WiCSE: Impact of a Women's Support Group on Increasing the Percentage of Women Students in a Department of Computer Science and Engineering

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Abstract

This paper is an experience report describing the creation and expansion of a CSE women's student support group. In 2013 we started WiCSE (Women in Computer Science and Engineering) in order to improve recruitment and retention of women in computer science, computer engineering, and information technology. This support group has provided significant support and benefits (including career guidance, career opportunities, and social outings) to women CSE students.

The key contributions of this paper are the description of the mentoring programs, student-led outreach programs for K-12 students, and recruitment of officers. Specifically, we share our experience of growing from a small informal group of women students to an official student organization of about 300 members; forming long term relationship with industry partners through an industry mentoring program and technology-focused workshops; lessons learned in the K-12 outreach program; organizing trips to the Grace Hopper Celebration and ACM Richard Tapia Celebration of Diversity in Computing conferences.

Our Department has seen significant growth in the percentage of degrees awarded to women students. In 2012-2013 academic year, the percentage of degrees awarded by the department for women students was 9.79%. In 2017-2018 academic year, the percentage of degrees awarded by the department for women students was 14.86%. The percentage of degrees awarded for women students has increased 52% in the past 6 years. These numbers indicate the success of efforts of WiCSE on increasing the percentage of women students.

Introduction

Diversity in computer science and engineering is a vitally important issue. The U.S. Bureau of Labor Statistics predicts a faster growth than average for employment of computer and information technology occupations from 2016 to 2026 [8]. However, women continue to be underrepresented in computing fields. Closing the gender gap in computing is socially and culturally related, meaning that solutions in places other than just classrooms are needed [13]. In this paper, we describe how a women's support group in a computer science and engineering department can provide support for women in personal growth, social encouragement, and academic exposure.

Studies found that the top four influencing factors for whether or not young women decide to pursue a Computer Science degree are: social encouragement, self-perception, academic exposure, and career perception [1]. Social encouragement can come from parents, friends, faculty/staff, or peer. It is a major factor in girls' decision to explore and pursue career in STEM and computing. A support group provides an excellent vehicle for these factors by offering workshops, social events, outreach activities, and mentoring.

In 2013, we started a support group WiCSE (Women in Computer Science and Engineering). This paper describes the programs of WiCSE and the impact on recruiting and retaining women students, and developing partnerships with industry. This paper makes a number of recommendations regarding officer recruitment, outreach, and mentoring for departments that are interested in forming or expanding their women support groups in engineering and/or computing programs.

We conducted a survey on how WiCSE students perceived the WiCSE programs and activities in fall 2018. Through survey data, we found that more than 70% students agreed or strongly agreed on the improvement of social encouragement, career perception, and educational resources with the help of WiCSE.

Literature Review

There are many studies on the gender gap in engineering and computing in the past two decades. Zeng and Duncan [17] analyzed the factors that promote persistence by women in engineering programs. They found that the two driving forces that are common among persisters and switchers are formal support programs and peer support programs. Researchers at Harvey Mudd College [18] described three promising practices for increasing the number of women studying Computer Science: Broad CS1; Recruiting via Grace Hopper Celebration of Computing, and Research experiences for first-year women. They found that these efforts have significantly increased women's participation in their CS program. National Center for Women & Information Technology (NCWIT) reported a systemic approach employed by the Extension Services for Undergraduate Programs (ES-UP) at NCWIT to increase the enrollment and retention of women in undergraduate computing [4]. One of their systemic change model component is institutional policies and support. They stated that visible, high-level support from the administration is required for long-lasting change.

Beck [5] reported their experience of forming a women's support group at a small undergraduate CS department. The initiatives of the support group included a one-week summer computing headstart camp for incoming freshmen women, a mentoring program, a role model program, and a series of two-day field trips to visit corporations, government agencies, and graduate schools. The key components of their group are providing mentoring and outreach experiences. Their experience has demonstrated that a women's support group can be vibrant and valuable to the department and provide significant benefits to women students.

Institutional Information

The University of South Florida is a large, public 4-year university offering undergraduate, graduate, specialist and doctoral level degrees. The USF System includes three, separately accredited institutions: USF**;** USF St. Petersburg**;** and USF Sarasota-Manatee**.** Serving more than 50,000 students, the USF System has an annual operating budget of $1.8 billion and is ranked 45th in the nation for research expenditures among all universities, public or private. USF's acceptance rate in 2017 was 45% and the average SAT score of admitted applicants was 1230.

The Department of Computer Science and Engineering (CSE) described in this paper is on the USF main campus in Tampa.

The CSE department at University of South Florida (USF) has 39 faculty members (tenure-track and instructors) of which eight are female, and offers B.S., M.S., and Ph.D. degrees, serving about 2000 undergraduates and 200 graduate students. It has four degree programs – Computer Science, Computer Engineering, Information Technology, and Cybersecurity (new). These four BS programs graduate about 280 students per year with an additional about 80 MS and 10 PhD graduates per year.

Our student population is racially diverse; 23% of our students are Hispanic and/or black. Across the university, 28% of degree-seeking students are Hispanic and/or black. However, there is significant gender gap. Freshman level course (Foundation of Engineering) in the College of Engineering has about 20% women students on average. Introductory level courses in the CSE department has about 17% women students. These data show that women students were not initially attracted to the engineering majors, especially computer science and engineering.

Forming The Support Group

During the period 2005 to 2010, a female CS graduate student in the department has informally led and organized events specifically for CSE women students. In 2010, the student leader graduated and left before a new leader had been recruited. In 2013, the department recognized the need for a support group for women students and a female faculty was appointed to lead the effort. Since then, the group has evolved from a small informal group to an official student organization with about 300 members.

The sections below describe the challenges we faced when forming, sustaining, and expanding the group and how we overcome these barriers.

Officer Recruitment and Sustaining the Programs

The first challenge when we started the organization was recruiting officers. Due to the lack of female students, it took some time for us to identify female graduate students and senior undergraduate student for president positions every academic year. And very often the presidents were not able to recruit sufficient number of officers to carry out the tasks.

Things changed when we started to consider recruiting lower-level undergraduate students. For the last three years, we have recruited sophomore students for president positions, first by appointment, and later by officer elections. These lower-class presidents do not have as much experience as senior students or graduate students in the computing fields. They do not have the same academic and career planning pressure as senior and graduate students, however, they were enthusiastic and energetic. They were able to recruit sufficient number of officers, expand the group, and organize events.

The executive board of WiCSE has evolved from four positions (president, vice president, secretary, treasurer) in 2014 to eight positions in 2018. Below is the list of officers and their main responsibilities.

- President – Report to faculty advisor, work with Student Government, organize officer meetings, organize trips to diversity focused conferences, budgeting
- Vice president of external affairs – Technical and professional workshops
- Vice president of internal affairs – Peer mentoring and social gatherings
- Secretary – Newsletter, event announcement, polls, and officer meeting reports
- Treasurer – Budgeting, purchase orders, fundraising, food options
- Marketing chair – Promote events on social media and design promotional items
- WiCSETech chair – Webmaster and Engineering Expo
- WiCSEKids chair – Great American Teach-in and Engineering Expo

Through board election every year (usually in April), new officers are elected. Any student in the CSE department can run for an officer position. The president has to be an officer from the executive board of the previous year. This ensures the continuity of the main programs. We again reach out to students in entry level courses to recruit officers. Majority of WiCSE officers are women student. We had one male officer on the executive board each year in the past three years.

Our experience shows that the faculty advisor should play an active role in helping the officer recruitment. The faculty advisor reached out to female students in her classes. When encouraged by a professor that a student is taking classes with, the student is more likely to apply for an officer position. Becoming a student leader makes a student more involved on campus and peers. Several WiCSE officers have become officers of other student organizations after completing their WiCSE positions.

In 2014, the group applied to become a formally recognized university student organization and was chartered as WiCSE, Women in Computer Science and Engineering. Student organizations can manage their members, events, and website. Any student, male or female, can request to join a student organization. Student organizations at USF have the option to apply for annual budgets and travel fund. Student Business Services at USF, a bureau of Student Government, assists student organizations in utilizing their allocations. Student connect with student organizations at USF through the Bullsync website (USF on the orgsync website). This gave the group visibility on campus and the local community and the eligibility for applying for campus grants.

Funding

We did not have funding when we began the support group. For WiCSE kids actitives, we were able to raise $500 from local tech companies. In 2014, after becoming an official student organization, we started to apply for campus grants through the USF student government. Student Government at USF evaluates the activities and expenses yearly and award fund for the next year. WiCSE was given an annual budget of $4,000 by Student Government for the 2018-2019 academic year based on the evaluation of WiCSE for the 2017-2018 academic year.

However, the student government fund at USF covers only food, t-shirts and other small items with organization logos, and printing. Funding for travel can be applied for but it is usually granted to cover less than 50% of the travel cost and it cannot be combined with other university funds. We needed better ways to fund students to attend conferences.

In 2017, WiCSE created a corporate package for fund raising. The sponsorship package describes the volunteering and outreach activities of the organization and provided four levels of sponsorship ranging from up to $500 to $1,500+. We were able to secure one ultimate sponsor ($1,500) and one Friends of the Future Sponsor ($300). These fund were used to sponsor students attending Tapia Celebration of Diversity in 2018.

Institutional Support

Real change requires institutional support and commitment. The CSE department and the College of Engineering at USF have been supportive of WiCSE activities and programs. In 2017, the CSE department sponsored Grace Hopper celebration as a Gold Sponsor ($5,000) and sponsored Tapia Celebration of Diversity in Computing Conference as a Gold Sponsor ($6,000) in 2018. These sponsorships include a career booth and several faculty and student registrations/discount for the conference. The department has financially supported the industry mentoring luncheon program and has designated a staff member for event planning and organization.

The CSE department has formed a Broadening Participation in Computing (BPC) committee in 2018 to develop a departmental BPC plan focusing on increasing women and underrepresented minority's participation in our programs. The committee will also work with faculty to support BPC component in research proposals and projects. The committee co-chair is also the faculty advisor for WiCSE, was given course releases in fall 2017 for organizing trips to Grace Hopper Celebration and in spring 2019 for BPC efforts by the department. The department also provides administrative support for coordinating industry mentoring luncheons and trips to diversity focused conferences.

The CSE department started the Computing Partners Program (CPP) in 2018 to enable industries to develop close working relationships with students and faculty. The industry partners joining the program get exclusive access to Department students through the program. The annual membership is $5000 for Tier 1 and $10,000 for Tier 2. The funds will support expenses such as scholarships, travel, academic conferences, competitions, educational events, relevant seminar series, tutoring, student program ambassadors, summer programs and student recruiting. Some of WiCSE activities such as trips to Grace Hopper Celebration will be funded through CPP in the future.

Faculty Involvement

The faculty advisor of WiCSE makes sure each WiCSE program runs smoothly by regularly meeting with the officers. Other responsibilities of the faculty advisor include communicating the need of WiCSE with the department and college, and corporate sponsors; actively helping the officer recruitment; providing mentoring and advising to women students in the department; working with administrative staff on event coordination; leading the effort of organizing trips to diversity focused conferences.

Faculty involvement becomes especially important when special situations occur. This year, two WiCSE officers quit in the middle of an academic year. One officer quit because of heavy course load and the other officer quit for unknown reasons. In such cases, the president, the board members, and the faculty had to work together to look for replacements on short notice.

WiCSE Programs

WiCSE's programs include outreach programs, workshops, mentoring programs, and trips to diversity focused conferences. In addition, there are two social events every semester, a welcome back social and an end-of-semester banquet.

When we began WiCSE in 2013, we had one program, an outreach program called CSE Roadshows. We have been adding new programs since then.

- In 2016, weekly technical or professional workshops were added with the goal of increasing academic exposure for women students.
- In 2016, with the help of the associate chair of the department and the advisory board, we started the industry mentoring luncheon program.
- In 2017, WICSE started organizing trips to diversity conferences.
- In 2018, we started a peer mentoring program.

When creating and expanding WiCSE programs, we focus on providing social encouragement and academic exposure to women students to increase their interest and persistence in computing.

Outreach Programs: CSE Roadshows and Engineering Expo

Research suggested that student-led outreach programs engage undergraduate women with the broader community [19]. These programs effectively increase interest in computing among K-12 female students and eventually contributed to the actual recruiting of participants in the computing programs [20].

WiCSE started CSE Roadshows in 2014 following the example of the Carnegie Mellon University [3]. It was an interactive presentation at local K-12 schools and organizations by undergraduate and graduate students at the department. The presenters were WiCSE officers and volunteers. They talked about CSE applications, problem solving and algorithms, and their current experience and career expectations. We have visited 13 K-12 schools and student organizations since 2014, with multiple classrooms at the same schools and/or multiple years at same schools. The roadshows were well received at the schools. After a school visit, a middle school math teacher wrote us:

"Thank you for coming to Madison. Elizabeth and Misti had an excellent presentation and the students were engaged, especially the girls!

I appreciate you all donating your time to this project. We don't really know how big our impact will be in the lives of young people. It is so worthy to go out and try to show them that there are opportunities for everyone. They deserve it!"

Some teachers provided valuable feedbacks. A high school teacher told us that their students wanted the USF students to personally speak about USF and their major:

"What were their own experiences in the Computer Science major? What kind of classes did they take? What did they like about them? What are their career aspirations? More about what jobs in Computer Science that are attracting women."

Trips to K-12 schools requires communication with schools, paperwork for volunteering, and planning. We find that doing roadshows during Great American Teach-in (GATI) makes life much easier for us. GATI is an annual one-day event in Florida where speakers visit K-12 public schools and discuss their career, educational trajectories, and hobbies. Schools are open for volunteers during GATI and volunteers can simply sign up with GATI coordinators. We have utilized this opportunity and started to schedule our roadshows during GATI since 2015.

The outreach effort of WiCSE also includes participation in Engineering Expo at USF. Engineering Expo is an annual two-day celebration of all-things STEM that connects kids with technology. Every year about 10,000 K-12 students come to USF during Engineering Expo. It is an excellent outreach opportunity that does not require trips to K-12 schools. WiCSE has held booth at Engineering Expo since 2015. WiCSE has demonstration of computer science and engineering projects and information and brochures about WiCSE. This has also given us visibility to local community and help with our recruitment effort [14].

Workshops

Computing education can be promoted through workshops, conferences, mentoring, and information disseminating. WiCSE began offering workshops in 2016. The workshops include (but not limited to) professional development, elevator speeches, and resume critiques, and technical workshops. Our goal was to inspire women students and provide an alternative to academic exposure from regular classrooms where students must be frequently tested. Attending a workshop gives them a different kind of experience, one that allows them to understanding the problems being solved in the industry, variety of careers that they can apply their knowledge to, and knowledge that complements and fills in the gaps of formal learning.

The challenges of running technical or professional workshops were finding companies and groups that could come and speak to our members and planning calendar of events a few months ahead. When we started, the WiCSE president was in charge of the workshops. Because of the amount of work, it prevents her from implementing other ideas. In 2018, we created two new positions, vice president of external affairs and vice president of internal affairs. The vice president of external affairs was in charge of communicating with collaborators and sponsors for event scheduling and the vice president of internal affairs was in charge of internal programs such as peer mentoring (described in next section). This restructure of the executive board has made a significant difference. In 2018-2019 academic year, we are able to experiment with new programs such as peer mentoring and research workshops.

Mentoring programs

I. Industry Mentoring Luncheons

Mentoring is an excellent way for social encouragement and academic support [14]. The idea of industry mentoring luncheons was initiated by the associate department chair in 2016 before the annual meeting with the department advisory board. Two companies went on board with the program.

Industry mentoring luncheons are designed as informal small group lunch meetings on campus. It provides an opportunity for our undergraduate and graduate women students to connect with women tech leaders in the Tampa Bay area and to discuss the challenges and opportunities that they face as women in the computing disciplines.

The luncheons have been conducted about four lunches per semester, one company per semester since 2016. It helped us form a long term relationship with the two large local companies. They also become sponsors of the department Computing Partners Program in 2018.

II. Peer Mentoring

Research has shown that peer mentoring is an effective tool to engage students [15]. Women-to-women peer mentoring in undergraduate education can be in the form of upper-class women students serve as mentors of lower-class women students. We have been planning the peer mentoring program since 2017.

We conducted informal surveys to understand students' need and recruit mentors. The survey was sent via email to WiCSE students. Five students responded. One of the questions we asked on the survey was "What do you expect to get out of the program?" Responses from students who would like to be mentee include technical skills; help with classwork; help navigating the department; advice on improving resume and obtaining internships. Responses from students who would like to be mentors include an opportunity to help others and leadership experience.

We piloted the peer mentoring program in fall 2018. 6 mentors and 11 mentees signed up. The pilot program was successful and received positive feedbacks. We hope to expand the program in future semesters by recruiting more mentors. One of our industry partners has offered to be part of the incentive for the peer mentors. In spring 2019 their women technologists will meet with our mentors for a mini mentoring session to talk about how to better coach and mentor mentees and to help our mentors think about what their next steps towards your career are.

Trips to diversity focused conferences

Research has shown that attending diversity focused conferences such as the Grace Hopper Celebration of Women in Computing can significantly increase students' confidence in studying computing disciplines [2], [16]. With the support of the department and college, WiCSE has organized students' attendance of the Grace Hopper Celebration and Tapia Celebration of Diversity in Computing conference in the past two years.

The college and the department has supported this effort by sponsoring the conferences which includes career booths at the conferences and covering some registration for faculty and students.

The donations from sponsoring companies were used to cover the rest of the travel expenses. The costs are between $10k to $15k each year.

- In 2017, the department funded 17 students to attend the conference with outside sources helping on student registrations.
- In 2018, the department funded 9 students to attend the Tapia Celebration of Diversity in Computing.

At these conferences, students were offered the opportunity to speak with companies including Google, Microsoft and Salesforce, as well as graduate schools including Stanford, Carnegie Mellon and Georgia Tech. Multiple students, after making a very good impression in initial conversations, were offered the opportunity to interview for internships and full time positions.

Having a career booth at the conferences made students feel connected and supported. A student said "The whole experience was honestly so amazing and inspiring!". A second-year student expressed her experience as, *"I didn't want to leave because I felt energetic and passionate among all of the tech women at Grace Hopper."* Our experience has shown that attending diversity focused conferences can provide significant benefit to students' understanding of the computing fields and increasing their interest in computing.

Evaluation

Survey

Surveys targeting the entire WiCSE organization were conducted in fall 2018. In this survey, we sought to understand how WiCSE students perceived the WiCSE programs and activities. WiCSE students were invited by email to participate in surveys. We collected 20 survey responses (15 women and 5 men) from freshmen through seniors. The survey questionnaires covered a wide range of topics. The focuses are on what programs students participated, whether they find them improve their academic exposure, social encouragement, and career perception.

The top three programs that students participated are technical workshops, professional workshops, and industry mentoring luncheons.

- With regards to academic exposure, we asked students in the surveys if, with the help of WiCSE programs, they were able to integrate and combine knowledge and abilities, pursuing ideas and finding information related to problems, issues and/or topics. 68% students agreed or strongly agreed.
- They were also asked if they learned about educational resources and services that have/will help me progress toward graduation. 70% students agreed or strongly agreed.
- When asked if they become more confident in handling academic challenges, 48% students agreed or strongly agreed.
- When asked if, with the help of WiCSE, students learned to define their career goals after graduation. 74% students agreed or strongly agreed.
- For social encouragement, we asked students in the surveys if, with the help of WiCSE, they were encouraged by peers and faculty/staff members. 80% students agreed or strongly agreed.

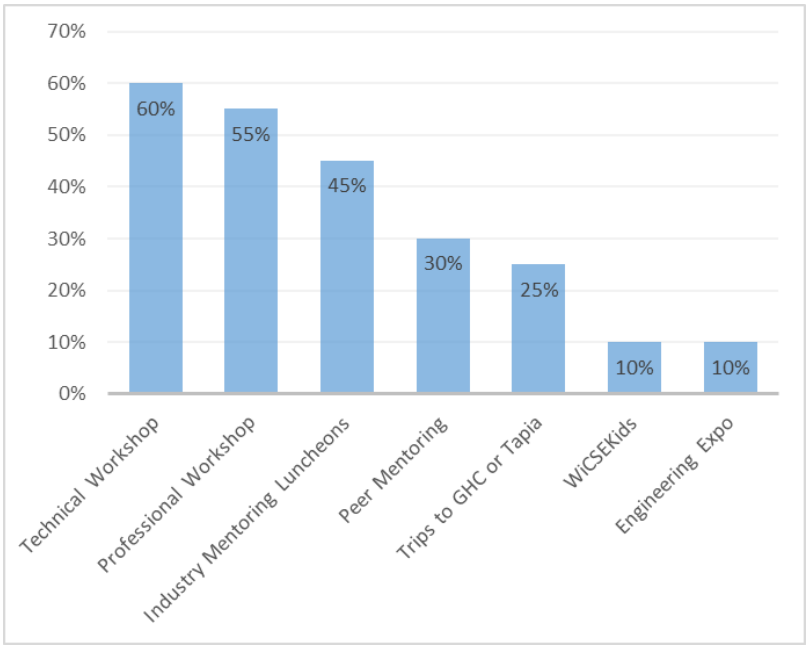

Fig. 1. Analysis of the participation of WiCSE programs.

- Overall, 70% of the students who participated the surveys are satisfied or very satisfied with WiCSE.

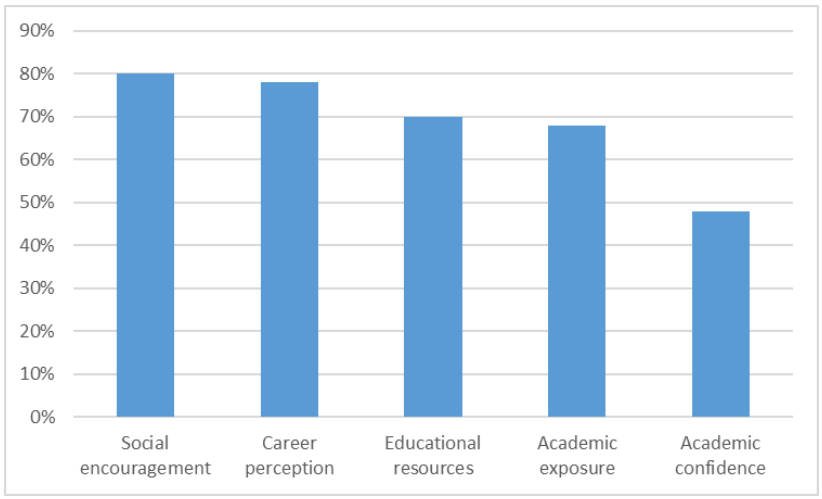

Fig. 2. The percentage of students agreed or strongly agreed on the improvement of the areas with the help of WiCSE

Confidence is culturally and socially related. Research shows that social and culture factors such as gendered self-presentation and stereotypes plays a large role in developing confidence [10]. Western stereotypes that women are less suited for technical fields can threaten women's

expectation of success and depress their performance on tests [11]. We plan to expand the mentoring programs to help women students overcome stereotypes and replace self-presentation with objective measures of ability.

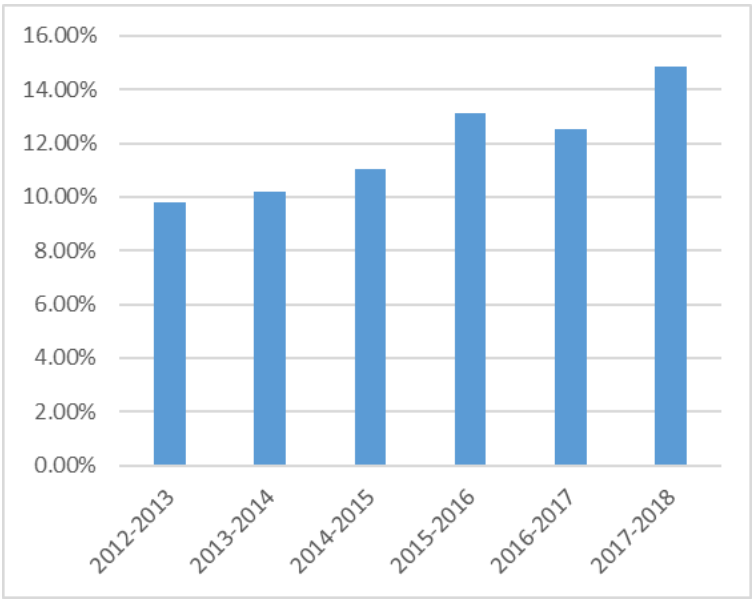

Fig. 3. Percentage of degrees awarded to women students from USF CSE in the past 6 years.

Graduation rate

As shown in Figure 3, in 2012-2013 academic year, the percentage of degrees awarded by the department for women students was 9.79%. In 2017-2018 academic year, the percentage of degrees awarded by the department for women students was 14.86%. The percentage of degrees awarded for women students has increased 52% in the past 6 years. The Department is on a trajectory to reach national average (19.2%) of degrees awarded for women students [6].

There was a slight increase of percentage of women students admitted to the CSE department. Figure 4 shows the percentage of students who met the entrance requirement of the CSE department and were admitted to the department in the past 6 years. These numbers indicate the success of efforts of WiCSE on increasing the percentage of women students.

Conclusion

WiCSE is an essential part of the effort of the CSE department to increase women's participation in computing. It is where women students receive encouragement, academic exposure outside of classroom, career opportunities, and mentoring. The key components to the success of our support group are mentoring programs and workshops. These programs provide students the experiences emphasizing on social relevance of computing and the multitude of industry. We would like to summarize this paper with lessons learned and our future plans.

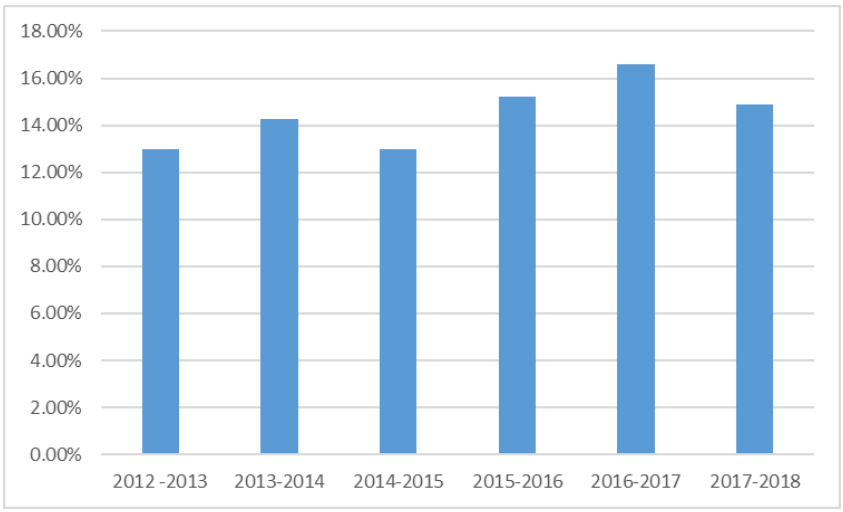

Fig. 4. Percentage of women students admitted to USF CSE in the past 6 years.

Lessons Learned

The experience gained through the WiCSE programs has been valuable. Through creation and expansion of various programs, we have effectively met the needs of the women students in the department. There are several lessons learned we would like to share with deparments who are interested in creating or expanding such a support group.

- Recruit lower-level undergraduate for officer positions. Faculty advisor should play an active role in helping the officer recruitment. More officer positions are needed as the group expands.
- Institutional support and corporate sponsorship are needed for programs such as trips to diversity focused conferences and industry mentoring luncheons. Resources and administrative support are also needed to support the faculty advisor such as providing release time and assigning staff time to assist the programs. This helps ensure the efforts are sustained.
- K-12 outreach efforts can be difficult to sustain. We find that aligning the outreach efforts with activities of the local school district and the college can help. For example, we schedule our roadshows during Great American Teach-in (GATI) and participate in Enginnering Expo organized by the College of Engineering.

Future Plans

We plan to add research workshops to our programs. Undergraduate research experience has been shown to be a key factor in retaining students in computer science, particularly in the undergraduate to graduate school transition [9], [2]. The research workshops will be conducted by faculty or graduate students with the goal of involving undergraduate students in computer science and engineering research early in the program.

The College of Engineering at USF has a recruiting program that targets at high schools with high student success rate of college education. We plan to align our outreach efforts with this more considerable college effort. These efforts will be aimed at nurturing and supporting an interest towards computing and creating recruitment opportunities. We also plan to seek external funds to support students and faculty leaders to attend diversity-focused conferences.

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