Managing an NSF-Funded Information Technology Scholarship Program

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Abstract

Our nation's competitive edge is highly dependent on the success of STEM education and the ability of information technology (IT) graduates to find jobs. The School of Information Technology at Illinois State University (ISU) is strategically positioned to offer S-STEM scholarships to talented, financially disadvantaged students in the IT discipline. This article shares our experience and strategies from managing the ISU CS/IS Scholarship Program, a National Science Foundation (NSF) S-STEM scholarship grant. Leveraging our unique educational setting and multiple student support activities, we were able to provide financial support as well as implement several strategies needed to educate and retain qualified undergraduate IT students.

Keywords: Information Technology, Scholarship, STEM, Education, Recruitment, Retention

1. INTRODUCTION

In the late 2000s, we witnessed a steady decline in information technology (IT) enrollment among incoming freshmen. In 2009, the National Secondary Computer Science Survey by the Computer Science Teachers Association (CSTA) indicated that there was an 8% drop from 2005 to 2007 and a 13% drop from 2005 to 2009 in the percentage of high schools that offer AP computer science (CS) classes (Nagel, 2009). Although many factors contributed to decreases in course offerings and enrollment decline (i.e., outdated curricula, other competing STEM majors, changing technologies and marketable skills, as well as lacking interest in the IT major; Kershenbaum, Hadimioglu, Ivanov, Schiaffino, & Hoffman, 2006), researchers were concerned that declining enrollment and the lack of public interest in computer science and information systems majors would have a significant impact on U.S. competitiveness and socioeconomic health (Klawe & Shneiderman, 2005).

Fortunately, in recent years, IT enrollment has been increasing. According to the CRA Taulbee Survey in 2007–2008 (Zweben, 2009), the United States experienced a 6.2% increase in the number of freshmen enrolled in computer science programs. The survey also showed an increased

number of CS graduates and near 100% employment for new PhDs in CS. Although these numbers were encouraging, recruiting talented IT students, especially from underrepresented populations (i.e., female, minority, and low-income students), has been an ongoing challenge. Educational opportunities may not be available to minority students living in low-income areas. Moreover students with disabilities and minorities were the least likely to receive a college-level education or to choose IT as an undergraduate major. Moreover, the retention of students majoring in STEM areas was another important concern for educators. A report from U.S. Department of Education (Chen, 2013) showed a high attrition rate for students in STEM majors from the years 2003–2009, which was 48% by 2009. The attrition rate for students in computer/information sciences bachelor's degree programs was the highest among STEM programs, with 59% of students leaving the degree programs by 2009: 31% did not graduate, and the other 28% switched to non-STEM majors.

Under the Division of Undergraduate Education, the National Science Foundation (NSF) Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) program intends to address the need for a high-quality STEM workforce in the United States and motivates "low-income academically talented students with demonstrated financial need" (National Science Foundation, 2017, Synopsis section, para. 1) to pursue academic degrees in STEM disciplines. Responding to NSF S-STEM solicitation in fall 2009, we proposed the ISU CS/IS Scholarship Program (2010–2015) pursuing the following objectives: (a) to provide S-STEM scholarships to academically talented, financially disadvantaged students majoring in either Computer Science and Information Systems (CS/IS) or Mathematics with a CS/IS minor; (b) to enhance the educational experience and increase retention among the S-STEM scholars; and (c) to assist the S-STEM scholars in finding employment opportunities.

Our proposed project received the necessary funding from NSF during the period from March 2010 to 2015, and a 1-year no cost extension was granted until March 2016. The objectives of this article are: (a) to communicate to STEM educators the characteristics of our proposed project; (b) to evaluate the effectiveness of our recruitment, retention, and job placement strategies; and (c) to share our experience from managing an S-STEM scholarship program. The next section summarizes the unique characteristics of ISU CS/IS Scholarship Program.

2. CHARACTERISTICS OF THE ISU CS/IS SCHOLARSHIP PROGRAM

The focus of our proposed scholarship program was to encourage academically talented students with financial need, especially underrepresented students (i.e., female, financially disadvantaged, minority, or physically challenged students), to pursue a specialization in IT majors and to help reduce the financial burden of their college education by providing financial support through S-STEM scholarships. It was our goal that those who successfully graduated from our program would become an essential part of the IT workforce or pursue other graduate or professional degrees, fulfilling the national need for IT professionals.

We put our efforts into three categories: recruitment, retention, and job placement. Figure A1 (found in the Appendix) illustrates and summarizes the logistical phases of our recruitment, education/retention, and job placement activities during the funding period. These three activities helped measure the success of the ISU CS/IS Scholarship Program.

- *Recruitment*: Award at least 30% of S-STEM scholarships to underrepresented (i.e., female, minority, or physically challenged) students.
- *Education/Retention*: Retain at least 60% of the scholarship recipients within the IT majors.
- *Job Placement*: Place 85% of graduates in an IT career path or continuing graduate education.

Through the process of recruitment, retention, and placement, we originally proposed to offer a total of around 35 S-STEM scholarships to five cohorts of qualified students over the academic years 2011–2012 (fall 2010) through 2015–2016 (fall 2014). We awarded both *full scholarships* to qualified IT students for up to 4 academic years of full-time enrollment and *transfer scholarships* to qualified IT students for less than 4 academic years of full-time enrollment because nearly half of the IT students were transfer students from the local community colleges. We originally planned to provide approximately 18 full scholarships (4 academic years) and 12–36 transfer scholarships (less than four academic years to qualified current/transfer students). Using the average debt of $18,200 for our undergraduates (in fall 2009, after financial aid), each scholarship recipient—whom we refer to as an NSF scholar—would receive up to $5,000 per academic year and would continue to receive the same installment for up to 4 academic years of full-time

enrollment as an IT major (or as a math major with an IT minor) while maintaining good academic standing (GPA > 3.0). Stipulated by NSF, the total amount of award payout to each NSF scholar is also determined by each individual's financial need, as determined by the cost of attendance (COA) minus the estimated family contribution (EFC). We anticipated that our targeted recruitment and retention strategies could reduce the number of student dropouts and would assist NSF scholars with educational expenses up to $20,000 over the 4-year period.

The next section describes the strategies of the ISU CS/IS Scholarship Program and the factors contributing to the success of our program.

3. RECRUITMENT, RETENTION, AND PLACEMENT EFFORTS AND OUTCOMES

Recruitment
We collaborated with the ISU Office of Admissions; the Center for Mathematics, Science, and Technology (CeMaST); the Chicago Public Schools system; and several local community colleges. They provided leads to our targeted populations. Throughout the funding period, open houses on the university's campus also provided an effective venue for us to meet with prospective students. Our recruitment strategy was also meant to change the perception of the IT profession as a weak job market (Lomerson & Pollacia, 2006; Panko, 2008); to educate students, parents, and counselors about IT career prospects (Carter, 2006; Panko, 2008; Zhang, 2007); and to encourage schools to increase students' exposure to computer science or information systems courses (Baker & Finn, 2008). Whenever there was opportunity, we also tried to address gender biases in IT, challenge stereotypes of IT professionals (Carter, 2006; Cory, Parzinger, & Reeves, 2006), and clarify misconceptions about the difficulty of IT programs (Carter, 2006; Zhang, 2007).

Retention
In a study of a scholarship program in Georgia, the researchers found that students majoring in science, engineering, and computing were "21 to 51% more likely to lose their . . . Scholarships than students in other disciplines" (Dee & Jackson, 1999, p. 381) as students from these technical disciplines had "fewer opportunities to earn high grades" (p. 381). To address the problem of attrition, we leveraged our existing support structures and instituted newer ones for our NSF scholars. Existing resources included debugging assistance (help with fixing an erroneous computer program), a department scholarship award reception, an IT student club, and several student-related academic services established by the university. The following student support activities were instituted for the ISU CS/IS Scholarship Program: faculty mentoring, peer mentoring, undergraduate research seminars, industry field trips, and face-to-face and online social networking, which included a list of current job openings from various online sources.

Job Placement
Through the online social networking website, NSF scholars received updates on internships and employment opportunities. Two industry advisory boards established by the School of IT provided up-to-date lists of marketable skills and job opportunities, which we conveyed back to our scholars. We also searched the Internet job sites and posted available positions on our online social networking website.

Table A1 (found in the Appendix) shows the list of previously existing and new student support activities corresponding to our recruitment, retention, and placement efforts.

Outcomes
The ISU CS/IS Scholarship Program had awarded 54 S-STEM scholarships to qualified students. As of this writing, 34 scholarship recipients had graduated from our program (63%), 17 had left the program (31%), and three remained active in the program (6%). Table 1 shows the status and percentages of our scholarship recipients.

Status	Count	%
Active	3	5.56%
Graduated	34	62.96%
Left Program	17	31.48%
Total Scholarship Recipients	54	100%

Table 1. Status and Percentages

Based on our measurable outcomes for success, we originally proposed to award at least 30% of S-STEM scholarships to underrepresented or disadvantaged students. Our recruitment efforts attracted 19 qualified underrepresented students (35.2%) into the scholarship program. Among the underrepresented students, there were 11 female, five minority, and six physically challenged students; there were three physically challenged students who were either female or belonged to a minority group. Importantly, 13 out of 19 underrepresented NSF scholars graduated from our program (68%). Unfortunately, we fell

just short of fulfilling our job placement outcome: Only 28 out of 34 graduates (82%) pursued an IT profession (job placement for three graduated students was unavailable). Table 2 shows the results of our proposed efforts in recruitment, retention, and placement.

Strategies	Measurable Outcomes	Results
Recruitment	30% of S-STEM scholarships awarded to qualified underrepresented students	35% of S-STEM scholarships awarded
Retention	60% of S-STEM scholars graduated within their designated majors	63% of NSF scholars graduated
Placement	85% of graduates pursued an IT profession	82% of NSF scholars worked in field

Table 2. Recruitment, Retention, and Placement Efforts and Outcomes

4. EXPERIENCE FROM MANAGING THE SCHOLARSHIP PROGRAM

Recruitment

We leveraged our connection with CeMaST, the ISU Office of Admissions and the Financial Aid Office, the Chicago Public Schools system, and some local community colleges. We also targeted our efforts to the groups of potentially interested underrepresented students (i.e., female, minority, and physically challenged students) nominated by their high school advisors. In several cases, we personally met with potential students at their high schools in small discussion or workshop groups. During these meetings, we introduced them to the field of computer science and information systems, the future of IT occupational demands, and the nature of the IT profession and informed them about scholarship opportunities. The ISU Office of Admissions also helped distribute brochures and promotional materials to high school guidance counselors and computer science and mathematics teachers throughout Illinois.

Although the required average ACT score of 27 for the scholarship was the main barrier for many qualified underrepresented students, combining other practical experience (i.e., IT certification, computer aptitude test, or a brief personal statement) and high school class rank comparable with the top 20% of all enrolled students in our CS/IS majors with ACT score was beneficial to our recruitment efforts when a student's GPA was less than 27. To be eligible for an S-STEM scholarship each semester, students were required to be a full-time student, demonstrate financial need (as determined by FAFSA), and maintain at least a 3.0 GPA overall.

We originally proposed to award approximately 18 full scholarships and 12–36 transfer scholarships (see Section 2). Based on each individual's financial need, we awarded 30 full scholarships and 24 transfer scholarships to qualified students.

Retention

NSF scholars were required to maintain at least an overall 3.0 grade point average every semester or risk losing the scholarship. Therefore, retaining NSF scholars presented a new challenge. Many top 20% students from underrepresented high schools experienced "academic culture shock"—their academic performance was considered "average" when compared to other high achievers—and this effect was even more difficult for the physically challenged NSF scholars. General education courses and the required mathematics courses that are taken during freshmen and sophomore year added to the difficulty of retaining NSF scholars. For these courses, the first 2 years of undergraduate courses prove to be the major hurdle for STEM majors. Several of underrepresented scholars failed to receive the full 4-year scholarship because their academic performance disqualified them as NSF scholars, forcing them to quit the program within the first 2 years. Some of them switched to non-IT or non-STEM majors altogether.

For the IT majors, computer programming was another barrier that NSF scholars had to overcome. In order to retain STEM majors, Varma (2006) suggests that we must make technologies accessible to minorities, understand their specific needs and background, and allow open communication among their peers. Therefore, to motivate our NSF scholars with a sense of belonging in the cohorts, our award acceptance letter stipulated that NSF scholars must accept the statement of responsibilities, as shown in Figure 1, and participate in student support activities.

With additional monetary support from our college, we had a graduate administrative assistant working with us to keep track of student required responsibilities and participation. Most successful NSF scholars accepted their responsibilities and consistently participated in the prescribed student support activities.

However, only a few students expressed interest in the undergraduate research seminar, and none actually participated in it.

Statement of Responsibilities

1) Maintain full-time status toward the completion of a bachelor's degree in Information Technology
2) Maintain a 3.0 GPA in the major and overall
3) Meet with your faculty mentor at least twice (or as needed) each semester
4) Become a member of the IT Student Club/AITP and participate in scholarship community to share experiences, opinions, and knowledge about your education and the scholarship program
5) Participate in 3 out of 5 following professional/ academic activities during the year:
   - AITP Illinois State University - Student Chapter
   - CS/IS Scholarship Social Gathering
   - Industry On-Site Visit
   - ISU/IT Undergraduate Research Seminar
   - Mentoring other CS/IS Scholarship Recipients
6) Respect and abide by the University's non-negotiable student values of character, conscience, civility, citizenship, appreciation of diversity, and individual/social responsibilities.

Figure 1. Statement of Responsibilities

The following subsection describes the lessons learned from these retention strategies.

Faculty Mentoring. Each semester, the scholarship program had four faculty members serving as mentors to NSF scholars. Each faculty mentor represented one of the four disciplines related to the ISU CS/IS Scholarship Program (i.e., computer science, information systems, telecommunications management, or mathematics). Two of the PIs of the scholarship program served as faculty mentors, and the other two faculty members were volunteers from the department. Volunteer faculty mentors received a small summer stipend. The faculty mentors monitored a group of NSF scholars' academic and personal progress and provided personal career guidance and academic support as needed. They also reported to the project team if an NSF scholar's progress did not align with the objectives of the scholarship program. Faculty mentors were requested to advise these NSF scholars based on their technical interests and personality. They also encouraged the scholars to serve in key administrative positions in the IT student club (e.g., president, vice president, or treasurer).

IT Student Club. Throughout the funding period, our NSF scholars led the IT student club, building strong AITP/ACM student chapters. The scholarship program paid for the NSF scholars' membership fees and paid for students to attend professional or student conferences. Those NSF scholars who did not serve in an administrative role were instrumental in organizing club activities. Some of them became advocates for the club as well as the School of Information Technology.

Peer Mentoring. Successful NSF scholars who had been receiving continuous scholarship renewals were asked to voluntarily serve as peer mentors to several first-year NSF scholars. In addition to building good academic standing for newcomers, the purposes of peer mentor–mentee relationships were to establish close connection among cohorts, foster active participation in student support activities, and build leadership and academic confidence. Although a small monetary compensation was given to successful peer mentors—as determined by satisfactory academic performance and progress of their mentees—some peer mentors felt that the compensation was not necessary for their willingness to assist other scholars.

Industry On-Site Visits. At least once or twice per year, the scholarship program hosted on-site visits to different local IT companies. These industry field trips allowed NSF scholars to become more familiar with a variety of IT jobs so that they could better plan their future careers. These trips also gave them the opportunity to observe various IT operations, facilities, and data centers of major employers operating in central Illinois. Senior NSF scholars were encouraged to submit their resumes to these employers, and several of them received internship offers. Overall, the NSF scholars enjoyed and actively participated in the industry field trips.

Online Social Networking. Our private online social networking website received very little traffic although it provided valuable information, including up-to-date career information, new internships and job opportunities, newsletters, and scholarship program announcements (i.e., news about our scholarship program, peer mentoring, upcoming industry field trips and signups, the undergraduate symposium, and other professional development conferences and seminars). NSF scholars were encouraged to share or blog their experiences, opinions, thoughts, and feelings about their educational and scholarship experiences via the website. If the goal was to establish rapport among student

cohorts, our website failed to establish close social bonds beyond any initial face-to-face meetings. Midway through our funding, we contemplated opening our private website to the IT student body as a whole by linking it to the other popular social networking websites (i.e., Facebook and Twitter). However, this change was not implemented due to privacy concerns and the resources required to monitor its content.

Undergraduate Research Symposia. Persuading NSF scholars to engage in undergraduate research was extremely difficult. None of our scholarship recipients were involved in the undergraduate research symposium. Faculty mentors tried to encourage the students to do undergraduate research, but most scholars were more interested in maintaining their scholarship statuses and academic performance or obtaining an IT internship position. Perhaps this retention strategy would be more effective for research-based universities or pure science disciplines.

Summary of Retention. Despite all of our efforts described above, 17 students (31%) left the program. Table 3 compares the difference between attrition in the two groups of NSF scholars: the majority group (White males) and the underrepresented minority group (physically challenged, female, or minority). It should be noted that the percent who left the program was nearly the same for both groups—11 out of 35 (31.43%) of the majority students and 6 out of 19 (31.58%) of the minority students—even though they left for different reasons.

Reasons for Leaving the Scholarship Program	Majority *n* = 11 (%)	Minority *n* = 6 (%)
No longer financially eligible	1 (9.09%)	1 (16.67%)
No longer a full-time student	2 (18.18%)	0 (0.00%)
No participation	1 (9.09%)	0 (0.00%)
Poor academic performance	0 (0.00%)	3 (50.00%)
Switched to a non-STEM major	5 (45.46%)	1 (16.67%)
Transferred to other institutions	1 (9.09%)	1 (16.66%)
Unknown	1 (9.09%)	0 (0.00%)

Table 3. Reasons for Attrition

Although there was greater attrition in the majority group, most students in this group left the scholarship program because they wanted to switch to non-STEM majors not because of poor academic performance. However, for underrepresented students, poor academic performance was the main reason for leaving the scholarship program—a GPA below 3.0 for two successive semesters would disqualified them from receiving a scholarship award, which was renewed on a semester basis. As a consequence of not receiving continuous financial support, they left the program or became part-time students.

Placement

Bloomington–Normal, Illinois has some of the largest IT employers. It is also home to the world headquarters for insurance companies and financial services. Bloomington–Normal is also home to a major automobile manufacturing plant and regional operations for major consulting and IT firms. These companies employ the majority of our IT graduates and are represented on the school's Business Industry Advisory Committee (see Table A1 in the Appendix), which helped direct the faculty in regard to curriculum changes, marketable skills, and technological trends. Faculty mentors also provided guidance and consultation to the scholars about their IT career paths. These factors enhanced our ability to find jobs for our scholars.

To keep track of our graduated NSF scholars, we contacted them directly or used LinkedIn—a popular professional networking website. Unfortunately, we did not utilize our private online social networking website for this purpose because it was not widely used during the program and lacked functionality. Table 4 reveals the current job positions of our graduate NSF scholars. As of this writing, two of three active, remaining NSF scholars had secured IT internship positions and were likely to enter the IT job market after graduation.

In summary, the ISU CS/IS Scholarship Program recruited academically talented, financially disadvantaged students from the Chicago Public Schools system and other urban areas served by Illinois State University. The project team had experience with similar recruitment efforts, and the School of Information Technology had the capacity to retain, graduate, and help place the scholars in the IT workforce. We successfully delivered S-STEM scholarships through our existing community–academic–industrial ties.

Majors of Graduated NSF Scholars	Job Types/Positions (count)
Computer Science* (*n* = 10)	Attending Graduate School (1), IT Services (1), IT Support Supervisor (1), Programmer Analyst (1) Software Developer (2), Systems Analyst (1), Unknown (3)
Information Systems* (*n* = 19)	Application/Software Developer (2), Application Performance Engineer (1), Business Analyst (1), Cyber Security Analyst (1), Development Operations (1), Information Security Specialist (1), Internet Analyst (1), IT Analyst (2), Network Engineer (1), Programmer Analyst (1), QA Engineer (1), Software Engineer (1), System Administrator (1), Systems Analyst (1), Unknown (2), Web Development (1)
Telecommunication Management (*n* = 4)	Application Developer (1), IT Support Specialist (1) Network Analyst (1), Switch Test Engineer (1)
Mathematics with CS minor (*n* = 1)	Liability Claim Specialist/Risk Management (1)
Total (*n* = 34)	* = ABET-Accredited Program

Table 4. Job Positions/Types held by Graduated NSF Scholars

5. CONCLUSION

To attract underrepresented students majoring in IT, our scholarship program consisted of three streamlined activities (i.e., recruitment, retention, and placement) that reflected the goal of the NSF-funded S-STEM scholarship program—to offer S-STEM scholarships to talented, financially disadvantaged students majoring in the IT discipline. The funded scholarship program recruited, educated, and retained multiple cohorts of qualified students through financial assistance and several student support activities. Retention success relied on substantial collaboration from various internal and external constituents, allowing the scholarship program to establish an active learning community with the assistance of faculty mentors, peer mentoring, and industry field trips. Other supportive strategies included community building through the IT student club, professional and social gatherings, and mandatory student–faculty interactions beyond typical educational settings. Educators can learn from our experience and incorporate any of the recruitment, education, and retention activities into their education strategies or scholarship programs. Researchers from various STEM disciplines can empirically explore the relationships between these activities and student retention.

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Appendix

Recruitment-Retention-Placement Supportive Strategies

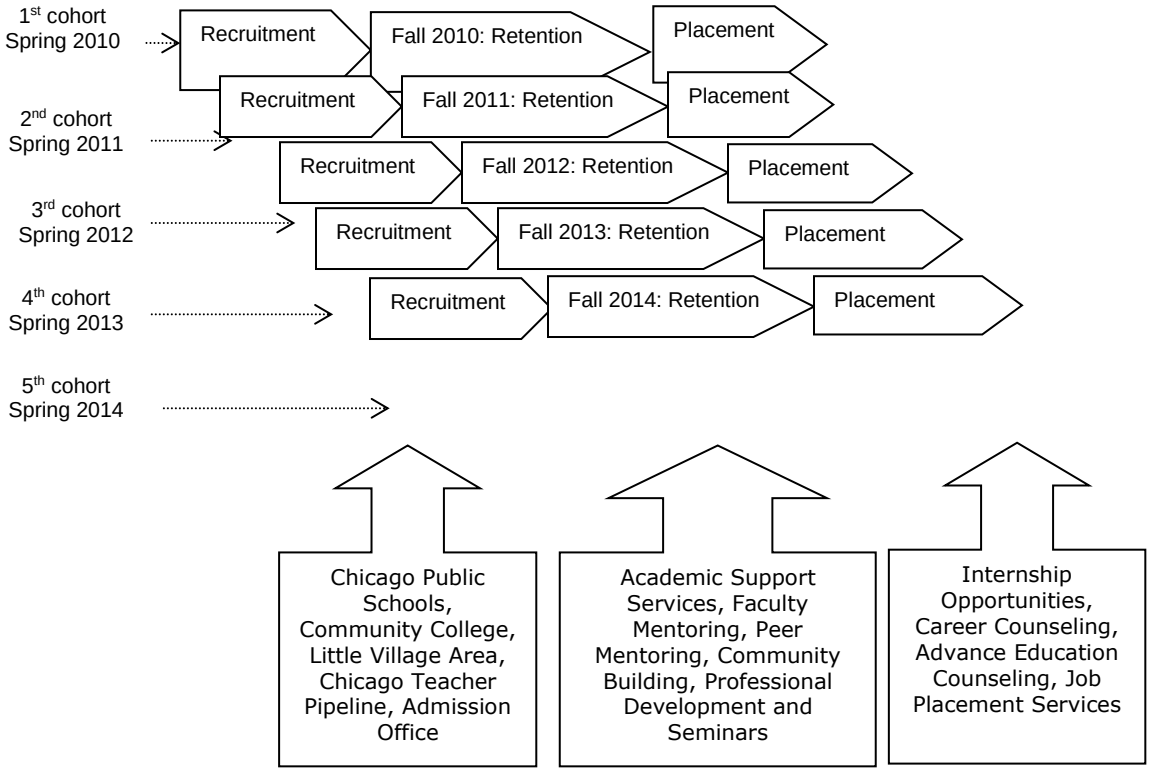

Figure A1. Recruitment-Retention-Placement Supportive Strategies

Summary of the Student Support Activities

S-STEM Support Services and Programs	School of Information Technology (IT)	Illinois State University (ISU)
Recruitment	As described in Section II	
Retention/Education		
Academic Support Services	Debugging Assistance	Disability Concerns, Student Affair Division Julia Visor Academic Center The University College The Minority Student Academic Center (MSAC) University Center for Learning Assistance (UCLA)
Academic Support Mentoring	IT Faculty Mentoring* Personality-IT Major Fit (part of IT Faculty Mentoring)* CS/IS as Minor Concentration* Peer Mentoring* Debugging Assistance	
Community Building	Scholarship Orientation* IT Academic Lifestyle Floor Spring IT Award Reception NSF Scholars Social Gathering* Online Networking Webpage/Weblog* Funded IT Student Club Membership*	Meeting During Preview/Open House Start of Semester & End of Semester Socials
Professional Development and Seminars	Industry On-site Visits* AITP/ACM Professional Conferences*	Undergraduate Research Symposia
Placement		
Internship Opportunities	IT Internships Business Industry Advisory Committee	N/A
Career Counseling	Faculty Mentoring* (See Education/Retention)	Student Counseling Services
Advanced Education Counseling	Continuing Education Counseling	
Job Placement	IT Job Opportunities and Internships via Online Networking webpage*	Office of Alumni and Student Placement Services ISU's Employment Job Fair

* = additional/enhanced services provided as part of the S-STEM Scholarships

Table A1. Summary of the Student Support Activities