

# Increasing Participation of Females and Underrepresented Minorities in Computing



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**Retaining and recruiting women and underrepresented minorities in computing is an important issue for computing educators.**

**T**he demand for computer scientists is growing,<sup>1</sup> but production of CS degrees in the US has been declining<sup>2,3</sup> and we may face a shortage in the computing workforce in the next decade. In recent years, women earned fewer than 20 percent of computing degrees in the US,<sup>4</sup> and African Americans, Hispanics, and Native Americans combined earned fewer than 8 percent of computer science and engineering degrees.<sup>5</sup>

The low participation of women and underrepresented minorities not only contributes to the shortage of computer scientists but also hampers creativity within the discipline by reducing the richness in perspectives that would accompany diversity. Therefore, recruiting and retaining women and underrepresented minorities in computing is an important issue for computing educators.

## THE INSPIRED PROJECT

Lamar University's INSPIRED (INcreasing Student Participation In REsearch Development) program is funded by a three-year National Science Foundation Broadening Par-

ticipation in Computing grant that started in September 2007. INSPIRED focuses on increasing the participation of women and underrepresented minorities in computer science. Its goals are to retain these students, transition them to advanced study or careers, and attract more females and underrepresented minorities to the field.

The literature on broadening participation is extensive. Space constraints permit inclusion of a small sample here.<sup>6-11</sup> A 2004 Computing Research Association Broadening Participation in Computing Report<sup>9</sup> concluded that many strategies can be used for increasing participation of both women and underrepresented minorities. These include

- faculty mentoring,
- providing research experience for undergraduates,
- protecting underrepresented undergraduates from isolation,
- providing mentors and role models for undergraduates,
- making students aware of the breadth of computer science and its benefits to society,

- creating programs to keep students interested in computer science, and
- outreach to K-12.

INSPIRED builds upon this body of knowledge and on the experience of the Women in Research Development (Wired), a program at Lamar University that was recognized as a best practice in retention of CS women by the Texas Engineering and Technical Consortium at its 2006 Best Practices Conference.<sup>10</sup> INSPIRED implements the same strategies as Wired but broadens the scope by targeting both women and underrepresented minorities.

The INSPIRED program implements mentoring, research experience, peer support, and exposure to beneficial applications of CS to retain and develop underrepresented students. These students are then transformed into a powerful force for attracting other students to computing.

INSPIRED students are paid a stipend to participate in research and outreach functions for an average of 15 hours per week, under the direction of the two professors who serve as mentors and role models.

INSPIRED students work in teams of four to five students. The ideal team has a freshman, sophomore, junior, senior, and graduate student led by a faculty mentor. This team composition facilitates stair-step mentoring that helps students from each level progress to the next and gives them a supportive peer environment.

The participants are selected based on their grades, test scores, interests, and potential to contribute to the project's mission. Students can participate for multiple years. Participants include talented students and students who have the potential to complete a computing degree but may need some extra help to do so. To participate, students must maintain a B average in their computing courses and a 2.5 overall GPA.

There is a large educational aspect to this program. The faculty mentors and more experienced students help to train the less experienced students. They guide the students through a progression from learning basic skills to support outreach to middle and high school students to learning advanced skills and the knowledge needed to support research.

### **FACULTY RESEARCH TEAMS**

INSPIRED research focuses on areas in which the faculty leaders teach and perform research, including autonomous robotics, intelligent systems, computer architecture, and embedded systems. These areas complement each other and have many applications that benefit society, including space exploration, hazardous materials handling, medical assistive devices, improving computer system speed, and lowering power consumption. Exposure to beneficial applications makes computer science more appealing to students and thus helps in retention.<sup>11</sup>

By engaging in this research, students gain valuable experience

applying concepts they learn in the classroom, including knowledge of software/hardware, analysis, design, specification, development, documentation, and testing. This helps develop students' technical skills and prepares them for careers or advanced study in computer science.

Team members are involved in all levels of research, from problem definition through experimental design, implementation, and publication. This enhances their communication and presentation skills, which also boosts their confidence and adds to their professional development.

ing workforce. These include career forums, research seminars, and career counseling seminars.

INSPIRED career forums bring successful computing professionals to the campus to talk to students about careers in computing. INSPIRED research seminars feature nationally known female and underrepresented minority computer science researchers whose presentations not only spark interest in CS research but also promote diversity by their example. Career counseling seminars give INSPIRED students advice on job search, résumé preparation, and



### **Engaging in research helps develop students' technical skills and prepares them for careers or advanced study in computer science.**

A first semester INSPIRED freshman commented, "[INSPIRED] has helped me by allowing me to participate in interesting research, getting me involved in university organizations and activities, and teaching me valuable skills and knowledge ..."

INSPIRED students present their research in an appropriate conference each year. In spring 2008, one INSPIRED student made a formal presentation to the Texas State University System Board of Regents, and in fall 2008 three INSPIRED students made poster presentations at state and international conferences. This enhances their professional development, exposes them to the diversity of research in the field, and allows them to network with other computing students and professionals.

### **DEVELOPING, RETAINING, AND TRANSITIONING STUDENTS**

The INSPIRED program engages students in several other activities that are designed to inspire, retain, and transition them to the comput-

interviewing techniques. INSPIRED students coordinate each of these activities. This helps develop their organizational and leadership skills and increases their confidence and self-esteem, which aids in retention.

With respect to these activities, one INSPIRED student commented, "Starting from the beginning, we have been involved in events such as presentations by industry leaders from companies such as Sysco, Sun Microsystems, and HP. At these events, we received an informative look at the state of current technology and the skills needed to succeed in these fields."

### **OUTREACH TEAMS**

INSPIRED students are actively engaged in outreach to entering university freshmen and middle school and high school students. Activities include on-campus events, road shows, and summer academies. The outreach activities incorporate the knowledge gained from their INSPIRED experience, training, and research.

**Table 1. Cumulative GPAs of spring 2008 INSPIRED students.**

GPA (4-point scale)	Number of students
3.5-4.0	2
3.0-3.4	2
2.5-2.9	3

**Table 2. Reliability and validity of assessment instruments.**

Instrument	Test-retest reliability	Internal consistency reliability	Concurrent criterion-related validity
SAA	0.916	0.880	0.606
SAI	0.985	0.940	0.997
LOQ	0.650	0.920	0.850

INSPIRED students work in teams to develop materials for the various outreach programs. This gives the students valuable experience in developing instructional materials, organizing events, and communicating their ideas to diverse groups in diverse settings, ranging from one-on-one conversations to instructional presentations for small groups. INSPIRED students are in turn role models to girls and underrepresented minorities who participate in our outreach programs, thus promoting diversity.

With regard to involvement in outreach activities, one student commented, "As the coordinator of [a middle school academy] I improved several of my skills. The organization skills that I had were definitely tested and improved while coordinating the events of the day. Another valuable skill that was improved was adaptable communication. Since my audience in this case was a much younger audience than usual, I had to change my usual style of communication in order to communicate effectively with the students."

### INSPIRED ASSESSMENT

The faculty program directors worked together to develop and fine-tune the instruments for assessing the program and establish the validity and reliability of these instruments. The objective of the assessment is to

determine the effectiveness of the program over a one-year period in meeting its goals of retaining, transitioning, and attracting students.

All seven INSPIRED first-year undergraduate participants were included in the assessment study. As Table 1 shows, the students' abilities as indicated by cumulative grade point averages cover a broad range.

To evaluate effectiveness in retention, the assessment compares retention rates, grades in computing courses, and drop rates of INSPIRED students with those of Lamar University female and underrepresented minority CS students over the past five years.

Self-assessment questionnaires ask students to rate their abilities (SAA) and the impact of the INSPIRED program (SAI) in seven areas, ranging from leadership abilities to technical writing skills. Proficiency in these areas can improve academic performance and thus aid in retention.

A learning outcomes questionnaire (LOQ) measures students' preparation for transition to advanced study or computing careers. With this instrument, students rate their progress toward attaining the CS Department learning outcomes.

Each of the questionnaires was administered upon entrance into the program and again at the end of the academic year. As Table 2 shows, strong reliability and validity have

been documented for measurements on both the SAA and SAI as well as the LOQ.

### Retention

The retention rate for INSPIRED undergraduate students in this first year was 86 percent. For the comparison group of female and underrepresented minority CS majors during the past five years, only 26 percent of the former and 21 percent of the latter were retained as majors after their first year. INSPIRED students' CS grades were higher (3.5 average versus 2.2 for the underrepresented minority comparison group and 2.4 for the female comparison group), and INSPIRED students' course drop rate (12.5 percent) was lower than that of the underrepresented minority comparison group (19 percent) and female comparison group (20 percent). Students' responses to the pre- and postparticipation SAI professional development questionnaires indicated that they felt their participation in the program had a significant positive impact on their development ( $t = 3.357, p = .008$ ).

### Transitioning students

The INSPIRED students' pre- and postparticipation LOQ responses document significant increases in their level of readiness for transition into advanced study or careers in computing ( $t = 2.942, p = .032$ ). One of the INSPIRED students graduated in the spring of 2008. The student began taking master's level courses and working with INSPIRED students as a graduate mentor in summer 2008. With the transition to graduate studies for the first INSPIRED graduate, the program is off to a strong start in achieving its goal of transitioning students to advanced study or careers in computing.


### Attracting students

While it is too early to say that our outreach programs have attracted girls and underrepresented minorities to

computing, the students report loving the academies. The assessments of the middle and high school academies based on pre- and postacademy content-based quizzes document significant increases in participants' knowledge of computing.

A middle school student who participated in a summer academy commented, "The most important thing I learned was that I am better with computers than I thought!"

**I**nvolving underrepresented university students in an enriched team research and outreach program with faculty and peer mentoring and additional support can help retain and develop them as computer science students. Working in teams reduces students' feelings of isolation and gives them valuable experience in teamwork. The research reinforces concepts that students learn in the classroom, and participation in outreach enhances the students' communication and organization skills. These students in turn become role models who can inspire others to enter the field.

For more information, visit the INSPIRED website at [cs.lamar.edu/inspired](http://cs.lamar.edu/inspired). 

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