The STARS Leadership Model for Broadening Participation in Computing

Teresa Dahlberg, Tiffany Barnes, Audrey Rorrer
University of North Carolina at Charlotte, Charlotte, NC 28223
tdahlber@uncc.edu, tbarnes2@uncc.edu, arorrer@uncc.edu

Abstract - Although demand for computing-related jobs is rising, enrollments in computing programs have been steadily dropping for the last 5 years. Participation by women and underrepresented minorities has also been declining. We have formed the STARS Alliance to address the need to broaden participation in computing. Our innovative STARS Leadership Corps (SLC) engages college students in a community dedicated to giving back, persevering, and striving for excellence. The SLC model incorporates best practices in recruiting and retention in computing, and allows us to compare a broad array of student activities at diverse institutions. SLC students engage with each other and their communities, through their computing projects in outreach, research, or service, the annual STARS Celebration conference, and ongoing professional development. We present the SLC model and preliminary results, which indicate that the SLC shows promise for sustained student retention and recruitment.

Index Terms - broadening participation, computing, diversity, leadership, student development

INTRODUCTION

Information technology (IT) is one of the fastest-growing areas of job growth. However, the Department of Labor projects that degree production will not keep up with demand for IT jobs in the current decade [1]. Researchers and newspapers alike tout the need for broader participation in computing and technology, and address some of the reasons for unequal representation [2-5].

While a number of programs have been successful in broadening participation in computing, these efforts have been isolated, and have yet to achieve impact on a large scale. The STARS Alliance has been formed to scale these successes to regional and national levels. STARS stands for Students & Technology in Academics, Research, and Service. This represents our central hypothesis: college students who use their computing skills in outreach, research, or service will be more likely to be retained, and will recruit younger students into the field. We have developed the STARS Leadership Corps (SLC) to combine these best practices into a single program. The SLC allows for freedom in implementation, but its common framework allows us to compare the impact of diverse programs on broadening participation.

The SLC represents a paradigm shift from isolated small-scale programs to a holistic, scalable approach that combines community building, interventions, and outcomes-oriented research to broaden participation in computing. This article provides an overview of the SLC model, the research motivation, an overview of a three-year project to implement the SLC with students from over 20 colleges and universities, our evaluation plan, and initial evaluation results. Our first year results indicate that the approach shows great promise for sustained student retention and recruitment.

THE STARS LEADERSHIP CORPS MODEL

The STARS Leadership Corps is a multi-year experience providing undergraduate and graduate students with support throughout their academic journey [6-7]. The SLC fosters an extended student community among academia, industry and the community through civic engagement, mentoring, professional development and research experiences.

The annual SLC cycle begins with the STARS Celebration, a four-day conference inspired by the Grace Hopper Celebration of Women in Computing and the Richard Tapia Celebration of Diversity in Computing. In contrast, we celebrate the induction of students into a national corps of STARS leaders dedicated to using computing in service to society.

The STARS Celebration introduces students to the STARS central values of service, leadership, and excellence, while also informing students of computing research, careers, and academic opportunities. Workshops train students to be mentors, role models, and leaders, and develop professional and technical skills to support their computing careers. Students are challenged to examine their ideas of who can be computing professionals, whether of diverse race, ethnicity, gender, or ability. Students are then called to help fill the national need for a larger, more diverse computing workforce by undertaking a leadership project. Leadership projects are broadly classified as: Outreach to pre-college students to inform and excite kids about computing; Peer outreach to other college students to mentor and retain slightly younger students; Community service to solve the computing needs of non-profit organizations; and Research Experiences and Internships to serve by improving one’s own expertise in computing. At the Celebration, experienced SLC students present their past projects, and new SLC students participate in training and planning for their new leadership projects.

During the academic year, students work in teams at their home institutions to carry out their projects. Teams are designed to foster partnerships among academic institutions and beyond academia. For example, the Minority Outreach SLC team in Charlotte, NC, includes students from UNC...
Charlotte (a primarily white research institution) and J.C. Smith University (a private historically black undergraduate university). These students accompany IT professionals, who are members of the Black Data Processors Association, to implement a Saturday computer club for minority high school students. High school students are better able to relate to college students, while college students are able to network and learn from IT professionals, forming a two-tiered system of role models.

The training begun at the STARS Celebration is continued through monthly seminar series and a tiered mentoring program at home institutions. SLC projects are enhanced through written reflection, presentation to peers, and outreach to younger students. Successful projects are showcased at the next annual STARS Celebration to motivate new students joining the corps.

RESEARCH MOTIVATION

A central hypothesis motivating the SLC model is that students who use their computing skills for outreach, service, or research will be retained and will also recruit younger students into computing programs. The SLC embodies this idea, and incorporates multiple effective practices and values into a unified framework. For example, civic engagement (outreach) and community service help change the image of computing from a machine-centered field to a people-centered field, making its application more relevant and concrete. Mentoring is used to provide support and build community among students. Internships, early research experiences, and hands-on training promote increased competence, confidence, and interest in computing. Leadership, professional development, and teamwork provide students with the needed soft skills to succeed in the computing workforce. Similar programs based on these values can be found through the Learning through Evaluation, Adaptation, and Dissemination (LEAD) Center and the National Center for Women in Technology, ncwit.org. Some examples are given below.

Civic Engagement, Recruiting and Bridging

Several programs have introduced students to service learning and outreach as ambassadors or recruiters with great success [8-11]. Civic engagement projects, such as Girls are IT! [12] and ChicTech [13] provide students with opportunities to be leaders and role models for younger students, providing both recruitment and retention benefits.

Connecting computing to real applications that help others may encourage retention of women and minorities [14-17]. Partnerships between universities, industry, and professional organizations will help computing programs stay connected to the job market. This connection has been shown to have a positive effect on gendered attrition [14].

Student participation in research, such as in the National Foundation (NSF) Research Experiences for Undergraduates, the Computing Research Association Distributed Mentor Project, the Georgia Tech/Intel Opportunity program, and the Tapia Spend a Summer with a Scientist program [18], has tremendous benefits for retention [19].

Collaborative learning

Research has shown that African-American success rates in science courses can be dramatically improved by shifting the learning paradigm from individual study to group processes, such as student work groups and student-student tutoring [20-21]. Others suggest such collaborative learning would improve retention of women in computing [14]. SLC students are encouraged to collaborate in their projects.

Persistence and Retention

Factors that contribute to persistence in STEM disciplines for all students include ensuring adequate preparation, lab participation, hands-on research opportunities with faculty, and positive peer interactions and influences [22]. High academic achievement prior to college and interest in STEM majors upon college entrance are also positively associated with STEM retention [23]. For example, Post, Stewart, and Smith [4] found that confidence regarding educational requirements was a significant predictor of math and science careers. Financial support, study groups, a supportive program community, specialized advising, setting high expectations for students, and peer solidarity have also been found to provide an environment highly supportive of strong academic performance [24]. Relationships between peers offer the best support to underrepresented students [14, 25].

A tiered mentoring model (students mentoring slightly younger and being mentored by slightly older students) has been shown to support students’ college adjustment, GPA, retention, graduation and career preparation [15, 26-27].

The persistence of doctoral students in mathematics, and the quality of experience in graduate school, has been linked to how well integrated students are in the academic communities of their department and discipline [28-30]. In addition, doctoral students who persist in mathematics are more likely to have family members who are involved in mathematics, to have participated in research experiences as undergraduates, and to have been committed to mathematics from a very young age [31]. Initial information obtained during qualitative interviews of incoming SLC students supports this research finding in computing as well.

A Unified Framework

Despite the number of best practices throughout these multiple programs, none of these approaches integrate outcomes measurement into longitudinal and comprehensive data analyses. The SLC model is designed as a framework to wrap successful programs, such as Research Experiences for Undergraduates, Civic Engagement, and Outreach, with community building and development opportunities for students. In wrapping these existing programs into one model, the SLC is able to accomplish several components beneficial to BPC. Standardized, collective, and systematic research will demonstrate what program interventions are most successful in recruiting and retaining students in computing education and careers to produce comprehensive, consistent and meaningful evaluation. This model allows for existing persistence and recruitment, and career preparation.
programs to continue ongoing efforts unique to each institution while contributing to the collective evaluation.

In addition, research shows that higher student retention rates and satisfaction, particularly among minority students, result from the existence of a community of “like” students to support the development of a student’s identity [14, 25-26, 32]. However, the representation of some minority student populations is so small within their institutions that it is difficult to foster communities of like students. The STARS SLC model broadens a student’s community to include other academic institutions, as well as the community at large. Furthermore, the SLC emphasis on developing the students as members of a corps serves to enable students to see their community as being comprised of computing leaders, rather than being defined solely by gender, ethnicity, or (dis)ability.

By building common STARS Alliance values, and wrapping programs together across the Alliance, we are able to create a larger community of like students, and thus strengthen the sense of community among both majority and underrepresented students. Students can participate in the corps multiple years, undertaking different leadership project, while remaining a part of the same corps. Based upon recent trends and research, we believe that the SLC model provides methods to foster community, as well as to systematically measure which efforts are most effective in broadening participation [3, 22].

REGIONAL PARTNERSHIPS AND STRUCTURE

The STARS Alliance is a partnership of eleven academic institutions. These are the University of North Carolina at Charlotte, Johnson C. Smith University (JCSU), North Carolina State University (NCSU), Meredith College, Georgia Institute of Technology, Spelman College, Auburn University, Florida State University (FSU), Florida A & M University (FAMU), the University of South Florida Lakeland (USFL), and Landmark College (www.starsalliance.org).

Funded by the National Science Foundation, the overarching goals of the STARS Alliance are to implement, disseminate, and institutionalize effective practices for recruiting, bridging, and graduating women, under-represented minorities and persons with disabilities in computing disciplines. The STARS Alliance is operating under a three-year program plan that began in February 2006.

The eleven alliance members are organized as a hierarchical structure best described as a constellation of “stars.” Each star is a regional partnership of research, minority-serving and/or women’s institutions, as well as K-12 schools, industry, and community groups. The regional partnerships focus on implementing programs in specific schools, locally. The alliance infrastructure promotes national collaboration among the regional partnerships.

The STARS Alliance as a whole strives to provide a comprehensive set of high-quality opportunities to students and a consistent evaluation of the success and failure of programs implemented. Initiatives include the SLC, collaborative learning and problem solving through instruments such as pair programming and socially relevant assignments, a Web portal, a “Marketing and Careers” campaign, Teaching Math for the Visually Impaired, and an annual STARS Celebration conference. The Alliance plans to actively disseminate our practices and findings and to study the long-term sustainability of the programs it implements. Continuous, and as automated as possible, assessment of the progress and value of the different practices is an integral part of our operational model.

Year 1 of the project included a number of activities. The Alliance Steering Committee of about 20 individuals from 12 institutions planned alliance activities, formed partnerships with local area industries and community groups, and designed materials to recruit university SLC students. Alliance Evaluators also collected publicly available data on the computing programs at participating institutions, to obtain a baseline measurement of computing discipline demographics, such as the number of women in each program. In August 2006, 107 college students from 20 universities and colleges began participating in the STARS Leadership Corps. In January 2007, the Alliance hosted Pair Programming and Tiered Mentoring training sessions, and kicked off a task force dialogue on Institutionalizing Effective Practices for BPC (I-BPC) with a meeting in Tampa, Florida. This begins a national dialogue to identify ways to incorporate STARS values into the core mission of universities and colleges, with support from industry and the community.

STARS Alliance institutions and participants convene regularly to disseminate information, collaborate, showcase successes and plan for upcoming academic cycles. Bringing students, faculty, and professional organizations together regularly via seminars and the annual STARS Celebration enables larger scale like communities to develop and continue. The annual STARS Celebration is integral to the success of the SLC, serving as the orientation of new participants in the program, providing training workshops, and serving as a capstone event for continuing participants to showcase individual and institutional successes.

EVALUATION PLAN

Evaluation is a critical component of the STARS Alliance, to assess program efficacy and to inform the academic community of the success of diverse interventions across widely differing institutions. Daniel Stufflebeam’s Context, Input, Process, Product (CIPP) model [33] is being used to assess the STARS Leadership Corps, providing valuable formative and summative evaluation measures. Using this model, evaluators record and assess the following:

- **Context**—the larger setting of the project.
- **Input**—all crucial project staff, materials, and resources.
- **Process**—strategies, activities, practices, and procedures used to carry out the project. This formative evaluation is used to solicit information to determine modifications and adjustments needed to improve how a project operates;
- **Product**—the ultimate result obtained that can be attributed to interventions carried out through the project. This summative evaluation is used to determine if a project should be continued, modified, or terminated.
The evaluation includes both quantitative and qualitative components. Rather than measure each institutional program in isolation, a battery of attitude measurements, qualitative interviews, and survey instruments are systematically and longitudinally implemented across Alliance institutions. This comprehensive data collection enables us to measure and compare outcomes on an array of variables. SLC initiatives are measured by student variables, program variables, and institutional variables; for example, results are disaggregated according to student demographics, university size and type, and what types of SLC projects the students undertake. This unique and comprehensive approach will provide specific outcomes data and meaningful descriptions of what types of programming initiatives are effective for particular student groups and institutions.

Alliance members are continually surveyed to measure the effectiveness of the overall alliance structure and progress toward alliance goals. Annual enrollment data is collected at each STARS Alliance, and is compared to national data to determine if the observed effects are the result of national trends or local interventions. National data are taken from NSF [17] and Computing Research Association surveys (e.g. the Taubee Survey, http://www.cra.org/statistics/).

The STARS Leadership Corps and other STARS programs are continually evaluated to compare outcomes. Each program evaluation collects demographic, performance, and satisfaction data from participating students. Student participants are surveyed throughout their participation to measure effectiveness of the programs on an individual level in terms of self-efficacy, identity development, college adjustment, and other demographic and attitudinal data. The experimental design is a repeated measures longitudinal design without a control group. This evaluation provides formative feedback for the continued improvement, and provides data for annual summative assessments.

Program evaluation for the SLC includes an online SLC pre-survey that students take when first joining the SLC, a STARS Celebration survey taken to determine how well the week-long conference meets its goals, a mid-year online SLC survey to measure students’ reaction to their first semester of participation, and a final online SLC post-survey at the end of their second semester of participation. In addition, we conduct taped one-on-one interviews with SLC students at each of these junctures to collect deeper qualitative insight to the effects of the SLC.

With our SLC evaluation, we aim to compare and contrast the students’ experiences with different types of leadership projects, as implemented at differing college settings. For example, we hypothesize that serving as outreach ambassadors to high school students (e.g., by tutoring or doing computing roadshow presentations to talk about exciting computing careers) will better serve to retain Freshman and Sophomore college students by helping them to “buy-in” to their major. These students may be too inexperienced or intimidated to participate in a research experience. The research experiences and internships may be better suited for Juniors and Seniors to provide more technical depth and breadth, and encourage continuance to graduate school. Furthermore, we wish to measure whether multi-year SLC participation might have a more powerful impact than short-term involvement. We also aim to determine the impact of the partnerships on students. For example, SLC students may have greater opportunities to participate in research, internships, or industry recruiting.

To complement our quantitative measures of enrollment changes, we are also developing instruments to assess the impact of student outreach on participating high school and middle school students, to determine if recruitment by other students is indeed more effective than that by older professionals. We will also assess our I-BPC efforts, the extent to which the STARS Alliance is able to sustain effective practices for BPC.

**First Year Results**

Based upon both student and Alliance member feedback, we believe that we are achieving the goals of student recruiting, retention, and bridging. Results also indicate that we are creating a sustainable project and mechanisms for long term information dissemination.

One hundred and seven college students from 20 universities and colleges participated in the SLC during year 1. Of the 80 SLC students who submitted demographic data, slightly more than half of the student participants were female. Table 1 indicates the ethnic distribution of the SLC students. Most of these students attended the inaugural STARS Celebration in Atlanta, Aug. 6–11, 2006.

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<th>DEMOGRAPHIC DISTRIBUTION OF SLC STUDENTS</th>
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Since then, these students have provided outreach to hundreds of K-12 teachers, counselors and students, and participated in numerous research and internship experiences. Two schools have started ACM-Women chapters. More than a dozen SLC research students regularly hosted lab tours for pre-college students. Several SLC students participated in Career Fairs for pre-college students. One SLC group started a Gamers’ Alliance to excite college and high school students about computing through game-play. A group of SLC students served as mentors for gifted high school students. Several student groups developed Computing Roadshows (presentations) to take on high school visits.

At the institutional level, all participating schools implemented the project aspect of the STARS Leadership Corps. One college implemented an SLC seminar series. Two universities implemented mentoring programs, while the others received training to prepare for implementing a tiered mentoring program for SLC students during year 2. Most
colleges have begun forming partnerships with industry, K-12, and community organizations.

The STARS Celebration post-survey indicates that the overarching goals of the conference were met. All respondents reported that the conference was beneficial, with 97% of students reporting that they felt welcomed at the conference and that it provided adequate opportunities for community building. Ninety-eight percent of participants felt satisfied with the statement that they received training that included statistics on the disparity in representation of women and people of color in computing careers.

SLC students have taken both a pre-survey and a mid-year evaluation to provide baseline data and formative feedback on the SLC program. The mid-year SLC evaluation shows that students are achieving their project goals, and that the alliance objectives are being met. Figure 1 shows student participation in SLC leadership projects. Significant findings from the Mid-Year SLC Evaluation are indicated in Table 2.

Eighty-three percent reported that their project goals were met, indicating that the students are creating projects and goals that are realistic within a semester-long period. Assuming that these projects have reached the intended audiences of K-12 students, non-STARS students on university campuses, and community members, the success of these projects can be taken as an initial indication that our goal of increasing public awareness of computing careers is also successfully underway. Of those students not graduating, 99% stated that they plan to continue participation in the SLC next year. All respondents would recommend participation in the SLC to other students. These results indicate that students are finding the SLC to be a positive and rewarding experience, and provide evidence that the SLC may be sustainable beyond the initial three-year funding period.

A key finding from the mid-year SLC evaluation is that participation in the SLC increased the commitment to computing majors for 88% of students, thus supporting retention. In support of bridging, 83% of students reported that SLC participation allowed them to develop computing skills and knowledge. A large majority (91%) felt that the computing faculty in their departments care about diversity. Eighty-eight percent of students felt that participating in the SLC gave them opportunities to work with people like themselves, supporting the goal of creating a community for both majority and under-represented computing students.

Through a survey administered in October 2006, Alliance faculty participants reported that the benefits to participation in the Alliance have been collaboration between institutions, networking, and emerging ideas for research and publication. Several faculty mentioned that it has been beneficial in adding to their portfolios and has helped in the formation of interdisciplinary partnerships across institutions.

Feedback from the I-BPC dialogue and from faculty and student surveys, indicates progress towards sustaining SLC values. Several schools identified a number of intended approaches to institutionalization. Approaches include establishing the SLC as a student organization, incorporating outreach into for-credit courses, and inculcating students and computing professionals with a life-long devotion to civic engagement. Also suggested is the evolution of the STARS Celebration into an annual conference for a Special Interest Group in BPC, to strengthen national collaboration on BPC activities.

These findings suggest that we are meeting sustainability goals, and will meet dissemination goals through future publications and conference presentations, e.g. at the 2006 Grace Hopper Conference [34]. At our present phase of implementation, no comparative data is available for the programs being implemented. We expect to have results indicating program effectiveness by institution, by program, and by student variables within the second year of Alliance implementation. Although at this stage in the project, we are unable to measure certain programming outcomes, the initial findings suggest that we are progressing toward the Alliance goals: building a community of students based on STARS values, reaching out to campus and local communities, and building new partnerships and institutions that will sustain STARS efforts.

**CONCLUSION**

The formation of the STARS Alliance enables us to dramatically enhance the impact of our BPC efforts by pooling resources and expertise across multiple diverse institutions. Our objectives are to consolidate, scale, replicate and sustain programs and evaluation to further enhance our knowledge of
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