loved being an Undergraduate Teaching Assistant and am extremely glad that I applied for this position. I have already applied for next semester, and plan on applying every semester until I am unable to anymore. It was the most positive experience I have had at [University] so far. I have made friends through the program that are in the major and can relate to the courses I am taking, and have a [University] professor know me personally.

This meaningful contact with the engineering community appeared to consequently have a positively impact the UGTAs' success as engineering students. Feedback shows that the experience of serving as a UGTA reaffirmed some student's choice of major, helped to build the

UGTAs' identity as engineers, and helped to shape the UGTA's academic and career goals. Here are some excepts from student papers that exemplify these outcomes.

> The UGTA program has helped me to realize that I love my major, and that I can go out into industry and help patients to live a better life. It has also helped me to see the bigger picture for Biomedical Engineering, it's not just about a job but it's helping to better child, a mother, or grandfather's life with a medical device that I create.
>
> This year being my sophomore year, I had entered what I would refer to as my "sophomore slump", where I had felt a bit overwhelmed and unmotivated with my own education. I have to thank these freshmen for reminding me why I wanted to be a computer system engineering as well as inspiring and reigniting my dedication to school.
>
> This experience has helped me confirm that I want to go to graduate school for a M.S. degree and eventually continue to get a PhD.

In addition to the positive impact on both students and UGTAs, the introduction of the program has had an impact on faculty instruction. Over the past several semesters, faculty who traditionally only lectured to students and questioned how they might utilize an UGTA have discovered new active learning teaching strategies by incorporating the UGTAs. These faculty have seen their teaching evaluations improve as a result.

Future improvements

Given the feedback from students, UGTAs, and faculty, we have identified three areas of improvement for the future success of the program. First, more visibility is needed for the program. The question most often asked of UGTAs is, "What is a UGTA, and how did you get the position?" Therefore, we must enhance visibility both inside and outside of the classroom. It is imperative that all faculty members introduce their UGTAs and explain the functions of the position to students within the first week of class. This helps to eliminate any confusion about the role of undergraduate and graduate teaching assistants, gives credibility the UGTA among the students, and equalizes UGTA expectations by all parties. Similarly, we must expand our website and resources for more exposure within the school and university. Second, the UGTA Program must acquire locations for UGTA office hours and review sessions, as a few students expressed frustration with this in their final reflection papers. A physical place for UGTA office hours would express the Ira A. Fulton Schools of Engineering's support for the UGTAs' efforts, formalize the program, and provide another sources of visibility. Finally, the faculty members and UGTAs both expressed a need for the UGTAs to receive more training on public speaking skills. Many engineering students are more comfortable working on a complex math problem than presenting in front of a group. As this is an expertise necessary for success in the engineering workforce, we must better prepare students with presentation skills. By providing students with more training through the FSE 294 course and requiring practice through guest lectures or exam review sessions, UGTAs will be able to build the confidence and skills needed to deliver an engaging presentation.

Conclusion

Overall, the UGTA Program has had a positive impact for everyone involved. Students express that having a UGTA in their classroom provides a peer resource from whom they can seek assistance for course material, college life, or major-related questions. UGTAs gain valuable experience for their resume, further develop their leadership and communication skills in an academic environment, build lasting relationships with faculty members in their major, and find personal satisfaction in helping other students. Instructors appreciate the additional source of help that is needed to provide hands-on, active learning activities in the classroom. Through the UGTA Program, these benefits came to the Ira A. Fulton Schools of Engineering at ASU at a relatively low cost. Schools looking to replicate the program could do so for a similar expense, or even less, as stipends may not be needed to develop a qualified group of UGTAs. However, training is a key component to future success. Ensuring that UGTAs have an appropriate combination of technical knowledge, pedagogical understanding, and personal skills ensures to an effective and sustainable program.

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