

S-STEM Scholarship Program in Manufacturing: First Three Years' Experience at the University of Michigan, Dearborn

Dr. Pankaj Mallick, University of Michigan, Dearborn

Dr. P. K. Mallick is the William E. Stirton Professor of Mechanical Engineering at the University of Michigan-Dearborn and the director of the Center for Lightweighting Automotive Materials and Processing at the university. His principal research areas are mechanical properties, design, joining and processing of polymers, composites and lightweight automotive materials. He has authored or co-authored four books on fiber reinforced composites, including two textbooks, "Fiber Reinforced Composites: Materials, Manufacturing and Design" and "Processing of Polymer Matrix Composites". He has also coauthored and edited a book, titled "Materials, Manufacturing and Design for Lightweight Vehicles". He is a Life Fellow of the American Society of Mechanical Engineers and a Fellow of the American Society for Composites.

Prof. Ghassan Kridli, University of Michigan, Dearborn

Ghassan T. Kridli is Professor and Associate Dean for Undergraduate Education at the College of Engineering and Computer Science of the University of Michigan-Dearborn. He teaches graduate and undergraduate level courses in the area of design and manufacturing. Ghassan leads the effort in program assessment for continuous improvement and is active in curriculum development. In addition, he is active in promoting engineering education to underrepresented groups.

Ghassan's research focuses on the application of fundamental engineering knowledge in the design and manufacture of sheet metal products of lightweight alloys. His work has significant industrial applicability and includes mechanical and metallurgical characterization of light alloys coupled with numerical models for predicting the material formability.

Ghassan received his Bachelor of Science and Master of Science degrees in Mechanical Engineering from the University of Miami in 1986 and 1988, respectively, and his Ph.D. from the University of Missouri in 1997. Since then he has been a faculty member in the Industrial and Manufacturing Systems Engineering department at the University of Michigan-Dearborn.

Dr. Elsayed A. Orady, University of Michigan, Dearborn

Dr. German Reyes, University of Michigan, Dearborn

Ph.D. Materials Science and Engineering, University of Liverpool, UK, 2002 M.S. Steel Metallurgy, Technological Institute of Morelia, Mexico, 1997 B.Eng. Industrial Engineering in Steel Metallurgy, Technological Institute of Morelia, Mexico, 1995

University of Michigan-Dearborn, Associate Professor, 2010-present, full time University of Michigan-Dearborn, Assistant Professor, 2003-2010, full time

Mrs. Jennifer M. Makas, University of Michigan, Dearborn

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Introduction

The NSF-awarded STEM scholarship program in the College of Engineering and Computer Science at the University of Michigan-Dearborn was started in September 2015, and now it is in its third year of its existence. The title of our NSF proposal is “S-STEM Program in Manufacturing Engineering Leadership Development”. The key objectives of this program are to provide tuition scholarship, academic support, mentoring and career guidance to academically talented, financially needy undergraduate students who will join the university as freshmen and complete their degree in either manufacturing engineering, industrial engineering or mechanical engineering with emphasis in manufacturing. The goal of the project is to create a group of highly talented and trained manufacturing engineers with leadership quality, which is much needed in manufacturing companies, both locally and nationally. Through the academic classes and leadership activities, the STEM scholars will gain knowledge in not only manufacturing engineering and practice, but also in communication, critical thinking, teamwork and professionalism.

This paper describes the first three years' experience of developing and managing the program. It includes the recruitment process, cohort building activities, academic support, mentoring effort and performance evaluation that have been developed for this program. Problems encountered in managing the program due to student attitude, participation and performance are described. The efforts to overcome these problems include short seminars on student success and goal setting, development of an on-line communication portal and self-assessment worksheet. The learning experiences gained from these efforts are also described in the paper.

Background

The University of Michigan-Dearborn is one of the three campuses of the University of Michigan. It is a regional campus located on the former estate of Henry Ford and about 15 miles west of downtown Detroit. Students who attend UM-Dearborn are predominantly commuters; however, the campus offers near-campus housing for up to 600 students through partnership with a private investor. Accordingly, UM-Dearborn draws the vast majority of its students from five surrounding counties of Southeast Michigan (Macomb, Monroe, Oakland, Washtenaw, and Wayne). In Fall 2017, the campus enrolled over 9,300 undergraduate and graduate students, with about 3,400 students enrolled in the College of Engineering and Computer Science (CECS). About one fourth of the undergraduate students who attend UM-Dearborn identify themselves as people of color and over 45% identify as first generation in college. Furthermore, over 40% of the students are Pell Grant eligible. Over 80% of the UM-Dearborn graduates are employed in businesses and industries in Southeast Michigan. Table 1 shows the average high school GPA and ACT/SAT scores of admitted freshman students in the College of Engineering and Computer Science over the past 5 years.

Table 1. Five Year History of Admissions in the College of Engineering and Computer Science

Academic Year	Composite ACT/SAT*		High School GPA	Number of New Freshman Students Enrolled
	Min.	Avg.	Avg.	
2017-2018	940*	1213*	3.62	423
2016-2017	16	25.9	3.58	375
2015-2016	18	25.6	3.66	369
2014-2015	16	24.9	3.61	314
2013-2014	18	25.4	3.65	287

*The State of Michigan switched from ACT to SAT starting with the freshman class of Fall 2017.

CECS has a strong emphasis in manufacturing in both undergraduate and graduate programs as well as in research. Because of its location, many of its graduates are employed in the automotive and related industries. After many years of downturn in manufacturing in the United States, the manufacturing industry is beginning to show a positive growth. As a result, there is a real need for education and training in manufacturing engineering. On the basis of this need, our S-STEM grant was designed to provide yearly scholarship to 25 undergraduate students for four years and give them experience in manufacturing leadership through a variety of support and extra-curricular activities, such as workshops, local plant visits, team building projects, professional society participation etc.

Recruitment and Selection of STEM Students

Students at UM-Dearborn apply for admission through the university's Office of Admissions and Orientation (OAO). This office reviews and makes admission decisions on all freshman applicants. The scholarship awards are managed by the Office of Financial Aid and Scholarships (OFAS). The recruitment of students receiving the S-STEM scholarship, henceforth referred to as STEM students, was coordinated with these two offices. They were selected from a pool of scholarship applicants who met the following selection criteria.

- Residency in one of the five eligible countries of southeast Michigan (listed earlier)
- High school GPA of at least 3 on a 4-point scale and a minimum ACT/SAT score of 22/1200
- Meet the financial-aid need criterion as stipulated in FAFSA
- Elect a major either in industrial and systems engineering, manufacturing engineering or mechanical engineering.

The STEM student recruitment process started with contacting the area high schools through OAO or directly by the program faculty, and announcing the availability of the S-STEM scholarship on the university's as well as CECS's webpage. A scholarship factsheet was prepared and distributed in local public and charter high schools. It included the scope of the STEM Scholarship Program in manufacturing leadership, the award amount, eligibility criteria, other requirements for the student selection, scholarship renewal information, support system, application deadline and contact information. The applications were submitted on an on-line

portal on the university’s scholarship webpage. This portal was specifically designed for the S-STEM scholarship program. In addition to providing a few basic information, the applicants were required to write the reasons for their interest in engineering and how the high school extra-curricular activities they participated in benefited them. From a list of potential candidates prepared by OAO and OFAS, the STEM Scholar Recruitment and Selection Committee (consisting of STEM program faculty and staff) selected the students that had the best academic potential. They were then phone-interviewed by the program faculty to evaluate their academic interest, communication skills, promptness and conduct during the interview and career goals. Once all the interviews were conducted, the committee, which also included representatives of OAO and OFAS, reviewed the outcomes of the interviews and letters of recommendation received from the applicants’ high school teacher/counselor before selecting the top candidates. The OAO and OFAS representatives ensured that the selected candidates had in fact met all the requirements specified in the selection criteria stipulated by the federal guidelines.

The program goal was to recruit a total of 25 students in the first two years of the program. Because of the late start of the program in 2015 (due to the award notification received in March 2015), the recruitment was difficult and the applicant pool was small in the first year (see Table 2). Only two students accepted the scholarship and joined the program. In the second year, there was a much larger pool of applicants; however, many of them did not qualify since they either selected non-manufacturing oriented disciplines on their applications or did not meet financial need criterion. Sixteen applicants accepted the offer in 2016 and eight in 2017. All current STEM students have selected Mechanical Engineering as their major. Except for the first batch of students, the average GPA and ACT/SAT scores were similar to the college freshman averages shown in Table 1.

Table 2: STEM Scholarship Information

Year	No. of Scholarship Applications	No. of Scholarship Offers	No. of Acceptance	Average High School GPA	Average ACT or SAT
2015	13	3	2	3.2	22.5
2016	41	19	16	3.61	25.3
2017	67	10	8	3.7	1252

Our goal was to recruit under-represented students from area high schools with economically-disadvantaged status of 70% or greater. However, as our first year’s recruitment effort showed and also according to OAO, this was too restrictive and did not give us a large pool of applicants with the needed academic record to select from. Therefore, it was decided to broaden this criterion of the scholar selection process and expand the recruitment activity to all area high schools. Out of 26 students who accepted the STEM scholarship, 15% are African-Americans, 4% Hispanic-Americans, 7% Asian-Americans, 7% Arab-Americans and the rest White-Americans. Four out of 26 students or 15% are female students.

Cohort Building

One of the requirements of the NSF S-STEM Scholarship grant is cohort building. In the first year of the award, there were only two students in the program and cohorting was achieved by regular meetings with the program director. In the subsequent years, the group has increased in size and more planned cohorting activities, both in-class and outside-the-class, were developed.

To start with, the students were assigned the same academic advisor in order to select classes they can take together. We will first briefly describe the general process of class selection for engineering freshmen and then the process used for the STEM students to build cohorts.

All new students at UM-Dearborn are required to attend orientations and take university-wide placement tests in mathematics and composition prior to their first semester at the university. The placement tests take place from mid-June through August each year. At the orientation, students attend group advising and registration, where university policies and procedures are reviewed, curriculum requirements are explained, and advising for the first-semester courses takes place. Students register for their first-semester courses at the orientation.

CECS undergraduate student advisors work with the students to create schedules appropriate to their major and math placement level. Students can place at various levels of Math ranging from Introductory Algebra (Math 080) to Calculus III (Math 215). Each level determines course choices. For example, for full-time mechanical engineering students placed into Math 080, the course choices would include Math 080/090, Composition, possibly Engineering Computer Graphics (ENGR 126) or one other non-technical course for a total of 12 credits. On the other hand, students placing into Math 105 (Pre-Calculus) or above, the choices would be: Math (at a level determined by placement), General Chemistry for Engineers (CHEM 144), ENGR 126, and Composition or other non-technical choice – for a total of 12 credits.

For the STEM students, a letter was sent encouraging them to attend early sessions of testing and orientation. The terms and conditions for the STEM scholarship were also communicated to them. When the math placement scores were available, class schedules were created by the academic advisor to maximize the number of STEM students placed in the same sections of classes and labs while still offering a degree of personal choice. For example, for students placing into Math 105, a schedule was created including specific sections of Math 105, CHEM 144 (including lab section) and ENGR 126, and leaving one course open for the choice of the individual. The university registration is normally first-come-first-served basis. To ensure that the STEM student cohorts were in the selected sections, arrangement was made with the Registrar's Office to allow them pre-register on the first day of registration. As a result, several STEM students became cohorts in math and chemistry classes, ENGR 100 and ENGR 126.

In addition to the in-class cohorting, the STEM students are urged to meet weekly to form problem-solving cohorts and an on-line communication/messaging system was created to hold discussions on issues of common concern, share information, participate in collaborative assignments and projects, and seek advice from STEM faculty and staff advisors. To maximize cohort building, a weekly meeting is held in which the STEM students meet with the STEM faculty and staff to discuss problems and issues related to the courses they are registered in, plan group activities, and listen to invited speakers on topics of common interest, such as goal setting. In one weekly meeting in November and March, the academic advisor helps STEM students select sections of classes for the winter and the Fall semester, respectively.

The STEM students did not initially realize the benefit of cohort building and working as cohorts for class assignments and projects. Students from the Fall 2016 cohort finally seem to be realizing the benefit and are meeting more frequently and working together. Some are also using the tutor or tutoring each other. Some of the students from the Fall 2017 cohort are attending the group meetings more frequently (than the Fall 2016 group did the first term) because of the mentorship example they have seen from the Fall 2016 cohort.

While it appears that the cohorting effort is slowly taking shape, there were several challenges to forming the cohorts.

1. Students entered the program at varied levels of Math – requiring quite different course choices, and in some cases no possible course cohorting. Since not all students in the group attended the first orientations, the process could not be applied later because class sections filled quickly; but every effort was made to maximize grouping.
2. The registration system is open to students from the time they register until the end of the second week of classes and some students altered the schedule to accommodate other commitments (such as sports, outside jobs, clubs, etc.)
3. Most of the STEM students have part time employment (some up to 16-20 hours per week) outside the campus. Since all of the STEM students commute to the campus, they are, in general, spend less time on campus. These two factors make it difficult for them to find time to meet with the cohorts outside the classes they take together.

Academic Support and Mentoring

The academic support is provided to STEM scholars in many different ways. Even before joining the program, each STEM student was invited to attend a math readiness program, called Jumpstart, organized by CECS in the summer. In addition, a graduate student was engaged to tutor the students in math and other courses. The tutor was available for 20 hours per week in an assigned classroom and at various times during the weekdays to accommodate the student's schedule. In addition, the students were encouraged to seek tutoring from the university's Math Learning Center and Student Engagement Office. However, students are using the tutor to a very limited extent. Even students who are told that they might lose the scholarship if their GPA does not improve are not coming to tutoring on a regular basis.

A group meeting is held every week during the semester for discussion and mentoring. In these group meetings, speakers are occasionally invited to provide information on goal setting, student engagement activities and other topics relevant to the group, such as manufacturing. A mentoring session is organized in the winter semester to discuss the course planning process, summer internship opportunity and resume preparation. Students are also encouraged to seek advice from the STEM faculty and staff advisors on academic and other issues that are of concern to them.

Several other group activities are being planned in the current semester. One of them is a visit to a design and product development center of an automotive supplier. The STEM students are now discussing and planning to reactivate the student chapter of the American Society of Mechanical Engineers (ASME). Several students have become member of ASME and some of them have come forward to take the leadership role in the ASME student chapter. The possibility of working with the student chapter of the Society of Manufacturing Engineers (SME) to hold campus and community events is also being explored.

To understand the student's needs and concerns, a self-assessment worksheet was distributed among the STEM students in Winter 2017 (Appendix A), all of whom were freshmen and in their second semester at the time. It was learned from this survey that the key challenges for the STEM students are difficulty to concentrate, difficulty in courses (particularly in chemistry and some math classes), difficulty in time management, uncertainty of academic and career goals, and stress anxiety. In open discussions with the program director, several students mentioned that even though they selected their major at the time of admission application, they

were not knowledgeable about the profession and career opportunity. Efforts are being made to address some of these concerns through mentoring, counseling and meetings with alumni.

Performance Evaluation

Performance and academic progress of the STEM students were monitored and carefully evaluated at the end of each semester. The average GPA of the three batches of students are shown in Table 3. The number of STEM students in each batch is shown in parentheses. We require a minimum GPA of 2.8 at the end of the academic year to continue with scholarship in the next academic year. This information is communicated to the STEM students in the first group meeting with the program faculty and staff at the beginning of the Fall semester. A reminder of this requirement is also given in many subsequent meetings.

As the data in Table 3 show, the first batch of students did not continue with the scholarship because of their low GPA. The number in the second batch of students decreased from 16 in Fall 2016 to 11 in Fall 2017. The reasons for the decrease are low GPA, switching to a major outside the STEM program, and in one case, not meeting the financial aid criterion in the second year. While the average GPA at the end of the Fall 2017 semester is close to 3.0, there are a few students who are significantly below the minimum required to continue with the scholarship. The tutoring facility provided to the STEM students has so far not worked well. Students maintaining high GPA do not consider that tutoring is needed for them. Students with lower GPA have come to the tutor only before the exams and do not seek the tutor’s help consistently through the semester. Mandatory tutoring for students with less than the required minimum GPA is an option and it may be explored in the next two years. Inadequate math background at the time of admission caused several students to start with pre-calculus or lower level math courses, and even then, some of them faced difficulty in these courses. Another reason for low GPA is that many of these students work outside to earn additional money. This reduces their time to study and does not also allow them time to meet with the tutor. Through counseling, some of these students are beginning to cut down the outside work time.

Table 3: Academic Performance of STEM Students⁽¹⁾

Year of Recruit	2015-2016		2016-2017		2018
	Fall	Winter	Fall	Winter	Fall
2015	2.265 (2)	1.86 (2)	2.28 (1)	2.07 (1)	-
2016	-	-	2.70 (16)	2.92 (14)	3.01 (11)
2017	-	-	-	-	2.92 (8)

(1) The number of students are given in the parentheses.

Conclusions

In the first three years of our S-STEM program, we experienced a number of challenges and gained learning experiences that are described in this paper. The first challenge was to recruit under-represented students from high schools in the economically-disadvantaged area school districts. The collaborative STEM student recruitment effort with the university’s admissions office has worked well; but if there was a separate recruitment office in the College of Engineering and Computer Science, the recruitment process in engineering programs could be more focused, which would have helped achieve the recruitment goal of the S-STEM program. The second and perhaps a bigger challenge was faced in building cohorts among the STEM students. In this process, working with the college’s academic advising office was crucial.

However, the initial response from the STEM students was one of aloofness and reluctance to attend the tutoring sessions and mentoring meetings. After numerous warnings and counseling, some of these students have now reduced the number of hours of outside employment. They are also beginning to work together in small groups they formed themselves, meet more frequently with the tutor and seek counseling from the STEM faculty and staff. The importance of close monitoring, frequent counseling, cordial relationship building with the students, and patience are the most important lessons learned in the first three years of the S-STEM scholarship program.

Appendix A: Self-Assessment Worksheet

**(Prepared by the Office of Advising and Academic Success
in the College of Engineering and Computer Science)**

Please take time to reflect on the questions below. Your advisor is there to assist you to find resources.

Name _____ UMID _____

Challenges – In your own words, please describe the factors that contributed to your academic difficulties.

Strengths – Include both academic and personal successes over the past few months.

Resources – The following people, offices or resources can provide me support as I move forward.

Please check the following areas that have been challenging recently.

<p>Study Skills</p> <p><input type="checkbox"/> Concentration easily broken</p> <p><input type="checkbox"/> Difficult classes</p> <p><input type="checkbox"/> Difficulty managing time</p> <p><input type="checkbox"/> Too heavy a course load</p> <p><input type="checkbox"/> Unable to understand course material</p> <p><input type="checkbox"/> Unsure how to study</p> <p><input type="checkbox"/> Other: _____</p>	<p>Major/Career Related Issues</p> <p><input type="checkbox"/> Difficulty with courses in my major</p> <p><input type="checkbox"/> Uncertain of academic/career goals</p> <p><input type="checkbox"/> Unsure of interests, skills, and abilities</p> <p><input type="checkbox"/> Unsure of major choice</p> <p><input type="checkbox"/> Other: _____</p>
<p>Family/Social Related Issues</p> <p><input type="checkbox"/> Adjustment to UM-Dearborn</p> <p><input type="checkbox"/> Connection with other students</p> <p><input type="checkbox"/> Home or family problems</p> <p><input type="checkbox"/> Housing/roommate issues</p> <p><input type="checkbox"/> Separation from friends, family, home</p> <p><input type="checkbox"/> Other: _____</p>	<p>Personal Issues</p> <p><input type="checkbox"/> Balancing school, work and/or family</p> <p><input type="checkbox"/> Financial difficulties</p> <p><input type="checkbox"/> Illness, health problems</p> <p><input type="checkbox"/> Stress and/or anxiety</p> <p><input type="checkbox"/> Social distractions</p> <p><input type="checkbox"/> Substance abuse</p> <p><input type="checkbox"/> Sadness or loneliness</p> <p><input type="checkbox"/> Other: _____</p>