MEP Summer Bridge Program: Mathematics Assessment Strategies

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ABSTRACT
Arizona State University's (ASU) Office of Minority Engineering Programs (OMEP) has hosted two successful Minority Engineering Program (MEP) Summer Bridge Programs to promote greater awareness of and recruit potential candidates to the College of Engineering and Applied Sciences (CEAS). Through a collaborative effort, the two-week residential program was funded by the Western Alliance to Expand Student Opportunities and the CEAS Dean's Office. The program content and curriculum were designed to prepare underrepresented ethnic minority students for success in the CEAS at ASU. The curriculum focused on engineering design, technical communications, and included a design project. Academic scholarships were awarded to all participants based on a team design project competition. The competition included the design of web pages, documentation in individual design notebooks, and a presentation to industry representatives and parents.

During the summer of 1996, 44 students participated and completed the program. As a recruitment tool, the program was an overwhelming success with 43 of the 44 students completing the academic year (one chose not to because of the family's financial situation). During the summer of 1997, 39 students also completed the program. Currently, 38 of the 39 from the 1997 program have enrolled in the CEAS (one choosing not to enroll because of problems with financial aid). During both programs, the students were given university mathematics placement examinations. The students were then advised to take either MAT 117: College Algebra, MAT 170: Pre-Calculus, MAT 270: Calculus with Analytic Geometry I, or more advanced classes based on their placement test results. However, students were not required to register for a mathematics course based on their exam score. The academic success of these students in their first mathematics course is evaluated relative to their placement score as well as their participation in an academic success seminar and use of the MEP tutoring program.

INTRODUCTION

In Fall 1997, Arizona State University (ASU) enrollment figures including the East, West and Main campuses grew to over 47,000 students, placing it as the fourth largest university in the United States. The Main campus supports 44,255 students: 33,497 are undergraduate (75.7%) and 10,758 are graduate students (24.3%). The undergraduate underrepresented minority students included 2.2% Native American, 3.1% African American, and 10.5% Hispanic students. The graduate underrepresented minority students included 1.3% Native American, 2.4% African American, and 6.3% Hispanic students. [1]

Within the College of Engineering and Applied Sciences (CEAS), the Fall 1997 enrollment of undergraduate engineering students increased by 5.9% (3,625) and the increase in graduate level

students by 1.4% (1,791) constituting an overall 4.4% (5,416) growth in the college enrollment. During this same period, the minority undergraduate engineering enrollment grew by 15.8% (to 579 students, representing 16.0% of the undergraduate engineering students) and decreased by 7.3% (to 89 minority graduate students, representing 5.0%) at the graduate level. [2]

The Office of Minority Engineering Programs (OMEP) in the CEAS at ASU is a growing support system for underrepresented minority students and others. Nearly 580, approximately 16%, of the undergraduate students in the CEAS are underrepresented minorities (African American, Hispanic, and Native American). The OMEP is a support program that targets historically underrepresented students in CEAS. The goals of the program are to increase the number of underrepresented minority students who enroll in the CEAS and to increase the number of underrepresented minority students who successfully complete their undergraduate engineering degree at ASU. These goals are accomplished through programs such as the Peer/Tutor Program, Academic Excellence, skill workshops, MEP New Student Orientation, and ASE 194: MEP Academic Success Seminar.

MEP SUMMER BRIDGE PROGRAM

ASU's OMEP has hosted two very unique Minority Engineering Program (MEP) Summer Bridge Programs to promote greater awareness of and recruit potential candidates to the CEAS. The program content and curriculum were designed to prepare underrepresented ethnic minority students for success in the CEAS at ASU. This residential program was funded through a collaborative effort by the Western Alliance to Expand Student Opportunities (a federally funded agency) and the CEAS Dean's Office. The program offered room and board, classroom materials and supplies, and academic scholarships. The two-week academic program provided participants the opportunity to reside on campus, experience university life and attend classes just as a university student would. The goal was to simulate the college experience, so that the participants would be prepared for the rigors of the engineering curriculum in the fall.

The focus of the program was achieved by centering the curriculum around the introductory engineering course ECE 100: Introduction to Engineering Design. The catalog description of the course is the following:

> Introduction to engineering design philosophy and methodology: computer modeling of systems, processes, and components; design for customer satisfaction, profitability, quality and manufacturing; economic analysis; flow charting; sketching CAD; and teaming. A term design project is included. [3]

This course is the first course that an engineering student will usually take in their curriculum and is a four semester hour, open-ended design course. The course has three components; laboratory, projects and modeling; and consist of six contact hours.

During the summer of 1996, 44 students participated and completed the program. As a recruitment tool, the program was an overwhelming success with 43 of the 44 students completing the academic year (one chose not to because of the family's financial situation). During the summer of 1997, 39 students also completed the program. Currently, 38 of the 39 from the 1997 program have enrolled in the CEAS (one choosing not to enroll until the spring because of problems with financial aid).

THE RETENTION ISSUE

Retention is a major issue at ASU. ASU is primarily a commuter school. Over 80% of the students commute and over half of them work, many over 20 hours a week.[4] In a study by the National Action Council for Minorities in Engineering (NACME), retention in an engineering school was examined relative to five institutional characteristics: 1) institutional control (public versus private), 2) college cost, 3) selectivity 4) number of accredited engineering programs, and 5) number of student support programs.[5] Among the variables examined for this study, selectivity of the institution was the most significant variable in predicting degree attainment for both minority and non-minority engineering students.[5] It is interesting to note that the correlation was even higher for non-minorities than for minority students. All students who qualify for engineering at ASU are admitted, although the prerequisites for admission to engineering are greater than for general admission. This same study stated that "although public institutions graduated almost 2.7 times as many students as private institutions and offered their undergraduates a greater number of support programs, the mean graduation rate of 60.5 percent at private institutions was significantly higher than the mean graduation rate of 38.5 percent at public institutions."[5] In addition this study showed that minority students were graduated at almost the same mean rate as non-minority students in private institutions, while their mean graduation rate was significantly lower in public institutions.[5] ASU is a public institution. Other research has shown that the demographics of an "at-risk student" are low income, minority, first-generation, and commuter.[6] Most of ASU's students are commuters, many are low income, and many are first generation. Thus, the CEAS at ASU has all of the normal predictors for a severe retention problem.

Since ASU has many transfer students from the large, local community college district, retention cannot be measured by comparing graduation numbers with freshman enrollment numbers. Instead, freshman cohorts are followed to determine retention rates. The freshman cohorts are first-time, full-time freshman (FFF), a student who enrolls at ASU with less than 12 transfer hours and enrolls for at least 12 semester hours. Over the last seven years, approximately 70% of the Fall FFF in engineering attend ASU as sophomores.[7] However, only 52% of the Fall 1995 CEAS class were retained in engineering for their sophomore year.[8] Obviously, extensive engineering recruitment efforts are rendered somewhat useless, if we are unable to keep the students in engineering for more than just a year. In addition, in 1995, in cooperation with the Board of Regents of the three Arizona Universities, ASU adopted the goal of a 78% retention rate of freshman cohorts, to be accomplished by the Fall 1999 class. This goal was part of an overall accounting effort to the Board of Regents known as the Hurwitz Measures. Implied in the University adoption of the Hurwitz Measures was the assumption that all units would make efforts to reach the goals.

The CEAS took several steps to increase retention. The orientation program for entering freshman was expanded to include seminars on time management, project management, effective note taking, and the benefit of joining an engineering student society. In an effort to have more faculty (as opposed to graduate student assistants) in the classroom, additional funds were made available to the Department of Computer Science to hire more faculty adjuncts for the many service courses offered by the department. (Obviously, most of the courses taken by the CEAS

freshman are offered by departments outside of the CEAS, such as mathematics, chemistry, physics, and English.) An engineering dorm floor was created as part of the Freshman Year Experience (FYE) university program. In addition to the integrated classes offered by the Foundation Coalition, cluster classes were formed to help combat the isolationism often experienced by women, minority, and commuting students. The Engineering Student Council was reestablished and funding support given to student organizations to send their members to national conferences to help give the students a vision of engineering and to strengthen ties to engineering and ASU.

THE FIRST MATHEMATICS CLASS

An additional concern was the welfare of the freshmen engineering students in their first mathematics class. It was well known that many of the engineering freshmen do not do well in their initial mathematics class. In a survey of freshman students enrolled in ECE 100, it was shown that the grades in the first mathematics class were very significantly different for the students who were retained to their sophomore year versus those who were not retained.[9] See Table 1.

Math Class Grade Earned Fall 95	Still CEAS (n=99)	Left CEAS (n=31)	p
A, B, or C	81.8%	41.9%	0.0001*
D, E, or W	18.2%	58.1%	

Table 1: Comparison of Math Grades earned in Fall 1995 by Students Enrolled in ECE 100 Between Those Who Were Retained for Fall 1996 and Those Who Were Not.
** with Yates' correction*

Although a lower percentage of the minority students in this survey received an A, B, or C than the non-minority students, there was no statistically significant difference in these grade groups. See Table 2.

Math Class Grade Earned Fall 95	Minority (n=21)	Non-minority (n=109)	p
A, B, or C	66.7%	73.4%	0.7154*
D, E, or W	33.3%	26.6%	

Table 2: Comparison of Math Grades earned in Fall 1995 by Students Enrolled in ECE 100 Between Those Who Were Minority Students and Those Who Were Not.
** with Yates' correction*

MATH PLACEMENT PILOT EXAM

Inspired by Lori Hunter of Syracuse University, the CEAS took action to try to improve retention through better placement of students in their first math class. In a presentation to NAMEPA (National Association of Minority Engineering Program Administrators) in January 1996, Ms. Hunter described how she reduced the attrition rate of engineering freshman in her engineering school from 30% to 15% in one year through the use of math placement exams. When freshman took the exams, but were not required to take the math class suggested by the placement score, attrition was 30%. By the next year, Ms. Hunter, now in an Assistant Dean position, was able to have a lock on the enrollment of all freshmen, and thus each student was required to take the math class indicated by the placement exam. In this way, the attrition of engineering students

was halved at Syracuse and the average GPA of the students by the end of their first year had increased considerably.

At ASU, math placement tests had not been used in some years. When the Mathematics Department was approached by the CEAS about the possibility of reinstituting the math placement exam, they were most receptive. In fact, a committee had been working on making a placement exam available for the pre-Calculus, Calculus I, and Calculus II. The decision of the committee at that time was not to make the placement exams available until the whole set was ready. A major issue was that the scores earned on the placement exams in the past had not been an accurate predictor of the math grade to be earned by the student. However, in response to the CEAS request, the Mathematics Department, in the summer of 1996, made available a pilot math placement exam for MAT 270, the first calculus class required by CEAS.

The Calculus Placement Exam was composed of 25 questions covering six problem areas: 1) Area, Volume and Distance; 2) Functions and Graphing; 3) Log and Exponential Functions; 4) Equations, Inequalities, and Factoring; 5) Trigonometric Functions and Their Graphs, and 6) Trigonometric Identities and Trig Equations. A recommended score was given for each subtest area. Recommendations were made to take MAT 117 (Algebra) if the Problem Area Scores were uniformly low and the student felt uncomfortable with algebra. A student with three or more problem areas suggested serious weaknesses and was advised to take MAT 170 (pre-calculus). If the student only had one or two problem areas below the recommended score, they were advised to review those areas and enroll in MAT 270 (Calculus I). In general, only those who scored a 15 or higher were advised to take MAT 270.

The pilot group, on which this exam was first tested, were the 44 participants of the 1996 program. This was a small, manageable group and individual counseling was possible. No math review was given before the exam. The math placement scores ranged from 2 to 23. The placement exam was useful in at least two ways. Some students, who had had Calculus in high school and would ordinarily be advised to begin college with the second semester of Calculus, related that they were not confident of their Calculus skills, and thus would prefer to take MAT 270 at ASU. An example of a typical reaction to this request, would be a student who scored 6 on the placement exam reinforcing their own assessment that they were not prepared for college calculus. The student then took MAT 170, the pre-calculus course, and received a C grade. (The next semester this student earned a D in MAT 270, but was able to repeat this course with a B in the Fall of 1997.) On the other hand, some students who were hesitant to take MAT 270, did so with encouragement based on their math placement score.

The Mathematics Department conservatively suggested that, based on past history, a student had a high chance of obtaining a grade less than a C in MAT 270, if their math placement score was less than 13. Only two students in the pilot group with placement scores less than 13 chose to enroll in MAT 270. Six students scored 22 or higher and chose to enroll in MAT 271 or higher. Four of the six received an A in this math class. One received a C in MAT 271 (and a W in MAT 272 the next semester) and one received an E (retaken the next semester with an A).

Fifteen students took MAT 270. Their math placement scores ranged from 10-22. For those with placement scores of 15 or higher, over 83% of the students received a C or better. Three scores were below 15 and these students received a B (score 10), an E (score 11), and a W (score 14). Among those who score 15-22, three received A's, four received B's, three received C's, and two D's. A regression analysis on this data failed to show a significant statistical correlation between the placement score and the MAT 270 score.

Fifteen of the students chose to enroll in MAT 170 (pre-Calculus). Their placement scores also ranged from 10 to 22. Over 84% of the students received a C or better if their placement score was 8 or higher. The distribution of scores were: three A's, five B's, three C's, two D's, and one E. Although the linear regression was stronger with the MAT 170 enrollees, still only a little over 30% of the MAT 170 grades were accounted by the placement scores. A smaller percentage of the 96 Summer Bridge participants received an A, B, or C in their first math class than did the minority students in the Fall 95 survey (with no placement exam), but the statistical difference was insignificant. See Table 3.

Math Class Grade Earned	Minority Students Fall 95 (n=21) No Placement Exam	Minority Students Fall 96 (n=42) Placement Exam	p
A, B, or C	66.7%	54.8%	0.5265*
D, E, or W	33.3%	45.2%	

Table 3: Comparison of Math Grade Earned in Fall 95 by All Students with No Placement Exam versus Minority Students Enrolled in Fall 96 with Placement Exam Input

** with Yates' correction*

INCREASED RETENTION

In spite of the lack of strong grade prediction due to the math placement exam, over 88% of the 43 bridge students enrolled in Fall 1997 for their sophomore year. Over 77% of these were retained in the CEAS for Fall 1997. (Only 76.2% of the Fall 95 students returned to the CEAS for the 1996 Fall.) The overall FFF retention in the CEAS for the Fall 1996 class was over 66.2%, a significant increase over the 52% that were retained from Fall 1995. In addition, FFF students were retained at a 77.3% rate in the University, a dramatic increase from 68.5% of the year before. This increase is believed to be due, at least in part to the increased retention activities of the CEAS, in general, and the OMEP, in particular.

REVISED PLACEMENT EXAM FOR SECOND BRIDGE PROGRAM

During the 1997 MEP Summer Bridge Program, some math review was given before the math placement test was administered. The students were encouraged to do math review on the internet using the AMP NET program. The process was judged to be ineffective by the students and thus its impact is not known. The math placement exam was revised slightly for use in Fall 1997. The exam was again given to the MEP Summer Bridge Program participants and also during the first week of classes to all students enrolled in MAT 270. The lowering of one grade was used as a threat to get students to take the placement exam. Students were advised on whether they should continue in MAT 270, but there was no penalty for noncompliance. If a student scores less than 15, they are strongly recommended by the Math Department, to take MAT 170. If a student scores less than 10, an academic advisor must approve enrollment to

MAT 270. All of the 97 MEP Summer Bridge program students were counseled and advised on which math class they should take. Only one student took MAT 270 who was advised to take MAT 170. The student withdrew from school during the semester.

Twenty-two of the thirty-eight 1997 participants took MAT 270 their first semester at ASU. Their placement scores ranged from 8-22. For those with placement scores of 15 or higher, all received a C or better. Ten of 22 students took MAT 270 with a placement score of less than 15. None of these students earned a grade better than a C and six earned a grade below C in the MAT 270 course. Six of their scores were less than 13 (actually less than 10) and all earned a grade of D, E, or W. Three students were advised to take courses above MAT 270. One took MAT 270 and earned a B, one student took MAT 271 with a B, and one student chose not to take any math the first semester.

Eleven students chose to enroll in MAT 170. Their placement scores ranged from 6-15. Only two of the students earned less than a C: a student with a placement score of 13 earned a D and a student with a placement score of 6 earned an E. Only one student took MAT 271 (B grade) and one student chose to take MAT 106 (D).

The performance of the 1997 participants in their first math course was significantly better than the performance of the 1996 class. See Table 4.

Math Class Grade Earned	Fall 1996 (n=42)	Fall 1997 (n=36)	p
A, B, or C	54.8%	75%	0.10*
D, E, or W	45.2%	25%**	

Table 4: Comparison of Math Grades of Students in MEP Summer Bridge Program 1996 vs. 1997
** with Yates' correction ** Of these 9 students, two underage freshman withdrew during the semester*

ADDITIONAL ASSISTANCE FOR MINORITY BRIDGE STUDENTS

The 1997 MEP Summer Bridge students were given two additional support systems for retention during their fall semester. The first was required participation in the MEP Academic Success Seminar or a program that clustered students. The second was clustered tutoring sessions offered by the MEP. The overall effect of these additional support programs is shown in the following table. These numbers are small, but if we contrast the students that made use of the tutoring services as well as the seminar, with those that did not use the tutoring services, there is a significant difference at p=0.2101 (with Yates'correction).

Math Grade	Seminar & Tutoring		Seminar & No Tutoring	
	MAT 270	MAT 170	MAT 270	MAT 170,106
A, B, C	8 (88.9%)	6 (85.7%)	8 (61.5%)	4 (66.7%)
D, E, W	1 (11.1%)	1 (14.3%)	5 (38.5%)	2 (33.3%)

Table 5: Comparison of Math Grades depending on Use of Seminar and Tutoring

CONCLUSIONS

Based on the data, students who score 15 or above should enroll in MAT 270. Those below that score should enroll in MAT 170 or in some special cases, MAT 106. To increase the probability

of earning an A, B, or C, the student should also attend an academic success seminar and participate in cluster tutoring. We will continue to monitor this data and will also examine high school GPA's, SAT/ACT scores, and Advanced Placement hours earned to better predict the most appropriate first math course for our students.

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BIOGRAPHICAL INFORMATION

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