



Increasing Opportunities and Improving Outcomes for Undergraduate Students in the College of XXX

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Abstract

Starting with the award of its first scholarships for the Fall 2010 semester, the goal of the S-STEM Scholars program at Western Michigan University has been to increase opportunities and improve outcomes for financially needy but academically talented students and to involve undergraduate students enrolled in engineering, technology, or applied sciences majors. The program has worked with first-time, first-year students and supports them as they progress in their academic careers. Each scholarship awarded is roughly equal to one semester of tuition per academic year for a full-time undergraduate student, and can be renewed for up to four years (eight semesters). The objectives of the project are to provide scholarships so recipients can give full-time attention to academic studies and participate in student development activities without outside employment distraction, and to provide professional development activities to connect scholarship recipients to other students and faculty, and to the engineering and applied sciences professions. Each academic year, an S-STEM Scholar selects to participate in one of three professional development programs: Student Organizations of Professional Societies, Undergraduate Research, or working towards placement in a Co-Op or Internship position. Criteria for scholarship awards include potential for academic success; demonstration of financial need through FAFSA filing; full-time student status; and an applicants' statement indicating the professional development program they wish to participate in, how the program is aligned with their interest, and how they will benefit. Monthly activities make students aware of university resources such as tutoring or supplemental instruction; and provide a focus on career development, including career seminars and meeting with alumni who are practicing engineers, applied scientists, and human resource managers from industry.

Our goal is to enhance the retention and graduation rates of academically talented but financially needy students, and to prepare them to successfully enter the engineering and applied sciences professions or to continue in graduate studies. This paper reports on program activities and outcomes to date, will include qualitative assessment and feedback from the S-STEM Scholars themselves, and a quantitative comparison of the retention rate of S-STEM Scholars in comparison to other identified student groups in the College of Engineering and Applied Sciences at Western Michigan University. Plans for a future extension of this program that will concentrate on transfer and URM students will also be presented.

Introduction to the College of Engineering and Applied Sciences at Western Michigan University

Western Michigan University is a comprehensive state-sponsored regional university located in Kalamazoo, MI. In the Fall Semester 2013, 19,198 undergraduate and 5,091 graduate students enrolled. The College of Engineering and Applied Sciences (referred to as "College" in the rest of this paper) offers 14 undergraduate degree programs with an enrollment of 2,220 in Fall Semester 2013; and offers 9 masters and 5 doctoral programs with 460 graduate students.¹ The

College offers the following undergraduate engineering or technology programs that qualify to potentially participate in the S-STEM Scholars Program: Aeronautical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Construction Engineering, Electrical Engineering, Industrial and Entrepreneurial Engineering, Mechanical Engineering, Paper Engineering, and Engineering – Undecided; Engineering Design Technology, Engineering Management Technology, Manufacturing Engineering Technology; and Computer Science. A Graphic and Printing Science degree program has not been a part of this effort, as it is not recognized by the National Science Foundation as a STEM discipline.

A typical College graduate profile, as gathered from senior exit survey and from employer survey, is a student who worked part-time while attending classes and took 10.5 semesters to graduate. The students enjoyed the practical hands-on side of engineering which they learn at through projects, laboratory, design-build competitions, and involvement in applied research. Employers rated College graduates as highly desirable when compared to other engineering schools because they have a shorter on-the-job learning curve as a result of the practical experience they gained. Faculty members engaged in industry-supported research usually involve undergraduates. Thus, the graduate profile reflects the College vision of “*A scholarly community dedicated to excellence through student-centered education and research emphasizing professional practice in engineering and applied science*” and the College mission of preparing “*job-ready graduates.*”

Background on S-STEM Scholars Program

Begun in 2010, the S-STEM Scholar Program increases opportunities for financially needy but academically talented students. These students:

- Come into the S-STEM Scholar Program as first-time, first year students
- Demonstrate financial need through FAFSA applications
- Will enter a STEM major in the College
- Have a math ACT of 24 or above

S-STEM Scholar awardees receive up to \$3,000 per semester, and continue to receive this amount for up to eight semesters with continued academic success and progress to degree.

S-STEM Scholar Program objectives are 1) to provide scholarships so recipients can devote full-time attention to academic studies and participate in student development activities without outside employment distraction, and 2) to provide professional development activities to connect scholarship recipients to other students and faculty, and to the engineering and applied sciences professions.

Financially needy students typically must work to support their academic pursuit, thus reducing the time they have to devote to study or to participate in professional development activities that can contribute to their future success. In a survey of first-time, first-year College students conducted as part of the First-Year Engineering Experience (FYEE), we learn that students often cite conflict with work as the primary reason they were unable to participate in professional development activities. Analyses of academic records show that while those who reported they

work part-time took about the same number of credit hours per semester during their first year at Western Michigan University and they achieved similar grade point average (GPA), students who reported they work part-time have a lower 2nd year retention rate in engineering and applied sciences (69.7%) than those who reported they did not work (75.8%), although the difference is not statistically significant ($\alpha=0.44$).²

Past work has implied that in some cases there is a negative connection between the number of hours worked by students and their academic success;³⁻⁶ that there is a positive effect from mentoring, student engagement, and professional development;⁷⁻¹⁰ the positive effect of scholarships to attract, retain and graduate high-quality students and under-represented students in STEM disciplines;¹¹⁻¹⁵ and the positive impact on student attitudes, aspirations, and plans for college.¹²

Professional Development Activities Integrated into the S-STEM Scholars Program

S-STEM Scholars choose one of three professional development opportunities when they apply to the program; students can switch each new academic year if they wish:

1. Undergraduate Research: Students learn engineering through experience and develop the habits and skills of a researcher. S-STEM Scholars get help finding an undergraduate research project but are expected to also be proactive in seeking such projects.
2. Student Organizations of Professional Societies: Scholars are expected to join and be active participants in at least one of 34 such organizations on campus.
3. Co-op and Internship Opportunities: Chosen mostly by second-year students and later, an excellent option for students to gain on-the-job experience, connect learning in the classroom to professional practice, and develop communication, teamwork, and leadership skills.

Outcomes from the professional development activities for the first three project years encompass the 2010-11, 2011-12, and 2012-13 academic years and are discussed below. Similar activities for Year 4, the current 2013-14 academic year, are underway but are not included as part of this paper.

Professional Development: Undergraduate Research

Two students selected Undergraduate Research as their Professional Development Activity during the 2010-11 academic year. Difficulty in finding suitable matches with a College faculty member and the unexpected demands of the first-year program resulted in little productive activity on research in Year 1 during the 2010-11 academic year.

For Year 2, three students in Fall 2011 (from among the then 16 active S-STEM Scholars) were matched with College faculty and undertook work on a research project. Two of these students were second-year S-STEM Scholars. Not unexpectedly, faculty were more interested in working with these second-year students than a first-year student, due to expectations that a more advanced student will be more likely to contribute to ongoing research efforts.

For Year 3, six of the 23 S-STEM Scholar students were involved in undergraduate research. This included three third-year students, one of the second-year students, and two of the first-year students. Areas of research include materials science, fermentation and reactor experiments, automotive processes, chemistry synthesis, and literature searches and training in experimental techniques for biomedical based research. As members of the student professional societies Concrete Canoe and Baja Car efforts, four additional students were actively involved in researching ways to make lighter and stronger grades of concrete, and improved frame components for the Baja car, as well as honing their teamwork, writing, and oral presentation skills as part of their project documentation efforts. Five students engaged in research through the S-STEM Scholars program presented three papers at a regional engineering education conference in April 2013. Additional student researchers are working in the current Year 4 towards presentations at the same conference in April 2014.

Professional Development: Student Societies

During Year 1 which began with the Fall 2010 semester, five of the seven active S-STEM Scholars selected Student Organizations of Professional Societies as their Professional Development Activity. During Year 2, 13 of the 16 active S-STEM Scholars selected Student Organizations of Professional Societies as their Professional Development Activity. In Year 3, 12 of the 23 active students participated in a Student Organization as their official Professional Development Activity. Year 4 participation in a Student Organization is 12 of 20 active students. Each student regularly participates in the student society of their choice and is in regular contact with one of the project co-PIs for discussions about their participation.

As expected, as the students have progressed into their second and third year, more of them chose to be involved in research or in seeking co-op and internship opportunities. During the 2012-13 academic year, all six of the third-year students were involved in either research or in seeking co-op or internship opportunities, but they are also still active members of Student Organizations. For the eight second-year students, three are involved in research or in seeking co-op or internship opportunities, and also in Student Organizations. Three of the second-year students, and one of the third-year students, took on leadership roles in the Student Organizations working on the 2013 version of the Concrete Canoe, and the 2013 Baja car. The 2013 Baja car finished 7th from a field of more than 30 teams in the Backwoods Baja National Competition held in June 2013, which was the best showing by the University in at least 10 years. For the nine first-year students during the 2012-13 academic year, six elected to participate in Student Organizations of Professional Societies as their Professional Development Activity.

Professional Development: Co-op and Internship Opportunities

As anticipated in our original proposal, as the students have progressed further into their college courses, internship and co-op opportunities have become more of a focus for the students. During the summer of 2012, three of the students had internships in their field of study (two were Fall 2010 S-STEM Scholar entrants; one was a Fall 2011 S-STEM Scholar entrant). Two additional students were working in REU programs (one from the Fall 2010 student group, one from the Fall 2011 student group). In addition, one student from the Fall 2010 S-STEM Scholar group accepted a May through December 2012 co-op opportunity in her field of study. Based

on the Spring and Fall 2012 student surveys, an additional six students confirmed that they had positions to work during the summer of 2012 in service industry positions such as a child development center, food service, and a funeral parlor. Six students (from a possible total of 16) actively engaged in an internship or research in their field of study during the Summer of 2012 which was a large increase from the Summer of 2011 (one of six possible students).

At the end of the Spring 2013 semester, thirteen students had their scholarships renewed for the Fall 2013 semester. Of these thirteen students, eight had industry internships during the summer of 2013 in their field of study. In addition to the thirteen students renewed, two other students had left the S-STEM Scholar program because they were no longer financially needy for the Fall 2013 semester based on their FAFSA score. Both of these students had also obtained summer internships. One of the thirteen students accepted a summer Research Experience for Undergraduates (REU) outside of Western Michigan University, and one worked on a STEM research project at Western Michigan University. Only three of the thirteen students with a scholarship renewed for the Fall 2013 semester were not involved in an industry internship or research experience during the summer of 2013. Two of those three students worked on-campus while enrolled in summer courses. Participation in summer internships has increased steadily when comparing 2011 (1 of 6 students) to 2012 (6 of 16 students), and to 2013 (8 of 13 students, plus two research placements).

The S-STEM scholar students have regularly attended the S-STEM Scholar program professional development sessions on looking for internships and co-ops, resume writing activities, and preparing for and using the College's Fall Career Fair. They have also made use of the University Career Services when looking for positions. It is not possible to say if the S-STEM Scholar Program had a direct impact on the students finding internships and co-ops, but it certainly was a contributing factor in assisting students in their efforts.

Monthly Professional Development Activities

Monthly professional development activities organized and carried out by the faculty investigators during Spring 2012 included academic advising in preparation for selecting Fall 2012 classes; informing students about the university co-operative education programs as they prepared for their second year of college; and an off-campus social event for the students with faculty.

During Fall 2012, the S-STEM Scholars program had 23 students enrolled in first-, second-, and third-year courses. The professional development activities included a resume writing workshop; preparation for and participation in a campus Career Fair; information about majors and career paths; and academic advising in preparation for selecting Spring 2012 semester courses. New professional development activities in Fall 2012 were two instructional work sessions with the students to write abstracts for submission to a regional engineering education conference. Additional work with students continued into the current Spring 2013 semester to complete the conference papers, and work on the PowerPoint presentations the students used. S-STEM Scholars have also been regularly offered discussions in regards to personal study skills, time management, and oral and written communication skills as an integral part of success in STEM related career fields.

A special emphasis that has carried over from Year 2 into Years 3 and 4 has been to inform all the students, but especially the second-year students, about the importance of summer internships in relation to their future career goals, and the availability of university resources in finding internship opportunities and applying for them. Many companies in industry do not recruit first-year students, which was the reason for our emphasis on the second-year students. Summer internships in research laboratory settings, especially those of the NSF REU program type, were discussed with all the S-STEM Scholars, as these types of summer experiences are more open to receiving applications from first-year students. For the summers of 2012 and 2013, students accepting internships or REU type research positions increased, as discussed previously.

S-STEM Scholar Program Retention to Date

From Fall 2010 through Fall 2013, the S-STEM Scholar Program provided scholarships to 33 individual students, for a total of over \$300,000. Of these 33 students:

- 22 have been retained in the College and in the S-STEM Program
- 2 have been retained in the College but did not meet cumulative GPA requirements (>2.75) to continue in S-STEM Scholars
- 2 are retained at the University but in non-STEM majors
- 2 were no longer financially in need but have been retained in the College
- 1 transferred from the University due to an athletic scholarship opportunity elsewhere
- 1 left the University for unknown reasons
- 3 have left the University as a result of poor academic performance

Thus, 79% of S-STEM Scholars (26 of 33) have been retained in the College. In comparison, the College's FYEE Program (supports retention of 1st- and 2nd-year students) had 62.2% retention after Year 1, and 49% retention after Year 2, for students starting in Fall 2010.² An analysis of the number of hours S-STEM Scholars have worked in comparison to other students is ongoing. Employment data has been collected for the S-STEM Scholars, but work on data for a comparison group has not been completed.

Qualitative Feedback from the Student Societies Activity

Fifteen undergraduate students (from Fall 2010 through Spring 2013) who were awarded the S-STEM scholarships elected to be engaged in a student professional society as part of their commitment to the scholarship program. Their chosen societies were: Society of Women Engineers (SWE), American Institute of Chemical Engineers (AIChE), Society of Automotive Engineers (SAE), American Institute of Aeronautics and Astronautics (AIAA), American Society of Civil Engineers (ASCE), and American Society of Mechanical Engineers (ASME). An electronic report was created and students are responsible to complete it periodically during the academic year. In their reports, the S-STEM Scholars are required to highlight their activities in their chosen societies and their levels of engagement, making them self-aware of the need to be engaged in their professions and reporting to the supervising investigators the value as perceived by the students.

Sixty-nine reports were submitted (as high as 12 reports by one student over the period of the scholarship and as little as only two reports from another). The S-STEM Scholars' levels of engagement varied from helping in fund-raising activities to being heavily involved in building a Formula Car or a Concrete Canoe. Students' comments on the value of their involvement also varied. One student expressed how it helped him maintain his interest in engineering because he was able to see how *“a group of people are trying to accomplish one goal. I like how in the group there are team leaders who update the rest of the team on how their section of the Baja car is going. Working on the Baja car is great hands-on work. I am able to gain experience in fabrication and also have to think on my own to solve problems.”* Another comment said: *“Listening to others talk about their discoveries/findings in the chemistry field makes me even more curious about the subject,”* while a third student said: *“The event did not directly impact my interest in engineering but I did get to spend more time with the other women in the field and bond with the members of the SWE organization. It makes the environment seem friendlier and I feel more encouraged to stay in my career field.”*

An effort is underway to compare the level of engagement in a student professional society to the S-STEM Scholars demographics, GPA, and retention rate. Other areas of interest to the project investigators include using the data collected to explore connections between making students aware of the value of professional activities while at the same time having the students understand how to create a balance between work and/or study requirements. This area also includes looking at other extracurricular activities the students have identified beyond the S-STEM Scholar program.

Future Work: Phase II Proposal

MI-LSAMP (Louis Stokes Alliance for Minority Participation) provides a summer program which focuses on a pre-freshmen introduction to college, as well as organizing activities during the academic year for undergraduate under-represented minority students (URM). Faculty experience with this current S-STEM Scholar effort and with the MI-LSAMP program within the College has shown that students often hit a financial roadblock by their junior or senior year, causing them to work more and take fewer credit hours. This can delay time to degree, or they may not finish at all. The faculty investigators are planning a Phase II proposal to focus on junior- and senior-level students who have shown commitment to STEM majors and also show financial need. Another main goal is to focus on diversity and less traditional students coming to the College, which includes transfer students. Partners in the Phase II proposal will include MI-LSAMP program, the University Admissions Office, and the College Advising Office. MI-LSAMP partners with a number of community colleges state-wide and will provide networking opportunities to identify and attract quality URM candidates as transfer students.

Table 1 shows the demographic target or potential head count for Phase II of the S-STEM Scholars Program. Data for the Fall 2013 time period are not yet available for all categories presented, and are not included. Note the differences between admitted first-year URM students and actual enrollments of freshman URM in the College. This difference provides a potential opportunity to actively promote the S-STEM program during the MI-LSAMP pre-freshman year program. This group provides a potential pool of students who would be candidates to participate as S-STEM Scholars. These students have an interest in the STEM programs offered

by the college, but they may have elected to not attend initially as first-year students. In addition, those students who enroll at the College as transfers from community colleges or other universities (as shown in Table 1) are another potential group to recruit S-STEM Scholars from.

The Phase II S-STEM Scholarship would be a goal or objective for students to attain as they reach the upper-division classes their junior or senior years, either having started their first-year at the University, or transferring into a STEM major in the College at a later point in time. The Phase II plan of working with financially needy but academically qualified upper-division students will assist the students by allowing them to complete their degree programs in a more timely fashion.

Table 1. Selected Student Demographics for the College			
	Fall 2010	Fall 2011	Fall 2012
Total Undergraduates ¹	2,235	2,297	2,208
New Admitted First-Year URM Students ²	171	183	142
Freshman URM Enrolled ¹⁶	76	88	77
Freshman and Sophomore URM Enrolled ¹⁶	137	149	135
Junior and Senior URM Enrolled ¹⁶	129	130	141
New Transfer Students Enrolled from Community College ¹	114	144	143
Total New Transfer Students Enrolled ¹	165	216	188

Conclusions

With the awarding of its first scholarships for the Fall 2010 semester, the S-STEM Scholars program at Western Michigan University has worked to increase opportunities and improve outcomes for financially needy but academically talented undergraduate students enrolled in engineering, technology, or applied sciences majors. The program has worked with first-time, first-year students and supports them as they progress in their academic careers. S-STEM Scholars participate in one of three professional development activities: undergraduate research; student professional societies; or preparation to pursue co-op or internship opportunities, as well as monthly professional development activities. To date, 33 students have participated, and 26 have been retained in a STEM major within the College. This 79% retention rate exceeds the retention rate of students within the College's first-year program.

Additional work is underway to analyze collected data to decide if there is a significant contribution of the three professional development activities (undergraduate research, student societies, and co-op or internship placements) to student success and retention. An effort is also

underway to concentrate a future Phase II S-STEM effort on URM and transfer students at the junior and senior upper-division level. Student at this level are generally committed to completing a STEM degree, but are often in financial need to complete their degree activities on schedule. The Phase II effort will seek to assist URM and transfer students in completing their degree requirements in a more timely fashion, so they are “job-ready graduates:” an expressed goal of the College’s mission statement.

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