

An Experimental Program to Enhance Retention of At-Risk Freshmen

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INTRODUCTION

In the Fall of 1992, the Mercer University School of Engineering implemented an experimental program entitled Applications in Math and Science (AIMS). This program targeted marginally-qualified and thus at-risk entering engineering freshmen. The goals of the program were to 1) increase the rate of retention of this group of students from their freshman to their sophomore year and 2) enhance their performance in introductory science and mathematics courses. The year-long program consisted of two parts: the Fall Quarter applications courses in math and science, and the Winter and Spring Quarter follow-up lab courses designed to provide academic support for the students while they were enrolled in regular Chemistry and Calculus courses. Program success was measured in terms of satisfactory performance in Calculus and Chemistry courses as well as persistence in the School of Engineering at the beginning of the student's second year in college.

Motivation for an Intervention Strategy

Approximately one-third of all of the undergraduate students who enrolled at Mercer for the 1990 Fall Quarter were no longer enrolled in the Fall of 1991. For the School of Engineering, the attrition rate was even higher. Almost half of the 1990 freshman engineering class did not return to the Engineering School for their sophomore year. These statistics clearly indicated that there was a need for some kind of intervention.

In addition to the concern about low rates of retention, the School of Engineering had a variety of other reasons for wanting to implement this experimental program. The primary motivating factors included several that may be somewhat unique to schools like Mercer. First, the School of Engineering has a primary mission of quality undergraduate education and teaching. This philosophy of quality education and teaching led us to examine the possible causes for the lack of persistence of our least-qualified entering freshmen. Second, because Mercer is a small private school, by the time the student arrives on campus, the university has already made a substantial investment of time and money in the student. Finally, because Mercer is a moderately selective school, our freshmen engineering students are academically qualified and expect to succeed in an engineering curriculum.

The Importance of the Freshman Year

In terms of retention, the freshman year appears to be the most critical. Various sources indicate that the freshman-to-sophomore attrition rate for four year colleges is approximately 30%.^{1,2,3} In fact, almost 20% of the freshmen leave before the end of their first term. Many of the students decide to leave within the first six weeks of classes. Because of the importance of the first year, the School of Engineering decided to design a program that focused on at-risk freshman engineering students.



THE AIMS PROGRAM

Recruitment of Students

During the first year of the AIMS experiment, we invited a stratified sample of students to participate in the program. Because participation in the AIMS program required the students to enroll in 14 credits in addition to those required for graduation from our ABET-accredited degree program, students were enticed to participate with the offer of free summer tuition so that they could “catch up” with the non-AIMS engineering freshmen. During the second two years of the program, all provisionally admitted entering engineering freshmen were required to enroll in the AIMS course with no offer of free tuition.

The AIMS Curriculum

The basic AIMS program consisted of four AIMS courses: the two primary courses during the fall term (five credits each), and one review/problem solving course during both the winter and spring terms (two credits each). The instructors for these courses were recruited from the regular engineering faculty, based on their teaching excellence and interest in and sensitivity to the needs of freshmen. -We also hired one or more student assistants each of the AIMS courses.

The two AIMS courses offered in the fall term were the benchmark courses of the program. One of these five-credit courses (AIMS Math) consisted of guided laboratory exercises and exploring calculus concepts through the use of the MAPLE software package. The other five-credit course (AIMS Chemistry), which is the primary focus of this paper, emphasized the study and practice of chemical concepts, and included a component which emphasized team-building, student-support and communication activities. The first two-authors team taught the AIMS Chemistry course. The third author coordinated the overall AIMS program and, along with Dr. Guerry Backer and Dr. Laura Moody, taught the AIMS math course.

Student Course Load

In addition to the two primary fall term AIMS courses, all AIMS students enrolled in EGR 101, which is part of Mercer’s three-credit per term freshmen engineering sequence. The AIMS students also enrolled in one other five-credit course which was usually English, speech or a lower-level humanities or social sciences elective. During the Winter and Spring terms, AIMS students typically enrolled in chemistry, calculus, the second and third courses in the freshman engineering sequence, the AIMS review/problem solving course, and possibly a social science or humanities course.

The AIMS Chemistry Course

The AIMS Chemistry course met for an hour and ten minutes on Monday, Wednesday, and Friday, and consisted of in-class academic activities and in- and out-of-class academic-related activities, social, group-building and enrichment activities. The in-class academic activities emphasized and concentrated on the understanding and solving of basic chemistry problems. The textbook used in the regular chemistry course was used for this portion of the course.⁴ Less than half the content covered in the first term of regular chemistry was covered in the AIMS course. This was due to the slower pace, extra time devoted to understanding and problem solving, and the inclusion of other classroom activities. During the first year of the AIMS experiment this course was graded on a pass/fail basis, and thereafter on an & B, C, D, F basis.

The chemistry concepts that were emphasized did not include the most basic concepts such as memorization of chemical symbols or an introduction to atomic structure, but rather on using and understanding chemical concepts to solve problems. The major topical areas that were emphasized included:



conservation of mass
 chemical formulas
 acids and bases
 significant figures
 quantitative analysis

density
 balancing equations
 molecular & ionic equations
 limiting reactants
 percentage yield

atomic weights and masses
 types of reactions
 mole concept
 molar concentration
 gas laws

The goal of this section of the course was to empower the student with chemistry knowledge and confidence through study, understanding, practice, and association to perform at a higher level that would otherwise have been accomplished in Mercer's freshman chemistry offerings.

Whenever possible, we emphasized active learning. For example, Mr. Craig Anderson, Mercer's Engineering Education Specialist, demonstrated practical and engineering applications of chemistry during two class periods each year.

The AIMS Chemistry Course: Nonchemistry Component

We devoted approximately one-third of the class time in the AIMS Chemistry course (usually every Friday) to activities related to factors which have been identified as having a positive correlation with retention.^{2,5,6} Specifically, we sought to help the students 1) increase their sense of involvement with the Mercer community, 2) have an opportunity for personal and social interaction with Engineering faculty and upperclass students, and 3) increase their commitment toward the goal of earning an engineering degree.

We required the students to keep a journal. Sometimes the students were given a specific topic for their journal; other times they were given time in class to write on the topic of their choice. Typical topics included 1) My reaction to orientation activities at Mercer, 2) Why I want to be an engineer, 3) Developing and maintaining relationships, and 4) Reaction to the AIDS lecture.

We conducted group-building and self-awareness activities. For example, on the first day of class, each student composed a bio-poem and read it to the class. Near the beginning of the quarter students drew a timeline describing where they had been and where they were going. At the end of the quarter, the students repeated this exercise and shared it with the class.

We emphasized the importance of teamwork and effective communication. During the AIMS Chemistry class, students

| AIMS-I DATA | | | | | | |
|----------------|----------|--------------|-----------------|---------|---------|--------------------|
| Student Number | SAT-Math | EGR 191 MATH | EGR 192 SCIENCE | CHM 111 | MAT 181 | Enrolled Next Year |
| 1 | 680 | s | s | c+ | B | Y |
| 2 | 560 | s | s | B | c+ | y |
| 3 | 540 | s | s | F | F | N |
| 4 | 520 | s | s | c | c | Y |
| 5 | *550 | s | s | c | c | Y |
| 6 | 550 | s | s | D | F | Y(CLA) |
| 7 | 470 | s | s | c | x | Y(CLA) |
| 8 | 620 | s | s | c | B+ | Y |
| 9 | 650 | s | s | c | B+ | y |
| 10 | 540 | s | s | B | A | Y |
| 11 | 510 | s | s | c | c+ | y |
| 12 | ----- | s | s | c | c | Y |
| 13 | 450 | s | s | c | D | Y |
| 14 | 580 | s | s | c+ | D | y |
| 15 | 530 | s | s | D | D | Y |
| 16 | 500 | s | s | F | F | Y |
| 17 | 530 | s | s | F | D | Y |
| 18 | %50 | s | s | F | w | N |
| 19 | 620 | s | s | c | c+ | Y |
| 20 | 560 | W | W | X | X | N |

KEY: X - Did not enroll in course W - Withdrew from course
 CLA - College of Liberal Arts A - Student's ACT score converted to SATM equivalent

Table 1: Data for Students Who Participated in AIMS I



made two oral group presentations. For the first talk, the students divided into teams based on their engineering specialty and made a presentation about their chosen field of study. For their second talk, students chose one of several environmental topics.

Extracurricular Activities

We made efforts outside of the scope of the two primary fall term courses to enhance the cohesiveness of the AIMS students. On the first day of class each student was given a notebook and tee shirt printed with the AIMS and university logos. During the fall term all of the AIMS students and participating faculty gathered for dinner in one of the faculty homes. Near the end of the academic year, we held a graduation ceremony and presented each currently enrolled AIMS student a certificate of achievement.

Other out-of-class activities scheduled individually and associated with the AIMS chemistry course included participating in a service project to scrape old paint off a community child-learning center, attending a performance of Messiah by the Mercer University Choir, and presenting topical talks for Parent's Weekend.

The AIMS Review/Problem Solving Courses

These courses formally met for one hour, two evenings per week. Although the students were free to work on any academic assignments, one of the evenings was designated for chemistry and the other for math. A course instructor and student assistant were present at each evening session. During the second and third years of the AIMS experiment, the student assistants were AIMS graduates. Course scheduling conflicts, and simultaneous scheduling of supplemental instruction for the regular chemistry course kept participation in these review/problem solving courses well below maximum.

PROGRAM EVALUATION

The authors collected the following data in an effort to evaluate the program.

- Calculus grades
- Chemistry grades
- Retention rates
- Comments from student evaluations

Selected data for students who enrolled in the first year of the AIMS program appear in Table 1. As was mentioned earlier in this paper, the first AIMS class (AIMS-I) consisted of students who were invited, but not required, to participate in the program. The average SAT math score (or its equivalent if the

| AIMS-II DATA | | | | | | |
|----------------|----------|--------------|-----------------|---------|---------|--------------------|
| Student number | SAT-Math | EGR 191 MATH | ECR 192 SCIENCE | CHM 111 | MAT 181 | Enrolled Next Year |
| 1 | 480 | B+ | c | D | c | Y |
| 2 | 500 | F | D | x | x | Y(CLA) |
| 3 | 540 | B+ | A | B | c | Y |
| 4 | 430 | A | A | B+ | B | Y |
| 5 | 530 | A | c+ | c | c | Y |
| 6 | 520 | B+ | B | c | B+ | Y |
| 7 | 490 | B | B | c | D | Y |
| 8 | 510 | D | c | x | F | N |
| 9 | 500 | D | D | x | x | Y(CLA) |
| 10 | 550 | B | c | D | F | Y |
| 11 | 570 | B+ | B+ | c | F | Y |
| 12 | 540 | c+ | B | c | D | Y |
| 13 | 500 | B+ | B+ | c | F | Y(CLA) |
| 14 | 490 | B | B+ | c | c | Y |
| 15 | 540 | B | B | c | c | Y |
| 16 | 540 | B | A | B | B | Y |
| 17 | 580 | B | B | x | D | Y |
| 18 | 530 | A | B+ | c+ | c+ | Y |
| 19 | 450 | c+ | B | x | D | N |
| 20 | 590 | B | c+ | D | D | Y(CLA) |
| 21 | 540 | c+ | c | w | F | Y |
| 22 | 480 | C | R | C+ | D | Y(CLA) |

Table 2: Data for Students Who Participated in AIMS-II



student took the ACT) for this stratified sample of students was 558. During the first year of the AIMS experiment, the **primary AIMS** courses, EGR 191 and EGR 192, were offered on a pass-fail basis. Nineteen “ out of twenty students passed both courses. One student withdrew during the fall term because of health reasons. The grades the students earned in their first calculus course (MAT 181) and their first chemistry (CHM 111) are listed in Table 1. There was a wide variation in the grades earned. Using a four-point scale, the CHM 111 grade point average was 1.55 and the MAT 181 grade point average was 1.66. 32% of the chemistry grades were a D or an F and 41% of the students earned a D or an F in Calculus. Records indicate that approximately 40% of all engineering students at Mercer earn a D or an F in their first science or math course.

Table 2 shows the data for the 22 students who participated in the second year of the AIMS experiment. This year was different from the first year in two important ways. First, the faculty involved in the AIMS course decided to use an A, B, C, D, F grading system instead of S/U. Second, these students exhibited one or more at-risk factors and were granted provisional admission. They were not *invited* to participate in the program; they were *required* to take the AIMS courses in order to be admitted into the School of Engineering. The average SATM score for this group of provisionally-admitted students was 40 points lower than the previous year’s AIMS students.

Once **again**, there was a wide variation in the grades earned in the follow-on Chemistry and Calculus courses. Using a four-point scale, the CHM 111 grade point average was 1.71 and the MAT 181 grade point average was 1.37. More important, only 19% of the AIMS-II students earned a D or an F in CHM 111. Results were not as good for the math section: 55% of the AIMS-II students earned a D or an F in Calculus I.

It is in the area of retention that the AIMS results are particularly positive. According to statistics from Dr. Maureen Biggers, the Director of the Freshman Experience, 71% of all engineering students who entered in the Fall of 1992 returned for the Fall 1993 term; however, during that same time period, 85% of the engineering students enrolled in AIMS returned the following year. Retention statistics for freshmen who entered in the Fall of 1993 were even better: 85% of all engineering students and 910/0 of those enrolled in AIMS were enrolled at Mercer one year later. Clearly, the AIMS program had a positive effect on the retention of freshmen engineering students.

| Year to Year Retention | | | | | | |
|------------------------------|----------------------|---------|----------------------|---------|----------------------|---------|
| | Fall '92 to Fall '93 | | Fall '93 to Fall '94 | | Fall '94 to Fall '95 | |
| | Raw Data | Percent | Raw Data | Percent | Raw Data | Percent |
| AIMS I | | | | | | |
| Retention within Mercer | 17/20 | 85% | 15/17 | 88% | 13/15 | 87% |
| Retention within Engineering | 15/20 | 75% | 10/15 | 67% | 9/10 | 90% |
| AIMS II | | | | | | |
| Retention within Mercer | N/A | | 20/22 | 91% | 19/20 | 95% |
| Retention within Engineering | N/A | | 15/22 | 68% | 14/15 | 93% |

Table 3: Year to Year Retention Within Mercer and Within Engineering

Table 3 summarizes data on the year-to-year retention of students who enrolled in the AIMS program during their freshman year. Nine of the original 20 AIMS students are still enrolled at **Mercer**. One of the students has earned enough credits to graduate **from** Mercer’s School of Engineering this year.



CONCLUSION

The AIMS program and AIMS chemistry course did impact the persistence of students in the School of Engineering and their success in the first chemistry course. Nevertheless, we hoped that the impact would be greater and longer lasting. Both the declining enthusiasm of the students and a judgment that the modest improvement in student performance may not be worth the large expenditure of limited human resources led to the cessation of the program after the Fall 94 Quarter.

Mercer University will convert from the quarter system to the semester system in the Fall of 1997, and the School of Engineering is using the change in academic calendar as an opportunity to implement a modern and integrated engineering curriculum. We plan to include the best parts of the AIMS curriculum in our new 14 semester hour Freshman Experience sequence. Thus, our experiences in the AIMS program are continuing to benefit Mercer entering freshmen engineering students.

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