

Work-in-Progress-Eos: A comprehensive approach to the retention of first and second year engineering students

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Abstract - This paper describes the Eos program at Wayne State University, and summarizes the effectiveness of various retention activities pursued by the College of Engineering. Eos is designed to *increase the commitment* of students to the pursuit of Engineering degrees, *promote engagement* between students and the College of Engineering, and *provide academic and financial support* that enables students to do their best work. This program supports students through the two points in the curriculum that are crucial to retention in Engineering: 1) their first semester on campus, and 2) their entry to discipline specific engineering coursework. From the moment students enter the university, they form learning/design teams of three students. These student teams register for the same mathematics, English and chemistry courses, study together and complete a number of hands-on design projects. Peer mentors act as advisors to the learning/design teams, help students develop skills necessary for success in college, and provide academic support. A learning community coordinator oversees the peer mentors, and provides additional academic support to students. The program coordinates with faculty in the mathematics, chemistry and English departments and uses feedback from these instructors to stage early interventions for students who are falling behind in their courses. Financial support is provided to subsidize the cost of meals, parking and/or transportation to and from campus, enabling students to spend more time on campus, which has been shown to increase academic achievement and ultimately retention.

Index Terms – freshman design, retention.

INTRODUCTION

Wayne State University serves nearly 28,000 students, and is one of only three Carnegie I research intensive universities in the State of Michigan. Approximately 2,000 undergraduates are enrolled in the College of Engineering, which offers ABET accredited undergraduate degrees in biomedical, chemical, civil, computer, electrical, industrial, and mechanical engineering. Due in part to WSU's location in the cultural center of Detroit, the student population is unusually diverse with respect to race, academic preparation and socioeconomic status. WSU has a large number FTIAC (first time at any college) students with high school GPAs of ~3.0 and math ACT scores of 21-25. These students are

known as the “murky middle.” While many of these students are very successful at WSU in engineering, nearly as many fail to thrive and drop out after 1-2 years. This is consistent with national data, which show that significant attrition of engineering students occurs in their first or second years of study[1, 2].

The Eos program was developed by the College of Engineering to enhance retention of students from the “murky middle.” The core program elements that support retention are: 1) a curriculum designed to maximize the chances of student success, 2) the extensive use of peer mentors, 3) student learning/design teams, 4) a learning community coordinator who is an expert in engineering education, 5) a dedicated academic advisor, 6) financial support for meals, parking and/or transportation to/from campus and 7) early academic interventions. These efforts are guided by the use of extensive institutional data on student academic performance. Many of these program elements are based on “best practices” proposed by the American Society for Engineering Education for retaining engineering students[3].

CURRICULUM

The curriculum for Eos is shown in Table I. Special consideration was given to the sequencing of courses, as well as the combination of courses taken by students each semester. Institutional data suggested that students who took and passed basic composition (ENG 1020) in their first year at WSU were 50% more likely than students with similar high school preparation to graduate in six years or less. Therefore, all students are required to register for ENG 1020 in their first semester. ENG 1020 is paired with a signature experience course, BE 1060: Introduction to Engineering. BE 1001 compliments BE 1060, and is where students spend time working on design projects as well as receiving academic support. Finally, students take a special version of MAT 1050: College Algebra, which includes an additional workshop where students work on more advanced material than the standard course.

In subsequent semesters, students take a course in Basic Engineering (BE) each semester until they reach their discipline specific course work at the end of the 4th semester. This provides students substantial interactions with faculty in the College of Engineering, and enables students to spend a significant amount of time in the Engineering building. These activities are expected to build students' identity as

future engineers, and increase their commitment to the attainment of a degree in engineering[4].

TABLE I
SUMMARY OF EOS CURRICULUM

	Fall	Winter
Year 1	BE 1060: Introduction to Engineering BE 1001: Intro to Engineering Lab MAT 1050: College Algebra ENG 1020: Basic Composition	BE 1200: Design in Engineering MAT 1800: Pre-calculus CHEM 1040: Chemistry Skills and Reasoning
Year 2	BE 1500: Introduction to Programming MAT 2010: Calculus I CHEM 1225: General Chemistry CHEM 1230: Gen Chem. Lab	BE 2100: Probability and Statistics MAT 2020: Calculus II PHYS 2175: Physics I

SIGNATURE EXPERIENCE

BE 1060: Introduction to Engineering, and the associated sections of BE 1001 provide a signature experience in the engineering design process for freshman. The purpose of the course is to engage students in engineering design immediately, helping build interest and commitment to the attainment of a degree in engineering. Students work in teams of three to complete a number of hands-on design projects, which include protecting an egg from a two story fall using limited resources, construction of PVC launchers and soda bottle rockets, balsa wood bridges and design of a drone chassis and use of their drone to deliver objects. In addition to the hands on design projects, students learn how to be professional college students, developing skills in time management, scheduling, prioritization, financial literacy and problem solving. Students learn about differences between fixed and growth mindsets, and how traits students may think people are born with, e.g. photographic memory, can be developed through disciplined practice.

BE 1060 meets for one hour per week, while BE 1001 meets twice per week for one hour. BE 1060 is primarily lecture based, and is used to teach students about engineering principles used in each of their design projects, and the general engineering design process. BE 1001 is an interactive lab setting, led by peer mentors who guide students through the design process. Peer mentors also provide academic support for math, science and English courses and help students develop the habits of successful engineering students. Academic success content is integrated into interactive activities to maximize student interest.

A key element of the signature experience is the use of learning/design teams to help build a support network for students, and increase retention[5]. On the first day of class, students form their learning/design teams. These teams are expected to persist through the students’ first two years at WSU. In addition to working on their design projects, these teams meet outside of class to study and discuss homework from their courses in math, science and English. The groups

provide students an academic and social support group, and help build a sense of community that is crucial to their retention.

FINANCIAL SUPPORT

Each semester, students receive \$750 that may be used towards parking, meals, books or supplies. Funds are dispersed in multiple increments during the semester, with the stipulation that students must make satisfactory academic progress in each of their classes, and participate in weekly meetings with their learning/design teams. These funds are used to motivate specific student behaviors that are beneficial to their academic success. For example, it is known that student success is correlated with the amount of time students spend on campus. At WSU, more than half of our students commute to campus, and parking fees discourage students from coming to campus unless absolutely necessary. Therefore, support for parking is expected to encourage students to spend more time on campus, increasing student engagement with the university community.

DATA SHARING AND EARLY INTERVENTIONS

WSU uses early academic assessment (EAA) as an early warning system for students who are in danger of failing their coursework. In our experience, the data from EAA come too late in the semester (at the midpoint) to make a significant impact on student success. Therefore, we have developed a system of data sharing between Eos and faculty in math and science courses. Faculty provide detailed weekly updates on student academic performance for all students in the program. These data are used to develop a personalized plan for improving student learning and performance for students at risk of failure. Efforts are coordinated between course instructors, peer mentors, academic advisors, and the learning community coordinator.

PREVIOUS RETENTION EFFORTS

The previous retention program, known as Engineering Bridge, was a one semester program that FTIAC students participated in during their first semester at WSU. In the previous version of the program, BE 1060 was focused primarily on the development of study skills and instruction about the various engineering disciplines. Students were required to research engineering careers and perform self-reflection activities. Student feedback on the course was overall negative, especially with respect to the writing assignments. Based on student feedback via student evaluation of teaching and focus groups, it was determined that students were most interested in participating in engineering activities, which motivated the overhaul of the course to focus on hands-on engineering design projects.

PRELIMINARY RESULTS

First to second semester (fall 2015 to winter 2016) retention for students participating in Eos was 85%. This was a significant improvement compared to the overall first to second semester retention of FTIAC students at WSU, which is 76%. The median GPA of Eos students after the fall 2015 semester was 3.14 compared to 2.77 for all FTIAC students at WSU. Student satisfaction with BE 1060 also increased significantly; overall scores for the student evaluation of teaching (SET) improved 25% compared to 2014 edition of the course. Both offerings of the course were taught by the same faculty.

CHEM 1040 has been identified as a key barrier to students in their first year at WSU, therefore any gains in pass rates in this course are expected to have a significant impact on student retention. Pass rates for Eos students in CHEM 1040 were 68.75% (winter 2016), compared to 50% (fall 2015) for students enrolled in the previous version of the program.

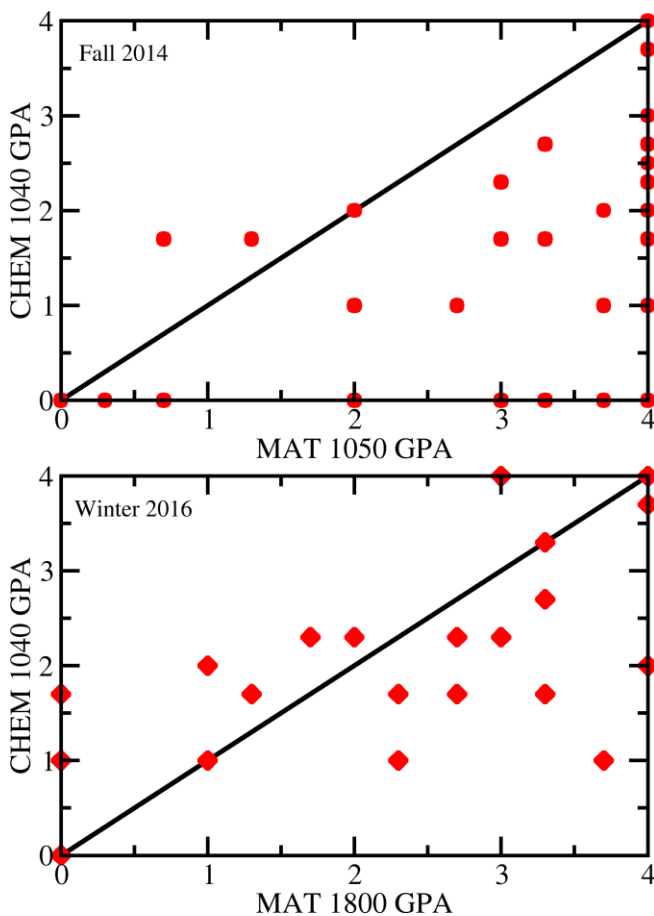


FIGURE 1

CORRELATION OF STUDENT PERFORMANCE IN CHEM 1040 COMPARED TO MATH COURSE TAKEN DURING THE SAME SEMESTER. TOP PANEL: PREVIOUS PROGRAM (2014-2015 AY); BOTTOM PANEL: EOS (2015-2016 AY).

In Figure 1, the correlation between math and chemistry grades is presented. For the 2014-2015 AY,

students took CHEM 1040 with MAT 1050 in their first semester on campus. In the revised program, students take CHEM 1040 in their second semester with MAT 1800 (pre-calculus). The data show that for the revised program (Eos), a stronger correlation exists between student performance in math and chemistry courses. In the previous program, the correlation between math and chemistry grades was poor, with students performing significantly worse in chemistry than MAT 1050.

CONCLUSIONS

The Eos program was designed to follow best-practices in the retention of students in engineering. It incorporates numerous hands-on design projects to motivate student interest and commitment to the attainment of a degree in engineering. Extensive use of group work and peer mentoring is used to create support networks for students while in their first year of study. The program also includes intensive academic advising, data driven course scheduling and financial support for parking, meals, and supplies. Preliminary data suggest that the program has made a significant positive impact on student academic performance and retention in their first year of study at WSU. However, additional long term data are needed to fully assess the impact of Eos on student retention and graduation rates in engineering.

ACKNOWLEDGMENT

Funding from the DTE Energy Foundation is gratefully acknowledged.

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