
AC 2012-5408: A SUCCESSFUL FOUR-YEAR ACADEMIC SCHOLARSHIP PROGRAM FOR UPPER DIVISION ENGINEERING AND COMPUTER SCIENCE NON-TRANSFER STUDENTS AND GRADUATE STUDENTS

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Mary Anderson-Rowland is the PI of an NSF STEP grant to work with five non-metropolitan community colleges to produce more engineers, especially female and underrepresented minority engineers. She also directs two academic scholarship programs, including one for transfer students. An Associate Professor in computing, informatics, and systems design engineering, she was the Associate Dean of Student Affairs in the Ira A. Fulton Schools of Engineering at ASU from 1993-2004. Anderson-Rowland was named a top 5% teacher in the Fulton Schools of Engineering for 2009-10. She received the WEPAN Engineering Educator Award 2009, ASEE Minorities Award 2006, the SHPE Educator of the Year 2005, and the National Engineering Award in 2003, the highest honor given by AAES. In 2002, she was named the Distinguished Engineering Educator by the Society of Women Engineers. She has more than 175 publications primarily in the areas of recruitment and retention of women and underrepresented minority engineering and computer science students. Her awards are based on her mentoring of students, especially women and underrepresented minority students, and her research in the areas of recruitment and retention. A SWE and ASEE Fellow, she is a frequent speaker on career opportunities and diversity in engineering.

A Successful 4-Year Academic Scholarship Program for Upper Division Engineering and Computer Science Non-Transfer Students and Graduate Students

Abstract

This paper describes a successful four-year academic scholarship program for upper division engineering and computer science students funded by a National Science Foundation's S-STEM grant that ran from Fall 2007 through Spring 2011. Scholarships of \$2,000 per semester were given to 72 upper division and graduate students. The upper division students were all non-transfer students, while the graduate students (after the first year) were both transfer students and non-transfer students who had graduated from an upper division S-STEM grant. The program was designed to especially encourage females and under-represented minority students to study engineering and computer science. Over 65% (47/72) of the students were either female or minority students.

The students in this program entered in four ways: through a lower-division NSF S-STEM program, as a new upper division applicant to this program, as a qualified graduate student who had just graduated from this program as an undergraduate, and as a qualified graduate student who had just graduated from an NSF S-STEM program for transfer students.

Of the 58 undergraduate students awarded scholarships, only one student left without an engineering degree, giving a retention rate of 98.3%. Only one of the graduate students in the program left without completing a Master's degree (student left after three semesters). Of the 58 students, 39 graduated with a BSE in engineering or a BS in computer science. Of these 39 graduated students, 22 (56%) have gone right on to graduate school full-time. Four of the 22 students are in PhD programs and eight of the other 18 students have already completed their Master's degree. Three additional students are completing their Master's degree part-time. Many of these students had not thought about graduate school until they became a part of this program.

The programming changed every semester. The paper will describe the Academic Scholarship Class that goes with this program and the changes that have been made over the four years, including a paper assignment on career plans after graduation. The students were encouraged to do research and to take internship positions. Twenty-one of the 30 students in the program worked during Spring 2011, the last semester of this program.

Challenges that still remain will be discussed including: convincing students that 18 hours is too large a load of classes if they are also working; convincing students that it is highly desirable for them to go to a Career Fair to practice interviews and to obtain an internship or job; convincing

students that reading the material before class and doing “bullet point notes” is a good use of their time; and convincing students that right after the undergraduate degree is an excellent time to go to graduate school full-time.

I. Introduction

In 2002, the Ira A. Fulton School of Engineering at Arizona State University (ASU) received a National Science Foundation (NSF) S-STEM grant (#0123146) for an academic scholarship program for upper division engineering and computer science students and some graduate students, with Anderson-Rowland as the PI. This program was motivated by the growing shortage of engineers in the United States and in Arizona and emphasized women and underrepresented minority students. The program was called CIRC (Collaborative Interdisciplinary Research Community) and ran from 2002-2007 as the scholarship program was growing.¹⁻⁴ Since half of the first cohort of students in the program were transfer students, mostly from local community colleges, the PI saw the need to have an S-STEM program just for transfer students. The next year, 2003, NSF funded a second upper division S-STEM program just for upper division transfer students (#0728695). This grant and the program ran from Fall 2003 to Spring 2008.^{1,2} After the first CIRC program concluded, a second successful NSF CIRC proposal was funded, which is the topic of this paper (#0631189).⁵⁻⁸ A third successful NSF CIRC proposal was funded (#1060226) and so the CIRC program continues with funding from Fall 2011 until Spring 2015.

The primary parts of the program are the \$4,000 per academic year scholarships awarded to about 30 students per year, the one semester credit Academic Success Class with assignments that scholarship students are required to complete each semester, and a Motivated Engineering Transfer Student (METS) Center that serves as the location for the Academic Success Class meetings. The Center provides good computer and study space, networking, free printing, and also informal counseling for both transfer and non-transfer students. The Academic Success Class is built on the “Guaranteed 4.0 Plan” by Donna O. Johnson. The students learn good study habits and detailed time management. The class meets six times per semester with 75 minutes classes and includes additional topics such as: resumes, preparing for a career fair, research, internships, how to interview, graduate school (choosing and applying),³ elevator speeches, scholarships, how industry works, career plans for 10 years after the BSE,⁸ how to get good recommendation letters,⁴ and speakers with graduate degrees from academia and industry. Another important aspect of the Success Class are the ice breakers held at the beginning of each meeting when everyone introduces themselves by year and major, transfer school if appropriate, and answers a basic question such as: What was the highlight of last summer for you? or How are your classes going? or What is your biggest worry between now and the end of the semester? Students are amazed to learn that other students are also struggling in a class and that they are not the only ones with concerns and problems! This is very important feedback for students. Sometimes these students will form study groups (encouraged for all students for all classes) and help each other learn a course better.

The qualifications for the students to receive a scholarship are: US citizen or permanent resident, full-time engineering or computer science student, minimum 3.0 GPA, and unmet financial need. As the program has grown by advertisement and by word of mouth, there are more qualified students that apply each year than can be awarded a scholarship. Students that graduate from the program with a BSE in engineering or BS in computer science, can be continued on the scholarship for four semester of graduate school. This incentive, coupled with a 4 + 1 Plan offered by most engineering majors, has helped to build the graduate numbers at ASU. The 4+1 plan allows qualified students (GPA requirement is major dependent) to take three courses that double count towards their BSE degree and a Master’s degree.

II. Enrollment

This CIRC Program has now successfully completed its final year. Scholarships of \$2,000 per semester have been given to 72 upper division and graduate students. The current Total Undergraduate Resident Tuition & Fees is \$4,860 per semester (Spring and Fall 2011)⁹. Therefore, although the students have to find additional funding, the CIRC Academic Scholarship pays about 41% of tuition and fees. The program was designed to especially encourage females and under-represented minority students to study engineering and computer science. The breakdown of the students by gender and ethnicity is given in Table I. Under-represented minority students include Blacks, Hispanics, and Native Americans. As can be seen from Table I, both women (33.3%) and underrepresented minority students (44.4%) are overrepresented in this program as compared with upper division and graduate engineering students in general, and in Ira A. Fulton Schools of Engineering, in particular. Of the US citizens and permanent resident undergraduate students in the Fulton Schools of Engineering (not including construction), only 18% are female and 23% are underrepresented minority students. Of the corresponding Fulton graduate students (excluding construction), 18% are female and 15% are underrepresented minority students. In addition, we note that 47/72 (65.3%) of the students are either female or underrepresented minority.

CIRC Fall 2007 – Spring 2011			
	Female	Male	Total
Minority	9	23	32 (44.4%)
Non-minority	15	25	40 (55.6%)
Total	24 (33.3%)	48 (66.6%)	72 (100%)

TABLE I. CIRC Program Student Participation by Gender and Ethnicity

The students entered the program in four ways:

1. Students who successfully completed a lower-division NSFS-STEM program directed by Dr. Armando Rodriguez. All qualified students who applied are automatically accepted into the CIRC program.
2. Qualified students in the Ira A. Fulton Schools of Engineering. There are more qualified applicants each year than can be accommodated by the program.

3. Qualified CIRC students who graduate and continue in graduate school in the Fulton Schools of Engineering. Students are automatically accepted into the program and given a maximum of four semesters of graduate support.
4. Qualified CIRC/METS (transfer) students who graduate and continue in graduate school in the Fulton Schools of Engineering. Students are automatically accepted into the program and given a maximum of four semesters of graduate support.

For the last year of the grant there were more “automatic” acceptances (continuations) than money in the grant. The Fulton Schools of Engineering supported four of the graduate students at \$4K/yr each. During the first year of this program, two graduate students were admitted for support who had not come through the S-STEM program as an undergraduate. After the first year, all new CIRC graduate students were graduates of either the CIRC S-STEM program for non-transfer students or the CIRC/METS S-STEM program for transfer students.

III. Retention

Of the 58 undergraduate students given scholarships, only one student left ASU without an engineering degree, giving a retention rate of 98.6%. One other student changed her major from Mechanical Engineering to Mechanical Engineering Technology. Of the 14 students who were in graduate school when they received their first scholarship from this grant, all have completed a degree or are still working on their degree, except for one student. This student completed his BSE in the first CIRC program sponsored by NSF and then entered graduate school under this grant. The student completed three semesters of a Master’s degree, then quit and went to work full-time. Therefore, the overall retention rate to an engineering/computer science degree is 95.8% (69/72), the retention to a STEM degree is 97.2% (70/72), and the retention to at least a Bachelor’s STEM degree is 98.6% (71/72).

IV. Graduate School

In addition to graduating the students at a high rate, a major goal of this program was to have as many students as possible go right on to graduate school full-time in engineering after completing their BSE or BS degree. Nationally, this rate is below 20% for all engineering graduates. Before the CIRC program and its companion program CIRC/METS for transfer students, only 10% of ASU engineering graduates were going right on to graduate school full-time. The emphasis on the full-time and going right on is based on local statistics and examples. For instance, a group of 14 engineering students from a local industry purposed to all get their Master’s degree at ASU. Only two of the 14 actually completed their degree. It is difficult to work full-time and go to school at the same time. Also, life happens.

Of the 58 students, 39 have graduated with a BSE in engineering or a BS in computer science. Of these 39 graduated students, 22 (56.4%) have gone right on to graduate school full-time. Four of the 22 students are in PhD programs and eight of the other 18 graduate students have already completed their Master’s degree. One of the students who completed his Master’s degree is now in a PhD program. Three additional students are completing their Master’s degree

part-time. Several of the students are in the 4 + 1 program, in which they can take three courses that double count for a Bachelor's and a Master's degree and so can complete a Master's in one year after receiving their Bachelor's degree. Degrees details are in Table II for undergraduate students and in Table III for students who entered this program as Graduate students.

Number of Undergraduate CIRC Scholarship Students									
Year	Total	Earned BSE	Earned MS/E	Enrolled MSE F/T	Enrolled MS/E P/T	Enrolled PhD	Enrolled BSE	No Grad School	Left or Changed Major
07-08	15	15	6	2	2			5	
08-09	20	18	4 ^a	6	1	4	1	6	1 ^b
09-10	14	6		3			7	3	1 ^c
10-11	9						9		
Total	58	39	8	11	3	4	17	14	2

TABLE II. Degrees Earned by the Undergraduate Students Supported with CIRC Scholarships
a = 1 earned P/T; b = Withdrew 2nd semester of program; c = Changed to Mechanical Engineering Technology

Number of Graduate CIRC Scholarship Students						
Year	Total	Earned MS/E	Earned PhD	Enrolled MS/E	Enrolled PhD	Left No Degree
07-08	8	3	2		2	1
08-09	2	2				
09-10	3	1			2	
10-11	1				1	
Total	14	6	2		5	1

TABLE III. Degrees Earned by the Graduate Students Supported with CIRC Scholarships

Tables IV and V look at the 56 undergraduate and the 13 graduate scholarship students who have completed degrees or are currently enrolled by their academic program by gender and ethnicity.

Academic Program for Undergraduates by Gender and Ethnicity							
	Female			Male			Totals
	BSE	MS/E	PhD	BSE	MS/E	PhD	
Underrepresented Minority	3	4	1	12	8	2	30
Non-Minority	6	5		9	4	2	26
Totals	9	9	1	21	12	4	56

TABLE IV. Academic Program for Undergraduate Students by Final Degree or Level of Enrollment by Gender and Ethnicity

Academic Program for Graduates by Gender and Ethnicity					
	Female		Male		Totals
	MS/E	PhD	MS/E	PhD	
Underrepresented Minority				1	1
Non-Minority	1	2	5	4	12
Totals	1	2	5	5	13

TABLE V. Academic Program for Students Who Started Program as Graduate Students by Gender and Ethnicity.

Some of the students had thought about graduate school before they became part of the CIRC program, but many had never thought of it. Many of these students are first-generation students.

Graduate school is mentioned often in the meetings. Engineers from industry with graduate degrees come and speak to the students during the meetings and point out the importance of a graduate degree in their company and how doors are opened because of a graduate degree. The most popular program each year is the “Graduate Student Panel”. Graduate students, mostly ones who have gone through the CIRC Program (or the partner CIRC/METS Program for transfers), come and speak as a panel to tell the students what “graduate school is really like”. The potential graduate students are assured that you do not have to be a “brain” or “genius” to go to graduate school and that if they can do it, then certainly others like them can. This message has been very reassuring to students such as the 3.8 GPA student who feels that s/he just isn’t really “smart” enough for graduate school. We also talk about the “imposter syndrome” and students are amazed to learn that many students with good GPAs have feelings of inadequacy without any real cause.

V. Programming

The programming and assignments are changed each semester. The “Guaranteed 4.0 Plan” is a staple for the students and the first meeting each semester is devoted to this topic. A new topic this semester was “mentoring” presented by the project co-PI. The students were encouraged to invite mentors to help them with different aspects of their lives.

In the 2009-2010 year, the students were asked to write a 3-5 page paper about their career plans for the next five years. In Fall 2010, this assignment was changed to a career plan for 10 years after the Bachelor’s degree on a list of topics, with a minimum five page paper.⁸ Although the PI felt that the expanded assignment was beneficial for the students, she wanted to know what the students thought about the assignment. In the Spring 2011 semester, the students were asked to write a critique on the assignment answering a list of questions. In general the students found the assignment interesting and helpful, as well as challenging. The students were also asked for ideas to improve the assignment. Eight of their ideas were incorporated in the Spring 2012 semester including:

1. Tell the students to take the assignment seriously and that the plan is not “set in stone.”
2. Talk more in class about the Plan
3. Clarify “contingency plans”
4. Don’t have assignment due at the end of a semester
5. Include how mentors could help with plan
6. Add a health/fitness plan
7. Add a finance section: paying for graduate school, building financial stability/good retirement
8. Include steps to accomplish each plan area

The suggestions to add a visual flow diagram with multiple paths and to give the current status of their student/senior design plans are now optional. However, the ideas of making the paper cover a shorter time period, making the assignment more structured, and making the paper shorter in length were not incorporated into the assignment.. It should be noted that the assignment was never due at the end of the semester. In the past, some students were late with their assignment and so did not turn it in until the end of the semester.⁸

A new assignment in Spring 2011 was to have the students read the book “Don’t Sweat the Small Stuff at Work” by Richard Carlson. The students are able to buy this book used for \$4 or \$5 through Amazon.com. The students were asked to read the 100 suggestions made by Carlson and then to pick out the five topics that most resonated with them. The students enjoyed the assignment, requested more discussion time on the subject, and generally agreed that this was a book that they would want to use to remind them from time to time on how to make life easier. The students are strongly encouraged to do a research project through the several programs available at ASU. The project co-PI has offered to help with proposal writing for any students who are interested in doing research. Of the 30 CIRC/METS students during Spring 2011, three students had a research position (one an NSF REU) and nine students had internships for Summer 2011. Six of the 15 students in their first year of the program had either a research position or an internship for the summer. Another new topic for the students in the Spring 2011 semester was how to write a proposal.

A total of 9 papers, including this one, have been presented and published on the CIRC program.¹⁻⁸ The papers include evaluations of the program both quantitatively⁵ and qualitatively⁶. In spite of following the 4.0 Plan, the students are not very good predictors of their semester GPA.⁷

VI. Research, Internships, and Work

An emphasis of the program is on research and internships since these will help the students get into graduate school. Eighteen of the 32 students in the CIRC program for the Spring 2011 semester had either an internship or research position for Summer 2011 and two others did engineering-related work for the summer. Of the 32 students, 25 have had a research position or an internship or worked in an engineering-related job. Twenty of the students worked during the Spring 2011 semester. This information is summarized in Table VI.

Research, Internships, and Work		
	Research or Internship	Work
Summer 2011	17	2
Anytime to date	23	2
Spring Semester 2011		
0 hrs/week		12
5-17 hrs/week		10
20-40+hrs/week		10

Table VI. Number of CIRC Students With Research, an Internship, or Work

VII. Challenges Still Left

The following challenges continue after nine years of directing this program:

- Convincing a student that 18 credit hours are too many to carry in a semester, especially if the student is also working 40+ hours per week or if more than two of the courses have labs.

- Convincing a student that the best way to get an internship is to go to several career fairs (especially in the fall) before they are “desperate” and to practice interacting with industry representatives
- Convincing a student that reading the material before class and doing “bullet point notes” is a good use of their time
- Convincing a student that it is essential to get to know their professors in order to have good letters of recommendation later
- Being too lenient on late assignments for the FSE 394 course. Changes were made in Fall 2011 that greatly reduced the number of students who did not complete their final portfolio of assignments on time. (Students were instructed that only if all assignments were submitted on time, could they earn an A+ in the course.

On the positive side, the primary findings of this project are:

- With continual encouragement and good information, many students will decide to go on to graduate school even if the finances are difficult.
- Having a \$4,000 scholarship for each of the first two years of graduate school is a large incentive and encouragement for the students.
- For the four years of this project, 56.4% of the students who have graduated have gone right on to graduate school.
- There are now nine students from this program working on their PhD!

VIII. Conclusions and Summary

The results of this successful program speak for themselves. The retention rate to graduation for an undergraduate degree in engineering or computer science is over 95%. Of the 39 graduated students, 22 (56.4%) have gone right on to graduate school full-time. Four of the 22 students are in PhD programs along with five others who entered the program as graduate students. This is remarkable when we consider that some of these students are first-generation college students and all have unmet financial need. This high percentage of undergraduate students going right on full-time to graduate school right after graduation is extraordinary. Eighteen (78%) of the 32 students in the last semester of the program had had a research experience, an internship, or been employed in engineering-related work.

The program continued in Fall 2011 under a new NSF S-STEM grant (#1060226).

References

1. Anderson-Rowland, Mary R., "Retention, Graduation, and Graduate School: A Five-Year Program Focusing on Women and Underrepresented Minority Engineering and Computer Science Students", *ASEE 2008 Annual Conference Proceedings*, June 2008, 11 pages.
2. Anderson-Rowland, Mary R., "How Did They Fare: Women and Underrepresented minority Engineering and Computer Science Students in a Five-Year Program", *Proceedings of the 2008 WEPAN Conference*, June 2008, 11 pages.
3. Anderson-Rowland, Mary R., "Thinking About Graduate School", *Proceedings of the 2008 American Society for Engineering Education Annual Conference & Exposition*, June 2008, 16 pages.

4. Anderson-Rowland, Mary R. and Sharp, Julie E., "Helping Students (and Ultimately Faculty) Write an Effective Recommendation Letter", *38th ASEE/IEEE Frontiers in Education Conference*, October 2008, 5 pages.
5. Anderson-Rowland, M.R., "An Evaluation of Academic Scholarship Programs by Program and Ethnicity," *American Society for Engineering Education Annual Conference*, Louisville, KY, June 2010, 16 pages.
6. Anderson-Rowland, M.R., "A Qualitative Evaluation of an Academic Scholarship Program," *40th ASEE/IEEE Frontiers in Education Conference*, Washington, DC, October 2010, 6 pages,.
7. Anderson-Rowland, M.R., "Are Engineering and Computer Science Women Students Good Predictors of their Semester GPA?" *2011 WEPAN Conference Proceedings*, Seattle, WA, June 2011, 13pages.
8. Anderson-Rowland, M.R., "Evaluation of a Ten Year Life Planning Assignment for an Academic Scholarship Success Class," *4^{1st} ASEE/IEEE Frontiers in Education Conference*, Rapid City, SD, October 2011, 6 pages.
9. Arizona State University Tuition and Fees Schedules, https://catalog.asu.edu/tuitionandfees/fees_spring2012.html retrieved March 13, 2012.