Scaling Introductory Courses Using Undergraduate Teaching Assistants

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1. SUMMARY

Undergraduates are widely used in support of Computer Science (CS) departments' teaching missions as teaching assistants, section leaders, peer mentors, course assistants, and tutors. Those undergraduates engaged in peer teaching – hereafter referred to as undergraduate teaching assistants (UTAs) – have the opportunity to deeply engage with CS concepts and develop key communication and social competencies [1, 2]. Computer science programs are striving to become more inclusive and engaging of all students. As enrollments surge, UTAs play a larger role in student experience and outcomes [3]. While faculty and graduate student instructional support does not necessarily increase with the number of students in our courses, the number of qualified undergraduate teaching assistants for introductory CS courses should scale with the number of students in our courses [4]. With large courses, the significance of the UTAs' role in students' learning likely also increases. Students have relatively little interaction with the instructor, and faculty may have more challenges monitoring and supporting individual UTAs. UTAs have a major role in affecting climate in computer science courses. The climate in large courses has substantial implications for students from groups traditionally underrepresented in computing [5]. This panel will discuss how undergraduate teaching assistants can serve as a scalable effective teaching resource that benefits both the students and the UTAs themselves.

The panelists teach introductory computer science courses that have seen substantial growth in enrollment in the past 6 years. Each of the panelists' departments employ UTAs to work with 8-24 students. The panelists will describe how UTAs are initially trained and how weekly meetings serve as further training and community building. As the UTA programs have grown to meet the needs of the courses, faculty and UTA program coordinators have had to restructure programs by adding hierarchy (e.g., Associate and Senior Section Leaders at Stanford) or new processes (e.g.,back-grading at Washington). Each panelist will describe what the roles for their UTAs, how the UTAs are trained and evaluated, and how the programs have adapted to address large enrollments.

2. HEATHER PON-BARRY

The Megas and Gigas Educate (MaGE) program at Mount Holyoke College involves trained undergraduate students acting as *peer mentors* to beginner students in CS1 and CS2, providing close interaction and one-on-one feedback. The MaGE Training course (http://www.mtholyoke.edu/go/mage-training) focuses on diversity and inclusion as key tools for creating a welcoming and diverse learning environment, especially for students who may not automatically see themselves as computer scientists. The course provides research-based instruction on effective learning (motivation, strategic learning, self-efficacy, and growth mindset), enabling peer mentors to strengthen their education toolkits by self-assessing their own strengths, engaging in group discussions, and adjusting and stretching their personal perspectives[6]. After taking the course, peer mentors work with students in a 1:9 ratio and meet weekly for one hour as a cohort with a faculty member and lab instructor to keep up with course material and further develop as mentors. Initial findings, based on rating forms completed by CS1 students, show that students consistently rated the peer mentors as highly knowledgeable, approachable, and creative/flexible in their approaches

3. DAVID MALAN

Harvard's CS1 course (CS50) employs undergraduates as Teaching Fellows (TFs) who lead sections, grade work, hold office hours, and otherwise support the course. TFs also assist with course-wide events, including CS50 Puzzle Day, the CS50 Hackathon, and the CS50 Fair. As part of the application process (http://cs50.recruiterbox.com) to become a TF, undergraduates submit a 5-minute mock lecture video and optional GitHub profile in addition to resume, transcript, and short answer questions. If selected, TFs participate in a three-day training session before the school year as well as weekly meetings. Students in the course are are asked to assess various aspects of their TFs at the end of the semester.

Even as enrollment has grown in recent years, CS50 has aspired to maintain a TF:student ratio in the neighborhood of 1:12. In 2007, however, the course also introduced Course Assistant (CA) to the course's ranks, alumni of the course who volunteer 4 hours per

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week, primarily holding office hours and attending staff meetings, but still full-fledged members of the staff. A subset of these same TFs and CAs also occasionally serve as tutors for the course, working with struggling students more intimately in small groups. CS50 and the TF program are offered online and at another university, the experience of building a new TF program will be discussed in the panel.

4. STUART REGES

The University of Washington UTA program builds upon lessons learned from building successful programs at Stanford and the University of Arizona[7, 8]. In addition to regular UTAs, CS1 and CS2 appoint at least one and often several head UTAs who meet with the instructor weekly and take on extra duties to help the instructor. The two TAs who manage the overall program are called coordinators.

The CS1 and CS2 courses at the University of Washington are taught three days a week in large lecture halls that hold 300 to 700 students. We use paid UTAs to provide a small-group experience for students in weekly discussion sections. Each section has approximately 20 to 25 students. The undergraduate TAs attend lecture, work through assigned problems with their students in section, grade their students, and provide 2 hours a week as the on-duty "helper" in our intro lab.

We interview prospective UTAs and provide mandatory weekly training during their first quarter as a UTA. We also provide ongoing support through a UTA Wiki and online grading tools that streamline the grading process. In order to ensure grading consistency over the many UTAs, some UTAs back-grade other UTA's grading, checking to make sure that each UTA is properly following the grading rubric. We continue to see 5 to 10 applicants for each UTA position, and we attribute this mostly to our emphasis on community. More information can be found at http://tinyurl.com/uwcse14x.

5. MEHRAN SAHAMI

The Computer Science Department at Stanford University has a long tradition of using undergraduate teaching assistants (we call them "section leaders") to staff its introductory programming courses (both CS1 and CS2) [8, 9]. Section leaders have multiple responsibilities, including teaching a weekly section (usually to 8-12 students), grading programming assignments and exams, and holding weekly helper/office hours in the campus computer cluster.

We have witnessed tremendous growth in our introductory programming courses with enrollment in both our CS1 and CS2 courses nearly tripling in less than a decade. As a result, we currently have over 1000 students take our CS1 and CS2 classes in most quarters of the academic year, requiring between 80-100 section leaders per quarter as staff.

To address increased section leader attrition, we instigated several changes in our program. To reduce workload, we instituted the option for pair programming on several assignments in our CS1 and CS2 courses. Additionally, we changed the initial commitment for section leading to be two quarters (rather than one). This helps to break the cycle of section leader burnout and attrition, as more section leaders returning to the program each quarter means greater total staffing and a smaller number of students in each section as a result. Consequently, the grading burden for the section leaders is further lowered, which should contribute to less burnout.

Furthermore, we added a clearer advancement structure for section leaders. Specifically, students entering the section leading program would start as an "Associate Section Leader", while still having all their standard responsibilities. After two quarters in the program, they advance to be a "Section Leader" accompanied by a substantial pay increase. After an additional two quarters in the program, during which they need to section lead for both CS1 and CS2 as well as engage in an educationally-related project, they become a "Senior Section Leader", with an additional pay increase. We created this structure based on input from an alumni Advisory Board we formed to generate ideas to help address issues in the program as well as to give the program more visibility to department administration.

Finally, to address the issue of community, we created a position for "small group leaders", which would allow more senior section leaders to serve as mentors for a small group (typically, five) new section leaders. As a result, both the mentors and mentees feel more closely tied to the program. Initial indicators show that these changes are helping our program to better weather the stresses of huge enrollment growth.

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