Establishing an Effective Teaching Assistant Program for Computer Science Undergraduate Education

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Abstract—Academic support services (e.g., teaching assistantship services, enrichment activities) can be beneficial and at times crucial, for the success of low income, first generation, underrepresented, motivated students with gaps in their academic preparation. In this paper, we describe the establishment and growth of a teaching assistantship (TA) program in the Computer Science and Information Technology (CSIT) program at California State University Monterey Bay (CSUMB), a primarily undergraduate institution and evaluate its effectiveness. Developing a strong TA program in the CSIT program is challenging. Firstly, being an undergraduate only program, our teaching assistants have to be selected from undergraduate students. Compounding this issue is the fact that significant portion of our students are underprepared for the rigors of college education. Therefore, to create a successful TA program we recruit top-of-the-class junior and senior students (TA scholars). To ensure good quality of the TA program, we organize weekly workshops on effective tutoring and mentoring techniques for TA scholars. The TA program is currently in the third semester of its implementation. Data collected during the Fall 2014 semester suggests that nearly 60% of surveyed students availed TA services. Additionally, approximately 85% of students who availed TA services rate the TA program highly.

I. Introduction

Computer Science and Information Technology (CSIT) program at California State University Monterey Bay (CSUMB) is committed to providing high quality computing education and opportunities to low income, first generation, underrepresented students in the state of California [1]. Noticing that introductory computer science courses are becoming filter classes that are keeping out motivated students with gaps in their academic preparation from pursuing a computer science major, the CSIT program has invested significant effort in developing strong academic support services for students such as teaching assistantship services, mandatory study hours, professional development and internship/job preparation.

In this paper, we describe the establishment and growth of our TA program and evaluate its effectiveness. Prior research has demonstrated the benefits of undergraduate TA programs for introductory computer science courses [2], [3], [4]. While TA programs provide students additional academic support, it also helps teaching assistants improve their technical and communication skills. While there are multiple TA programs currently associated with large research institutions (e.g, Stanford University, University of Arizona) we explore the benefits of such programs for students at CSUMB, a teaching-focused Hispanic Serving Institution.

Developing a strong TA program in a primarily undergraduate institution has its share of challenges. Firstly, being an undergraduate only program, we do not have the luxury of selecting graduate students as teaching assistants; our teaching assistants have to be selected from undergraduate students. Compounding this issue is the fact that significant portion of our students are underprepared for the rigors of college education. Secondly, aligning teaching assistants' objectives that have traditionally been focused on reducing the instructors workload to a student centric model focused on improving academic outcomes requires significant effort for training. Lastly, the biggest challenge lies in creating a self sustaining TA program that requires minimal faculty or staff intervention for its operations.

The TA program at CSUMB (modeled after the section leader programs at the University of Arizona [2]) and Stanford [3], [4]) consists of specially trained tutors, providing necessary tutoring and mentoring support to CSIT students. Our TA program provides support for introductory programming and upper division computer science courses. To create a successful and sustainable TA program we recruit 'top-of-the-class' junior and senior students (TA scholars). Weekly workshops on effective tutoring and mentoring techniques are organized for TA scholars. TA scholars also share their experiences about the program (e.g., office hours, review sessions, workload) during this workshop. Program continuity is being ensured by having existing TA scholars share their experiences and provide guidance to new TA scholars.

The TA program is currently in the third semester of its implementation. To assess the success of our TA program we performed extensive data collection during the Fall 2014 semester. Our data suggests that nearly 60% of surveyed students availed TA services during the fall semester. We also observe that approximately 85% of students who availed TA services rate the TA program highly. Additionally, the program has been beneficial to TA scholars; many of them note that the program has helped improve their communication and presentation skills.

The rest of the paper is organized as follows. We provide a brief description of the ongoing projects and cohort programs in the CSIT program at CSUMB in Section II. We describe the growth and development of the TA program in the CSIT program in Section III and evaluate the effectiveness of the program in Section IV. We conclude the paper with a discussion of our current and future work in Section V.

II. Background

Since its inception in 2007, the CSIT program at CSUMB has been committed to providing high quality computing

education and opportunities to students identified in CSUMB's vision statement. Over the past seven years this commitment has resulted in significant efforts to develop learning communities to support student success through cohort-based programs.

In 2013, the CSIT program in partnership with Hartnell College launched a cohort-based, three-year bachelors degree program called CSIT-In-3 [5] as a way to improve learning outcomes and increase student retention. The first and second cohorts of CSIT-In-3 began in Fall 2013 and Fall 2014 respectively, each with 32 students. Cohort-based learning communities have been proven to be effective in both short term success and long-term retention [6]; learning communities also increase the success of underrepresented and first generation students in STEM majors [7].

Inspired by the initial success of the CSIT-In-3 program (e.g., high retention rate experienced so far), starting in Fall 2014, computer science faculty from CSUMB launched a cohort-based, 4-year bachelors degree program called CSIT++ [8]. The objective of the CSIT++ program is to create a rigorous, competitive curriculum and to provide additional student services so as to enable students to graduate with their CSIT degree in 4 years.

These cohort-based programs have provided CSIT faculty a launchpad for starting a number of initiatives such as TA programs, enrichment workshops, professional development and job preparation workshops. We have leveraged this opportunity to provide academic support services to all our students - the CSIT-In-3 students, CSIT++ students and our traditional non-cohort students. In this paper, we describe the development of our TA program and its positive impact on our students.

III. TA Program

As mentioned earlier, the CSIT program caters mainly to first generation, low income students. Many of these students are motivated, but fail to cope with the rigorous requirement of a computer science degree due to gaps in their academic preparation. Additionally, a large fraction of our students have to work part-time to support themselves financially, thereby leaving them with limited opportunity to attend instructor office hours. CSIT faculty thus realized that our students will greatly benefit from a strong TA program primarily aimed at providing tutoring and outside classroom assistance.

Establishing a strong and sustainable teaching assistantship program at CSUMB comes with its fair share of challenges. Firstly, the CSIT program being an undergraduate only degree program, our teaching assistants have to be selected from a pool of undergraduate students. Secondly, aligning the teaching assistants' objectives from decreasing instructor workload to a more student-oriented model requires considerable training. Compounding the difficulty of the task is the fact that currently the CSIT program has only four tenure track faculty and two academic support staff. We entrusted one of the academic support staff members with the role of being a TA coordinator. Table I provides an overview of the activities of the TA scholars. We note that TA scholars receive remuneration at the hourly student rate.

Recruiting TA scholars: The first batch of TA scholars was selected from the 'top-of-the-class' juniors and seniors.

Care was taken to ensure that TA scholars themselves had secured an 'A' grade in the courses they were selected as teaching assistants. TA scholars provide academic support in the form of tutoring and mentoring for all our students (CSIT-In-3, CSIT++ and traditional CSIT students). The interest in the TA program has increased over time and for the Spring 2015 semester, we had a large pool of applicants. The recruited TA scholars not only had good grades but were also screened via an interview process.

Training TA scholars: The primary task of the TA scholars is to hold office hours and to conduct review sessions and discussions. At the beginning of each semester, TA scholars receive training on effective tutoring and mentoring practices. The TA scholars meet weekly with the TA program coordinator and discuss their experiences over the past week. During the weekly workshop TA scholars are provided relevant material for the coming week; they are also given guidelines and tips related to improving overall student experience.

Program continuity: We plan to create a sustainable model for the TA program by having older TA scholars share their experiences and provide mentoring support to new TA scholars. Having older TA scholars guide new TA scholars will increase program scalability by utilizing older scholars as resources for training newer scholars. As the TA program is still at an early implementation phase, we are in the process of implementing the above mentioned program continuity model.

Tutoring in Study Hours: To improve student outcomes, CSIT faculty aim to reinforce good academic practices such as regular attendance, mandatory study hours and good note taking in our students. We note that certain activities such as attending study hours is mandatory for cohort students, but our traditional students are also give equal opportunity to participate. Apart from holding office hours, TA scholars provide additional assistance to students during study hours, thus helping them to be on top of their courses.

IV. Evaluation

To evaluate the benefit of the TA program for our students as well as the TA scholars, we conducted extensive data collection during the Fall 2014 semester. We collected data by having students fill out a questionnaire; the survey consisted mainly of quantitative questions, where the respondents had to select from a few options. We also included some qualitative questions to seek the students' and TA scholars' opinion on the effectiveness of the TA program and to explore avenues for future improvement.

Our main objective behind this evaluation is to answer the following two questions - *i)* Do CSIT students perceive the TA program as being an useful academic support service? *ii)* Do TA scholars perceive the TA program as having helped them improve their teaching and communication skills? Our analysis in the section answers both these questions in the affirmative.

A. Benefit to CSIT students

We made the survey available to all our students and obtained responses from 101 students. Among the 101 respondents there are 32 CSIT-In-3 cohort students, 33 CSIT++ students and 36 traditional CSIT students. We observe from

1. Specially trained tutors (TA scholars) comprising of 'top-of-the-class' juniors and seniors
2. Provide tutoring and mentoring for computer science courses; hold office hours; provide assistance during study hours
3. Engage and discuss class material during review sessions
4. Program continuity ensured by having existing TA scholars train new TA scholars

TABLE I.   OVERVIEW OF THE TA PROGRAM

Number of Visits	Percentage of Respondents
0	42
Greater than 0 & Less than 5	26
Greater than 5 & Less than 15	12
Greater than 15	20

TABLE II.   DISTRIBUTION OF OFFICE HOUR ATTENDANCE

Types of Assistance availed	Percentage of Respondents
Help on a specific assignment	35.7
Understanding a specific topic	17.5
Review for an exam or quiz	25.3
Clarification on missed test or quiz question	10.4
Clarification on missed homework question	11.0

TABLE III.   TYPES OF ASSISTANCE AVAILED

Course Names	Number of Respondents
CS1: Problem Solving and Programming	3
CS2: Intro to Data Structures	8
Physics of Computing	38
Intro to Computer Networks	3
Multimedia and Game Design I	2
Operating Systems	3
Internet Programming	9
Computer Architecture	8
Software Design	9

TABLE IV.   COURSES SOUGHT HELP FOR BY STUDENTS

Usefulness of TA office hours	Percentage of Students
Very Helpful	50.8
Helpful	33.9
Moderately Helpful	5.0
Little Helpful	8.5
Not Helpful	1.7

TABLE V.   RATING OF TA SERVICES

the data that we obtained larger number of responses from the cohort students than the traditional CSIT students. This skewed distribution can be attributed to the fact that filling the questionnaire is voluntary; cohort students were allocated time during their weekly enrichment workshops to fill in the questionnaire. We are aware of the biases introduced by data collection via voluntary filling of surveys, but we believe that our initial data collection provides us valuable insight about the impact of our TA program.

Table II shows the distribution of the number of times a student availed teaching assistantship services. It is evident from the table that nearly 60% students availed TA services, with some students attending office hours almost regularly. Table III provides an overview of the types of assistance sought during the TA office hours. We observe form the data that while some students used the TA scholars office hours to clarify points of confusion, a majority of them used the office hours as tutoring services and to seek assistance on specific projects and assignments.

We offered TA services for most lower and upper division computer science courses in the department. Table IV shows the number of respondents who sought help for the various courses. One can observe that a large number of students availed TA services for the Physics of Computing course; the primary reason is that the course is mainly project based and all CSIT++ cohort students were enrolled in that course. We also observe from the data that TA services for most other courses were availed equally. We would like to note that though we observed a large number of students availing TA services for CS1 and CS2, the lower number of responses is due to the fact that all students enrolled in these courses were traditional CSIT students.

Table V shows the overall satisfaction of the students with the teaching assistantship services. From the table, we observe

that most students (approximately 85%) found the TA office hours helpful. Table VI provides examples of some qualitative questions and sample responses. Evaluating the responses to both qualitative and quantitative questions, we observe that students found the TA office hours helpful. We also observe that the TA program has helped build a sense of learning community for CSIT students; it has provided a platform for students to get together, exchange ideas and to help each other.

B. Benefit to TA scholars

In this section, our goal is to understand the benefits of the TA program for the TA scholars. Table VII provides an overview of some of the questions and sample responses. Most TA scholars identified the TA program as helping them improve their communication skills. The TA scholars also appreciated the opportunity to be able to work with other students and to help them solve their problems. We also believe that being a TA scholar helps students revise prior material and retain information.

Through our TA program we hope to create role models for our freshman and sophomores. We believe that we have partially succeeded in the endeavor by providing an avenue for freshman and sophomores to interact with 'top-of-the-class' juniors and seniors. We have already noticed an increasing popularity of the TA program. In Spring 2015, we obtained applications from a large number of students for becoming TA scholars and selected the TA scholars after personal interviews.

V.   DISCUSSION AND CONCLUSION

Encouraged by the initial success of the program, CSIT faculty have been incrementally increasing the responsibilities

Question: What type(s) of help do you seek most often in the TA office hours?
Response: Clarification on topics discussed in class.
Response: Help with assignments, test preparation, and understanding missed questions from tests and assignments.
Question: What difference has attending TA office hours made for you academically and/or personally?
Response: Academically, it has helped me improved my grades and understand the topics covered in the course much better.
Response: I believe that the TA office hours helped me improve my academic performance on quizzes and exams.

TABLE VI.   QUALITATIVE QUESTIONS AND SAMPLES RESPONSES FROM STUDENTS

Question: Please reflect back on the training that you find most useful for you now, as new TAs?
Response: The most effective training I had was to positively encourage students at all times. Students usually show much more willingness to do the project rather than just give up; if you work with them, they go all the way through.
Response: I believe we were all picked because we have very good communication skills, but during the first training session some ground rules were explicitly stated on how to communicate and how not to put someone down, even unknowingly.
Question: What are you getting out of this professionally?
Response: It has helped me strengthen my fundamentals. It has also increased my soft skills, because I have to be able to communicate with students and professors regarding what I know or what I am thinking of in a way that they can understand.
Response: I feel like there is a lot of leadership that you have to take out of it. You cannot explicitly solve problems for students, but you have to be able to lead them to the solution. You have to show that you care for the students and I feel like that translates to leadership skills.

TABLE VII.   QUALITATIVE QUESTIONS AND SAMPLE RESPONSES FROM TA SCHOLARS

of the TA scholars who work with CS1 and CS2. The goals of TA support in these courses are to provide a learning experience that increases quality while also building community. In the first two semesters of the TA program, these TA scholars' responsibilities consisted of simply attending class and lab to assist the students, as well as holding office hours (Spring 2014, Fall 2014). In the next semester, TA scholars increased their responsibilities by also holding weekly optional review sessions (Spring 2015). In the following semester, TA scholars will lead lab time themselves, so that students can enjoy a lab session that is much smaller and more personalized (Fall 2015). This stage will closely mirror the "Section Leader" model employed at other universities.

With increased responsibility comes increased training. When TA scholars began holding weekly review sessions, their weekly training workshop included a review of a packet of problems based on the material covered in lectures the previous week. TA scholars are also provided training related to presenting these materials during the review session. When students will lead lab time, training will consist of reviewing the topics and activities to be covered in lab.

In this paper, we described the establishment and growth of a TA program in the CSIT program at CSUMB. We first highlighted the challenges involved in developing a strong TA program. Being an undergraduate only program, we had to hand pick our teaching assistants from 'top-of-the-class' junior and senior students. Furthermore, as majority of our students are low income, first generation, underrepresented students, many of them are underprepared for the rigors of college education. Additionally, considerable effort was needed to align teaching assistants' objectives traditionally focused on reducing instructor workload to a student centric model focused on improving academic outcomes. To ensure good quality of the TA program, we organized weekly workshops on effective tutoring and mentoring techniques for TA scholars.

Data collected during the Fall 2014 semester showed that nearly 60% of surveyed students availed TA services. We also observed that approximately 85% of students who availed TA

services rate the TA program highly. The program has been beneficial to TA scholars as well; many of them noted that the program has helped improve their communication and presentation skills.

VI.   ACKNOWLEDGMENT

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