



Seattle

122nd ASEE Annual  
Conference & Exposition

June 14 - 17, 2015  
Seattle, WA

*Making Value for Society*

Paper ID #13519

## Collaborative Interdisciplinary Research Community (S-STEM) after Ten Years

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## **The Evolution of a Collaborative Interdisciplinary Research Community**

### **Abstract**

The Collaborative Interdisciplinary Research Community (CIRC) program for native upper division students and graduate students who have graduated from the Academic Success and Professional Development program supported by NSF STEM programs, has been in existence in the Ira A. Fulton Schools of Engineering at Arizona State University since 2002. The current CIRC program is in its fourth year of NSF S-STEM funding (award #1060226). The program has evolved over the 13 years and now boasts a 95% graduation rate and a 50% rate of the undergraduate program students going directly to graduate school. For many years the program was fed by a lower division NSF S-STEM program, but funding is no longer available for that program.

The CIRC program serves native upper division students in engineering and computer science, as well as graduate students who have graduated from CIRC, a second NSF S-STEM program for transfer students, or an NSF STEP program for five non-metropolitan community colleges. The scholarship students have unmet financial need, maintain a GPA of at least 3.0, are full-time students, and are US or permanent residents. Approximately 60% of the scholarship funding has been awarded to females or underrepresented minority students.

This paper gives an insight to the evolution of the current CIRC scholarship program. The paper will also give summaries of the program and its impact.

### **I. Introduction**

First funded by the NSF CSEMS program (award # 0123146), the Collaborative Interdisciplinary Research Community (CIRC) program in the then Arizona State University (ASU) College of Engineering and Applied Sciences began quietly in Fall 2002 with 22 students. These students were all upper division majors in engineering or computer science. From this point forward in the paper, the acronym ENG will be used to mean both engineering and computer science. Two meetings were held in Fall 2002. During the first meeting, the students met each other and were very impressed with the nice meeting room and the refreshments that were served. The topic of the meeting was research. The second meeting was a workshop on the “Nuts and Bolts of Graduate School.” In the spring five meetings were held and due to limited student availability, each meeting was held two times: on a Wednesday and Friday in the same week. Faculty presented workshops on their research projects and on graduate school requirements. The students were required to put together a portfolio and to talk to a faculty advisor about graduate school and research. Several students received research positions based on this activity. After each meeting the participants were surveyed to determine how effective the meeting was and to identify topics of interest for future meetings.

Six of the 22 CIRC students were transfer students, leading to the realization that transfer students were very much in need of a “little hand holding”.<sup>1</sup> Based on this we applied for and received a second NSF CSEMS (award #0324212), this one focused on transfer students, beginning in Fall 2003. CIRC transfer students were then put into this second program called

CIRC/Maricopa Engineering Transition Scholars (CIRC/METS). Most of the transfer students were from the Maricopa County Community College District. In Fall 2003, CIRC had 30 students, 10 continued from the first year and 20 new students who were all ASU native students. During the 03-04 academic year we held six meetings in the fall and five in the spring. We tried to separate the transfer and native student meetings to better address their individual needs. This was partially successful, but often due to scheduling, students were not able to attend the meeting intended for them and attended the other meeting. Career Services gave the program in one of our meetings to give the students assistance with their resumes, interviewing, and cover and thank you letters. Graduate school remained a main topic and industry speakers with advanced degrees were invited to address the students. Evaluations were continued with every meeting.

From Fall 2003 on, then, the students funded through this CIRC program were either native students to ASU or graduate students. The native students in the program were fed either from a lower-division CSEM program funded by NSF or were new to the program as upper division native students. In the first couple of years of the CIRC program, five graduate students were given scholarships. It was good for the upper division students to integrate with these graduate students who served as role models. However, after the first few years of the program, the only graduate students who were given CIRC scholarships were students who had graduated through the program either with a CIRC or a CIRC/METS scholarship and graduate scholarships were limited to a maximum of four semesters. Later, transfer students, who joined the program through an NSF STEP grant (award #0856834), were also provided support for graduate school through the CIRC grant.

## II. CIRC I Results

A total of 67 students received CIRC scholarships, 62 undergraduates and 5 graduate students. The goal of the program was not only to graduate the students, but to urge them to go on to graduate school. The material for this section of the paper came from the final report written to NSF at the conclusion of the grant and papers that were published on the program.<sup>2, 3, 4, 5, 6</sup> A summary of the 62 CIRC undergraduates is shown in the following table:

Acad. Year	Total UG Students	F	M	Under rep. Minority	BSE/ BS earned	BSE/ BS enrolled	On to Graduate School	MSE/ MS Earned	MSE/ MS Enrolled	PhD Enrolled
2002-2007	62	25	37	16	52	8*	21	6	8	9
%	100%	40.3	59.7	25.8	83.9	12.9	40.4**	11.5	15.4	17.3

**Table I. Summary of CIRC I Program Undergraduate Participants 2002-2007 as of September 2007.**

\*= 1 student switched to business \*\*= Minimum known number of students to go right on to graduate school

In summary it is noted that the retention rate of the undergraduate students was 96.8% at ASU and 95.2% in the Ira A. Fulton Schools of Engineering (revised name). Only two students dropped out of the program: a male new transfer student discouraged over low grades (the first year) and a female student who inexplicitly withdrew with a 3.59 GPA. Since the estimated percentage of engineering students who go to graduate school nationally right after earning a BS or BSE is around 20%, the 40% in this program who went right on to graduate school is an excellent rate.

Programming changes occurred during the first five years of this program. A major addition the program occurred in spring 2005 with the introduction of the “Guaranteed 4.0” by Donna O. Johnson.<sup>7</sup> This learning system is taught to all CIRC scholars and the major reason that most students in the program improve academically and are more efficient in their time spent learning. Another part of the 4.0 Plan that is very valuable to helping the students organize their life so that they plan for adequate learning time is a detailed time management schedule. Students find this system very helpful and many continue to use this system after they graduate. The “Guaranteed 4.0 Plan” is an excellent learning system and is considered to be a major reason that we have such a high graduation rate for both native and transfer students.

Another new program development was to give back to the students the results of the evaluation of the previous meeting. One question on the evaluation is: “What would you like to know more about?” The evaluation remarks were summarized, answers written to the questions, and then the results passed out to the students the next meeting. Some questions were then discussed more fully with the students based on the summary.

During this first grant, several findings were established. First, many students who are eligible for a scholarship, even though they have unmet financial need, do not apply for scholarships for which they are eligible. The student fears that they are not competitive for the scholarship and therefore do not apply; however, if they are encouraged to apply and told that they have a good chance of being awarded the scholarship, then these students are more likely to apply. We were able to recruit more females and minority students to the program because we emailed and phoned females and minority students who were eligible for the Scholarship Program and encouraged them to apply. Due to that effort, for example, of the first class of 22 students, 15 students were either a minority or a female, or both. Word of mouth has increasingly become a good recruiter for the program in addition to the listing of the scholarship on the Fulton Engineering and METS (Motivated Engineering Transfer Student) Center websites.

A second discovery was that many good students do not consider graduate school. Since all of the CIRC students have unmet financial need, graduating, earning money, and getting out of debt as soon as possible is a major goal. Students think that a higher degree will take them out of the competitive salary market. Many ENG students think that the only reason they would consider graduate school if is they wanted to become a professor. However, once students learn about the advantages of an advanced degree (more challenging and creative work, higher salary, more chance to design), they are interested, although it sometimes takes students several semesters to come to this decision. Having engineers from industry with advanced degrees come and talk about what they have been able to do based on their advanced degree is very helpful to the students’ decisions to go to graduate school. The most popular meeting over the years has been the graduate student panel and learning what graduate school is really like. Most panelists are students who have gone through the CIRC or CIRC/METS program. Helping students make the decision to go to graduate school became easier with the adoption by the Fulton Schools of a “4 + 1” program which came into being during the first CIRC program. The minimum GPA varies by major, but students can apply for the “4+1” program and then be able to do a Master’s degree in one year past the Bachelor’s degree by taking two or three approved courses which count double for the Bachelor’s and the Master’s degrees.

Additional discoveries were made with these students. We learned that often students did not research the departments and faculty carefully before choosing a graduate school. Of course, this is most important for a PhD program, but any potential graduate student needs to do this homework. A presentation on “The Nuts and Bolts of Graduate School” is given each year, usually by graduate students in the program. Careful selection of the school is emphasized. We learned that some students did not know their professors. As a part of the 4.0 Plan, each student must meet with and get to know their professor. This pays off later in recommendation letters for scholarships, fellowships, internships, jobs, and graduate school. Discussing the professor’s research program with them can possibly lead to a research position, which can lead to support for graduate school.

The importance of networking among the students became evident early. A major benefit of this is that students learn that they are not the only one having difficulties. An icebreaker at the beginning of a meeting varies from meeting to meeting depending on the topic, such as how did you spend your winter break, to what questions do you have about working a career fair or to obtaining an internship, to what is your biggest academic challenge between now and the end of the semester. This last topic usually brings out that an individual is not alone in having difficulty with a particular class and often can receive help from other students on how to best cope.

The workshops went well and were considered successful through evaluation by the students. However, there were challenges. As the students began to take the workshops several times, assignments were changed depending on how many times the student had taken the workshop. Students were allowed to select from several assignments such as applying for an internship, a research position, or graduate school. Another challenge was the difficulty of enforcing that the scholarship students actually did what was suggested to them.

Four publications resulted from the CIRC I project.<sup>3,4,5,6</sup>

### III. CIRC II Results

Due to the success of and publications from CIRC I, we were funded a second time by NSF through the S-STEM program (award #0631189). This program ran from Fall 2007 to Spring 2011.<sup>8</sup> A major change in the program was to require CIRC (and CIRC/METS) scholars to attend a one-credit course FSE 294, an Academic Success and Professional Development class, in place of the workshops and seminars. The class was established in Spring 2009. It was called FSE 294 to go with a FSE 194, an academic success class for lower division students taught by a co-PI. Later, in Fall 2010, the course was renamed FSE 394 to designate that it was an upper division class. Although the class carries credit and the grade counts in a student’s GPA, the course does not qualify for a Program of Study. This made a tremendous difference in the mentoring done through the workshops. By having the students enrolled in a class for credit, assignments could be made and were completed by the students because they wanted a good grade in the class and unsuccessful completion of the class terminated the scholarship. Assignments were judged as either correct or incorrect. A student who attended all of the classes and turned in all of the assignments on-time would earn an A+. Students could miss one meeting a semester with an excuse, but still had to do all of the assignments.

At first we tried to have makeup assignments for missed classes, but having a class with over 40 students, which grew to 175, meant too many makeup meetings or assignments to handle. Instead we tape one of the sessions for each meeting (starting in 08-09), post it on our website, and students can make up a meeting by watching the video and completing an evaluation form which shows that they did view the meeting. The course is called “Academic Success and Professional Development.” As we built more material into the course (things you need to know, but won’t learn in the standard classroom), based on a vote by the students, we changed the course into a two credit class in Spring 2013.

Another change that occurred with the establishment of the Academic Success class was that while S-STEM scholarship students were required to attend the class, other students who did not have a scholarship could enroll in the class. Word-of-mouth brought many of the students to the class. Transfer students, in general, had been advised to take the ASU 101 Orientation Class. However, upper division transfer students were not that keen on sitting in classes with freshmen and being treated like freshmen. Therefore, the academic advisors in several of the departments started suggesting that upper division transfer students take the FSE 394 success course.

A new program component in 08-09 was to have faculty and staff experts speak to and help our students apply for large scholarships and fellowships. Two of the S-STEM scholars received NSF Graduate Fellowships that year. In this academic year we began using Blackboard as a means of posting assignments and material relevant to the course. A new program component in 2009-10 included writing 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. In the spring the students were asked to write a critique on their experience in doing this assignment. In general, the students found the assignment interesting and helpful, as well as challenging. Some students had not thought past getting their degree and getting a good-paying job. One student noted that this was the most creative task she had been asked to do in college.

Another new assignment for the Academic Success class was the introduction of the book, “Don’t Sweat the Small Stuff at Work” by Richard Carlson. The students were asked to read the 100 suggestions made by Carlson and then to pick out the five topics that most rang a bell with them. The students were asked to track how many times they broke their five rules during the semester and to write a report on the experience. 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 continually to remind them from time-to-time on how to reduce stress and make life easier.

The students were strongly encouraged to do a research project through several programs available at ASU. The project co-PI offered to help with proposal writing for any students interested in doing research. An emphasis of the program is research since this will help the students get into graduate school. Eighteen of the 32 students in the CIRC program for Spring 2011 had either an internship or research position for Summer 2011 and two others were employed in 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

were working during the Spring 2011 semester. To assist with research, an engineering librarian was a meeting presenter on how to research engineering data bases.

Major challenges that still existed include:

- Convincing a student that 18 credit hours is too much, especially if they are working 20 or more hours per week.
- Convincing a student that the best way to get an internship or a job is to work on a good resume and to go to several career fairs before they are ‘desperate’ and to also practice interacting with industry.
- Convincing a student that reading the material before class and doing ‘bullet points’ is a good use of their time (Guaranteed 4.0 Plan).<sup>7</sup>
- Convincing a student that it is essential to get to know their professors in order to have good letters of recommendation later.

A total of 72 students, 58 undergraduates and 14 graduates, were funded by CIRC II. The overall results of this project are seen in Table II.

Acad. Year	Total UG Students	F	M	Under rep. Minority	BSE/ BS earned	BSE/ BS enrolled	On to Graduate School	MSE/ MS Earned	MSE/ MS Enrolled	PhD Enrolled
2007-2011	58	21	37	30	39	17	25*	8	11/3	4
%	100%	36.2	63.8	51.7	67.2	29.3	64.1	20.5	28.2	10.3
	<b>Total Grad Students</b>				<b>PhD earned</b>					
	14	3	11	1	2			6		5
%	100%	21.4	78.6	7.1	14.3			42.9		35.7

Table II. Summary of CIRC Program II Participants as of Summer 2011.

\*Minimum known number of students to go right on to graduate school

The positive major finding of this project is that 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 encouragement for the students. For the four years of the project, over 60% of the students who have graduated have gone right on to graduate school, over 50% of them full-time. When we consider that the national average is less than 20%, that we had only 40% of the students going on to graduate school in CIRC I, and that all of these students have unmet financial need, this percentage is phenomenal. This is even more remarkable when we realize that some of these students are first generation students with no close role models.

There are eight publications based on the work done in this grant.<sup>8-15</sup>

#### IV. CIRC III Results

CIRC III began in Fall 11 with another NSF S-STEM grant (award #1060226) and is currently still in operation. A major change occurred in Spring 2013 when the FSE 394 Academic Success and Professional Development class went to two credits. The class used to meet six times a semester. The class now meets seven times each semester and a separate class(es) is held at the beginning of the semester on the 4.0 Plan for students new to the class. The students are expected to visit an engineering librarian to learn how to access engineering data bases.

There is a continued emphasis on graduate school and research. The students are challenged to do their best and not merely just graduate. There are too many major topics to be covered in one semester, but most are covered in two semesters. In one semester, usually the fall, there is an emphasis on research. Students are encouraged to write a proposal for at least one of two funded research project programs available in the college. There are many myths and much lack of understanding about what research really is. To help students understand research better, the students were asked to write a short research paper with some 10 references. Even though extensive instructions and guidance were made available, this assignment proved to be overwhelming for some students. Students are now asked to pick an interest or some area that they would like to know more about. Students are then asked to find 5 references and to write a couple of pages on what they learned. A second research assignment asks for more references and a longer paper. This approach seems to be easier for the students and a few actually found an area in which they are interested in doing more serious research.

The CIRC program has continued to support 8-12 graduate students each semester.<sup>16</sup> Not only are the graduate students happy to have the financial support through the scholarship, the students in the Academic Success class benefit from their presence as role models and their contributions to the meetings. The graduate students share what has worked for them and give advice on how to succeed as an engineering student. A continued challenge has been to provide different experiences for the graduate students. It is difficult to find one time that all of the graduate students can meet. In past semesters we have had them read a book and then discuss it. See references.<sup>17,18</sup> In exchange for not attending a meeting on material with which they are familiar or not turning in a duplicate assignment, the graduate students, for Spring 2015, are doing extra mentoring, developing a project concept to interest grade school students in engineering, or helping to develop two academic class meetings in which they will all participate. These two meetings are “The Nuts and Bolts of Graduate School and Student Organizations” and the “Graduate Panel” meeting, always a meeting favorite.

Another meeting favorite for the students has been industry representatives with advanced engineering degrees. By having these individuals present, the students not only learned about a particular industry, but also how an advanced degree helped the engineer advance and become involved in interesting and challenging projects. In the past few years, the Motivated Engineering Transfer Student (METS) Center, which is tied with the Academic Success Class as additional support for students, has been sponsoring several information sessions by engineering companies. The Academic Success students are encouraged to attend these sessions and required

to attend one, reducing the need to bring in as many company representatives to the Academic Success class meetings.

A recent added emphasis for the students has been to prepare well before a Career Fair and to attend Career Fairs for practice even before they may be ready to take an internship. Advanced preparation starts with a good resume, a good elevator speech, and researching the companies who will be at the Career Fair. In constructing a good resume, the students are able to see gaps in their resume that need to be filled in order to have a strong, complete resume, whether it be a better statement of engineering skills or doing some type of research. Fulton Engineering had 135 companies at the last Fulton Engineering Career Fair. In Spring 2015, for the first time, the career fair will be held over two days with one day basically for undergraduates and one day for graduate students. A third day of the Career Fair will be held at the ASU Polytechnic Campus, now a part of the Ira A. Fulton Schools of Engineering. These career fairs draw from some 17,000 students enrolled in the Fulton Schools of Engineering, necessitating a careful management of time in order to get the most value from attending.

Two novel programs held during the last three semesters were a “Health, Fitness, and Money”<sup>19</sup> and an “Applied Research” meeting each given by a volunteer student from the program. The health, fitness, and money talk, by a graduating senior, included interesting statistics on the economics (let alone lack of stress) of taking out loans to have adequate time to do well in their studies versus working part-time to avoid debt. Given the market and salaries for ENG students allowing rapid payment of debts after going into the ENG field, a study showed that unless students were making at least \$26/hour part-time, it was better to take a loan, avoid the stress, do well in school, and then be conservative for a couple of years and pay back the loan.<sup>19</sup> The applied research at nearby Mayo Clinic by a program graduate student gave students an opportunity to experience a virtual keyboard and to understand how honing devices can be used to help run the emergency hospital room.

A summary of the CIRC III program is seen in Table III. To date, 69 students, 44 undergraduates and 25 graduate students have received scholarships from this grant.

Acad. Year	Total UG Students	F	M	Under rep. Minority	BSE/ BS earned	BSE/ BS enrolled	On to Graduate School*	MSE/ MS Earned	MSE/ MS Enrolled	PhD Enrolled
2011-2015	44	10	34	21	33	10	15	4	9	2
%	100%	22.7	77.3	47.7	75.0	22.7	48.0	26.7	60.0	13.3
	<b>Total Grad Students</b>				<b>PhD earned</b>					
	26	11	15	8				15	7	2
%	100%	42.3	57.7	30.8				57.7	26.9	7.7

Table III. Summary of CIRC Program III Participants as of January 2015.

\*Minimum known number of students to go right on to graduate school

Three of the undergraduate students withdrew from the program due to work-related obligations. One of the graduate students did not complete their program. The retention rate is 93.3% for the undergraduate students and 96% for the graduate students.

To date there have been ten publications on this program, including this paper.<sup>16, 20-27</sup>

## V. Conclusions and Future

The CIRC S-STEM program is expected to continue for one more year on a no-cost extension. The funding for the NSF S-STEM scholarship program for transfer students ran out in Spring 2014. This means that there were no scholarships through our program for upper division transfer students from local community colleges. This means that there will be fewer transfer students feeding into the CIRC program for graduate school. The funding for an NSF METSTEP program provides some scholarship funding for ENG transfer students from five non-metropolitan community colleges. A second no-cost extension of this program could still provide a few scholarships next year.

The Academic Success class has been duplicated by the Ira A. Fulton Schools of Engineering in a one credit terminal course for new transfer students. The School is in the process of making such a course mandatory of all transfer students. This requirement now varies according to major. The enrollment in the two-credit Academic Success class is now a little over 60 students (down from 175 in Fall 12) due to the availability of a one-credit transfer orientation class and fewer scholarship students. This number of students is much easier to handle with a personal touch. The PI tries to have a 30-minute appointment each semester with each of the Academic Success students to better get to know the students and to learn if there is additional support needed. Now, as less scholarships are available, the FSE 394 course enrollment will likely decrease.

The non-scholarship students who attend the class are there by word of mouth or by academic advisor recommendation. Transfer students in their second semester, who did not have an orientation class this first semester, are likely to be advised to take our two credit Academic Success class since it will better suit their needs.

The Dean's Office is committed to keeping the METS Center open if all outside funding should cease. The Center would not be supported to the same degree, especially in the Director's position. The two credit Academic Success Class would probably close. It is hoped that in the near future our local industry board of over 30 companies will be able to help support the current program, especially in terms of internships and scholarships.

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