AC 2007-1089: INTEGRATED ENGINEERING MATH-BASED SUMMER BRIDGE PROGRAM FOR STUDENT RETENTION

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Dr. is the Assistant Director of the University of Alabama's Environmental Institute and a Research Engineer. She has broad experiences in environmental engineering and science. Dr. Boykin's personal research interests involve the reduction of greenhouse gas emissions from both anthropogenic and non-anthropogenic sources. Prior work included modification of EPA landfill emission model to include applications for soil amendments to cover systems. Efforts have also focused on methane emissions from wetlands and runoff from large confined animal and feedlot operations. Dr. Boykin's other research interests are directed toward developing and analyzing multi-disciplinary classroom and field demonstration methods for basic science and engineering education and distributing research results to K-14 classrooms. Dr. Boykin prepares and performs outreach environmental teaching programs for K-12 schools and environmental technical organizations in Alabama as part of her duties for with the Engineering Math Advancement Program (EMAP), the Environmental Institute, the West Alabama Chamber of Commerce, and Alabama's Experimental Program to Stimulate Competitive Research (EPSCoR).

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Sandra A. Wood received her B.S. degree in Biology/Chemistry from the University of Alabama in 1977 and pursued graduate study in Mathematics and Physical Chemistry before obtaining a Masters of Science in Engineering from the University of Alabama at Birmingham (UAB) in

1981. She has over twenty five years experience as an engineer and scientist in the areas of biomedical, materials and environmental engineering encompassing project and personnel management, technical sales, marketing, public relations, training, teaching, and research. In addition, she has over 15 years of volunteer service and work experience conducting outreach activities related to the encouragement, exposure, and education of students and the general public to careers in and the importance of science, engineering, and mathematics in today's society. Her professional contributions include over 25 technical papers and abstracts prepared for publication or presentation at regional and national association meetings and research conferences. Sandy joined the faculty at the University of Alabama College of Engineering in Tuscaloosa, Alabama, as the Freshman Program Coordinator in March 2002. Previously, she was employed as the Director of Outreach & Redshirt Engineering at the UAB School of Engineering in Birmingham, Alabama (2000-02) and as the Science, Math, and Relevant Technology (SMART) Coordinator at Girls Incorporated of Central Alabama (1999-00). Her current level of involvement in the UA Freshman Engineering Program includes assisting with academic advising, mentoring, retention, and freshman level curriculum instruction. During the summer months, she also assists with the development and instruction of high school students and teachers in UA's engineering outreach programs and with incoming freshman student orientation and registration. Prior to working in academia, Sandy was the Technical Representative and Regional Manager for Southeastern Distribution and Sales for Maryland based Neutron Products Incorporated (NPI). In this capacity she was responsible for marketing, sales, customer service, quality control, and production of flocculent polymers for mining, pulp and paper, and municipal wastewater treatment. From 1990-93 she worked in the Construction Materials Technical Center of Vulcan Materials Company (VMC) headquartered in Birmingham, Alabama. As a Research Engineer, she conducted and directed a variety of engineering projects ranging from customer technical service, construction materials design, waste recovery and minimization, by-product research & development to computer based environmental modeling while interacting with company personnel at all levels as well as with external technical, state and federal agencies, public and private research organizations, and academic institutions. Prior to VMC, Sandy held positions as Engineering Laboratory Manager, Materials Engineer, Construction Services Manager, and Environmental Scientist for a southeastern region based consulting civil engineering firm (1987-90). Early in her career, she performed basic and applied medical and biomaterials research at Southern Research Institute then the University of Alabama at Birmingham (1978-86). Ms. Wood is a Past President of the Engineering Council of Birmingham (ECOB) capping a 10 year commitment to that organization and has also served on its Executive Advisory Board. From 2002-2004, Sandy served on the National Board of Directors for the Society of Women Engineers and as the SWE 2003 National Conference Committee Education Chair. She is the recipient of several honors and leadership awards including Tau Beta Pi Engineering Honor Society, ECOB 1989 Young Engineer of the Year, ECOB 2001 Distinguished Service Award, and was named as a national Delta Chi Fraternity Faculty Advisor of the Year in 2006. Sandy's professional affiliations include the American Society of Engineering Educators (ASEE), UA Capstone Engineering Society, UAB Engineering Alumni Society and the UA National Alumni Association. In addition, she is a Life Member of UAB Alumni Association, Tau Beta Pi, and the Society of Women Engineers. Sandy is currently serving as a Vice-Chair for the ASEE Freshman Program Division.

Larry Bowen, University of Alabama

Larry Bowen is currently the Associate Director for the Center for Teaching and Learning (CTL) at The University of Alabama and adjunct instructor of mathematics in the Department of Mathematics. He also serves as Faculty-In-Residence in a freshman living-learning community on campus. Dr. Bowen obtained his B.S. and M.A in Secondary Education Mathematics, M.S. in Statistics, and Ph.D. in Statistics (with minors in Mathematics and Computer Science/Numerical Methods) all from The

University of Alabama.

Dr. Bowen works university-wide with a range of issues and programs related to student retention. He also works closely with the Department of Mathematics in providing supplemental assistance to students in introductory mathematics courses, including courses taught in the UA Math Technology Learning Center (MTLC), in curriculum design, and in textbook selection for departmentalized mathematics courses. He also

teaches a mathematics course in the Department of Mathematics each semester.

Kevin Whitaker, University of Alabama

Kevin W. Whitaker is currently the Associate Dean for Academic Programs in the College of Engineering at The University of Alabama. He has been a member of the UA faculty since 1987. Dr. Whitaker obtained his B.S. in Mechanical Engineering from General Motors Institute, a MS in Mechanical Engineering from Texas A&M, and a Ph.D. in Aerospace Engineering also from Texas A&M University. His professional research interests are in the areas of applied artificial intelligence, propulsion system inverse design and optimization and hypersonic aerodynamics. Dr. Whitaker has conducted numerous research projects for NASA, most recently analyzing spectral data from Space Shuttle Main Engine exhaust plumes using neural networks to monitor engine health.

Dr. Whitaker is also very active in educational research and curriculum reform. From 1995 until 1998, he served as the UA Participating Institution Coordinator for the NSF-sponsored Foundation Coalition, a multi-year, multi-million dollar effort to reform engineering education. Dr. Whitaker is also a co-PI for NASA Opportunities for Visionary Academics (NOVA). This is a NASA-funded national effort to reform higher education's science, math, engineering and technology courses for pre-service teachers.

Integrated Engineering Math-Based Summer Bridge Program for Student Retention

Abstract

The University of Alabama (UA) student retention statistics revealed that less than 33% of incoming engineering freshmen were retained through graduation. Furthermore, low performance in calculus was also found to impact upper-level engineering classes. This graduation rate is 19 points lower than the national average of 52% for similar programs [6]. Analyses indicate that the primary reason for low retention is an inability of incoming freshmen to perform well in calculus classes. At UA on average 30% of freshmen place into calculus and therefore are ready to follow the recommended program of study for engineering students, 10% of freshmen place into remedial math and the remaining 60% are the target group for our program. This group represents the students who will enroll in pre-calculus algebra or trigonometry and who are typically 1-3 semesters behind the recommended program of study for freshmen engineering students. To address this retention problem the UA College of Engineering developed a five-week summer residence class called the Engineering Math Advancement Program (E-MAP). This National Science Foundation (NSF) funded program prepares incoming freshmen for calculus in their freshman year. The program aims to increase retention by preparing students to 1) do well in calculus and 2) get excited about engineering. In addition to intensive math instruction, the program includes hands-on "Living-Lab" experiences, field trips and a community service project led by professional engineers.

The program is evaluated annually by a team of K-12 math and science teachers lead by a professional evaluator from out of state. Evaluators spend three days on campus each year during the five week program session. They review and evaluate the program and offer guidance for improvements. They have been generally impressed with the program design and implementation to date. Changes made in response to evaluations are mainly in the areas of student recruitment, grading criteria, study skills, and program cohesiveness. Although these changes resulted in a fewer percentage of participants being allowed to proceed to Calculus I, the second year showed overall improvement in student deliverables and grades over the first year. The upcoming year-three will involve more interactive problem solving, a better defined minority program, a standardized interwoven societal benefit project, and continued work to identify methods to compare the E-MAP control group.

One of the program goals is to determine the best set of teaching methods and materials providing greatest impact on performance, ultimately measured through increased graduation rates, in the limited amount of time available for instruction. Program assessment involves both qualitative and quantitative data involving standardized tests and stakeholder evaluations. Standardized tests include Learning and Study Strategies Inventory (LASSI), Math Science Inventory and Meyer-Briggs in conjunction with the Pre- and Post- Math Placement Tests. Results of the first two years of the program indicate that E-MAP has helped a majority of participating students in engineering-math preparedness. Math Placement Test data from both years show that 84% of E-MAP participants skipped at least one math course and 41% 2-3 courses. Analysis confirms results are statistically significant and provide very strong evidence

to conclude that the mean of pre and post E-MAP students' grades are not equal. At this level of significance, the data proves that, on average, post-program grades (course grade 79.7) are greater than pre-program grades (course grade 56.6). Of the 90% of year-one students who went on Calculus I, 67% passed the class which is close to the control group average. In addition 30% of participants have been minority and women students. Female averaged scores were higher compared to male scores, the first year showing a significant difference (up to 10 points) in math scores.

1. Introduction

The University of Alabama (UA) College of Engineering (COE) is the oldest engineering college in the state of Alabama and one of the five oldest in the nation starting in 1837. The College has been steadily moving up the rankings in "U.S. News and World Report". In the year 2004 the college was ranked 84th among all engineering colleges nationwide, up from 88th in 2003 and 98th the year before (2002). This is the third consecutive year the university has been ranked, and the third consecutive year the college has moved up in the rankings.

The College goal is to enroll 2,100 students by the year 2010 and provide one-third of the undergraduate students with scholarships. As of Fall 2006 semester, the actual enrollment at The University of Alabama is 19,474 undergraduate students of whom 1,858 are engineering undergraduate students. This represents approximately 9.5% of the total undergraduate enrollment per year at UA. The College of Arts and Science which includes the math and general science departments, makes up the majority of undergraduate enrollment with about 31.8% of the total undergraduate enrolment. It is followed by the College of Commerce and Business Administration with approximately 24.7% of the total enrollment. Table 1 shows the distribution of undergraduate students enrolled nationwide, in the state and at UA by their major college. This data confirms that although engineering enrollment is higher than the national average we lag the state average. There is a strong preference for Arts and Science across the data with UA showing the highest percentage enrolment compared to the state and national data (data from U.S. Department of Education, Alabama Commission on Higher Education and The University of Alabama) [1], [7], [8].

Table 1. Distribution of Undergraduate Students Enrolled in Doctoral Granting Colleges as of Fall 2005 (Percentages unless otherwise noted) [1], [7], [8]

College Enrolment/Total University Enrolment	National	State of Alabama (including UA)	UA
Engineering	5.8	11.3	9.2
A&S/Total	33.6	39.7	32.9
Commerce & Business	21.1	14.7	24.2
Other	*39.5*	*34.3*	*33.7*

2. Background

Math is one of the primary tools of engineering. The earlier the student learns to master the tool, the better he/she can manage the tool and apply it to problem solving. Lack of

preparation in math is one of the main factors contributing to student dropout in Engineering at UA. The UA student retention statistics showed that less than 33% of incoming engineering freshmen were retained through graduation. This is 19 points lower than the national average of 52% for similar programs. Analyses indicate the primary reason for low retention is an inability of incoming freshmen to perform well in first-year calculus classes. Studies at UA have established that around 60-70% of entering freshman engineering students are not calculus ready [3] [10]. Since the engineering program of study at UA assumes calculus ready students, 70% of entering freshman engineering students are under-prepared for the program due to deficiency in mathematics. The main results of this are poor performance in math related engineering classes, longer time to graduation and low graduation rates from engineering.

Math Placement Test scores (MPT) collected by UA's Engineering Student Services Office are one measure used to document the fate of students who enter engineering as freshmen and categorize them into two groups: those who stay in engineering, and those who leave the engineering college but stay at UA. This data is shown in Figure 1 as percentage in each group versus math placement score. Historically, students scoring below 310 on the Math Placement Test do not have the math skills needed to pursue a career in engineering and either do not enter into engineering or leave the college soon after starting the program. For students with math placement scores below 440, retention is also low. The majority of pre-calculus ready students leave engineering as a result of their math skills not being at the level that allow them to succeed in engineering math based courses. Although not as significant, retention is a problem in the higher scoring group. Based on research, the main reasons for retention problems in the 440 and higher group are 1) students are not challenged by material taught at lower math levels and 2) students were in general not motivated to continue in the pursuit of a career in engineering [3].
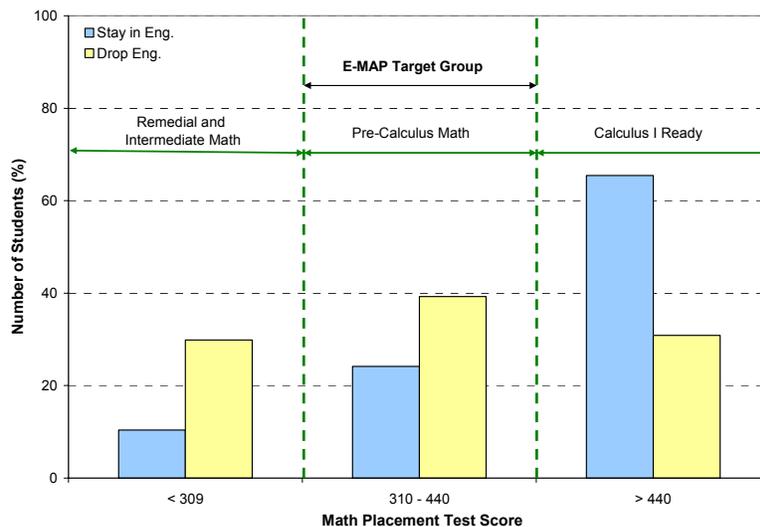

Figure 1. Student Retention in Engineering as a Function of Math Placement Test Score

To combat this deficit, UA developed a unique, informal, interactive, and interdisciplinary five-week summer residence class called the Engineering Math Advancement

Program (E-MAP) sponsored by the National Science Foundation, to prepare incoming freshmen for calculus. The program aims to increase retention by preparing students to 1) be successful in calculus and 2) be excited about engineering. In addition to a non traditional math class, the program includes hands-on "Living-Lab" experiences, field trips and a community service project led by professional engineers. The non-math aspects of the program were developed to strengthen mathematical skills indirectly through engagement of the students in laboratory and real world engineering problems, in the idea that solving skills are best nurtured through hands-on experiences [4], [5]

3. E-MAP Program

The E-MAP program is based on a number of pre-existing programs including those at the colleges of engineering at University of Alabama in Birmingham (UAB), Tuskegee University and Northwestern University. The UAB "Red Shirt" Program is a privately funded pre-engineering program. One of the Co-Principal Investigators of our E-MAP project previously oversaw and taught the Red Shirt program as an algebra based, pre-engineering calculus summer program [9]. Another similar program in Alabama initiated a few years ago for computer science ramp up at Tuskegee University has become so popular that students are being turned away due to the class size limitations [2]. Northwestern University also implemented a similar program. Northwester's program called "EXCEL", began 21 years ago and is specifically aimed at minority students. Northwestern credits this program for giving them the highest minority retention rate in the nation [6].

UA E-MAP program is five-week summer residence calculus ramp-up class for incoming freshmen engineering students and is based on a combination of the "EXCEL" and "Red Shirt" template. It is an optional program, offered the summer prior to the freshmen year of college. Its main goal is to prepare incoming freshmen for calculus class and thereby increase the number of students retained in engineering. Entering Freshman students with Math Placement Test scores in the program target range are eligible to enroll in E-MAP. The program is tuition-free, the only cost for the student being food and on-campus accommodation. Scholarship is also available for up to 30% of the participants based on their needs.

Although entering freshmen students are not required to participate in the E-MAP program, they are strongly encouraged to do so. They are expose to the program through an intensive mailing campaign and high school advising. Promotional material includes program flyers, poster presentations a program web site and program advertisements on UA and COE websites.

In addition to intensive math training the program also engages students in hands-on problem solving labs, a group project, and gives the students a "sneak-peak" at what engineers do after college. There are two other programs at UA that target high school and freshmen students: the Student Introduction to Engineering (SITE) program is a general interest program targets high school juniors and seniors interested in engineering, and the Freshman Engineering Program is the first official engineering class for the incoming students. Both programs promote math skills to some degree, but there is no direct "bridge" between high school and the first semester of college which would enhance or improve the engineering math skills of the majority

of students entering COE. The E-MAP role is to fill in this gap and provide the graduate high-school/pre-freshman students the necessary background to be engineering calculus ready. Figure 2 shows how the E-MAP program complements existing math based programs offered at UA.
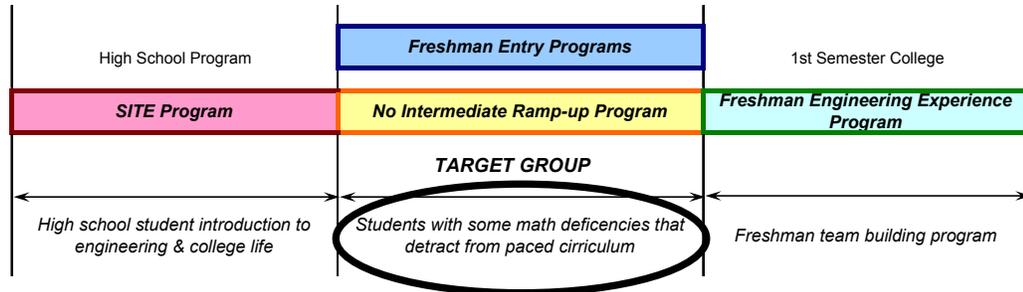

Figure 2. Freshman Entry Programs at UA

The E-MAP program specifically targets 60% of students entering the COE and transfer students coming in with math skills within the target group. Normally, these students would enroll in Math 112 (Pre-Calculus Algebra) and 113 (Pre-Calculus Trigonometry), or Math 115 (Pre-Calculus Algebra and Trigonometry), placing them in either case a year behind the remaining 30% entering at the Engineering Calculus 125 level. Up to an additional year is required to get back on track with the core engineering courses. The lower 10% are not yet ready to enter at the engineering pre-calculus level and would require additional instruction outside the scope of this program. The upper 30% consist of engineering calculus ready and are therefore also outside the scope of the E-MAP program (Figure 3).
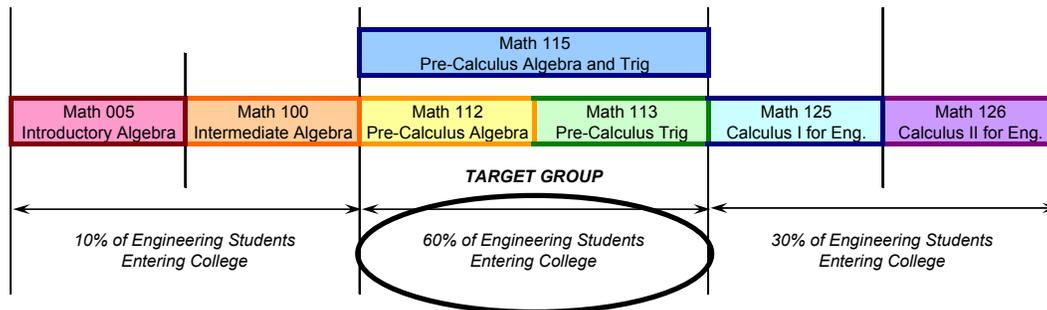

Figure 3. E-MAP Target Group Related to Math Placement Test Score

3.1 E-MAP Structure

The program is structured to include a variety of experiences to enhance math skills and student engagement in engineering. The engineering related activities include hands-on "Living-Lab" experiences, field trips and a community service project led by professional engineers. In addition, the incorporated fun learning experiences, teambuilding and social activities help avoid summer burn-out and encourage participation and bonding. Math classes are taught in blocks in

the mornings only. The afternoons are allocated by rotation to Living-Labs, Calculus Lab, and Community Service Project. One day per week is reserved for the learning experience through the field trips. Social activities and/or math tutoring are available in the evenings.

Math Class

The E-MAP program offers an alternative curriculum for pre-calculus math building upon the principal that students are individuals with different learning styles. The structure of the E-MAP math program provides time for individualized mentoring experiences that could not take place in the traditional lecture classroom because it involves all three forms of learning through the use of multi-media introduction of new material, one-on-one tutoring, and hands-on experience with applications. The classroom model is based on a small student/teacher ratio with a lead instructor assisted by two teaching assistants (TAs). Students are taught pre-calculus algebra and trigonometry for two hours per day. The math class incorporates relevant math concepts from engineering labs and service projects that the students are participating in. Additionally, tutoring sessions are available in the afternoon and evening. Classroom TA interacts within the groups to explain and reinforce concepts. In class testing including a final exam determines if E-MAP students are calculus ready.

Living Laboratory

The Living Laboratories are based on the eight areas of engineering at UA and they are taught in multiple blocks to keep student-instructor ratios low and to allow flexibility in scheduling. Each student is required to take four three-hour labs. Students may select three out of nine offered laboratories, the fourth one being assigned by the program coordinators based on student interest and lab availability. The two primary objectives of the laboratories are: the use of math skills in an engineering setting, student exposure to the practical side of each engineering discipline. The application of math skills in engineering is experienced, for example, by exposing students to "data-gathering" experiments in each laboratory, data is then used to examine, explain, or derive basic engineering theory. The second objective is achieved by giving "broad-picture" engineering problems to illustrate the thought process behind each step of engineering analysis, and to design and teaching students how to break large, complicated projects down into small manageable pieces. This is an opportunity for the departments to immerse the students in the "hands-on" work within each field and assists the student in career selection and development.

Field and Campus Trips

One day per week is dedicated to exposing students to off-campus engineering practice such as plant and project tours. The field trips, usually a day long, are designed to focus on one or more engineering career fields. We believe that the field trips will facilitate student exposure to potential employers by providing introductions and promoting interactions between students, key industry, government representatives and decision makers. Societal impact events were conducted to educate students on engineering responsibilities. An effort has been made to line

up effective speakers, demonstrations and interactive exhibits at the plant sites so that students are engaged rather than just observers.

Campus tours of local interest sites were interwoven with presentations by key freshman program personnel to assist with orientation information including registration and housing. Societal and campus activities were held in the afternoons on days where no laboratory components were conducted.

Community Service Theme Project

The societal benefit component introduces students to participate as "team engineers" on real-world projects sponsored by the West Alabama Chamber of Commerce's Environmental Task Force. The "Chamber Project" addresses how to research a project, how to work as part of an engineering team, and the thought process in tackling a large engineering problem. The Chamber members were extremely impressed with the student's presentations and their interaction with local engineers. They asked for continued sponsorship of E-MAP as a Chamber outreach program and have helped to advertise activities with the local press. Year two incorporated a real world societal benefit project for the creation of a "theme park" in the Lake Tuscaloosa area (Figure 4). Problems related to the various design aspects were reiterated and reinforced in various program components.

Figure 4. Community Service Theme Project - Water Park

4. Program Evaluation

4.1 External Evaluation

Each year, the program is evaluated over a three day period by K-12 math and science teachers as part of a team lead by a out of state professional evaluator from Cape Ann Economics (CAE), Dr. Edward Moscovitch, who has worked over 20 years to assess and develop educational programs in Alabama. Evaluators participated in classes, labs, tutoring sessions, and held one-on-one interviews with the students and program participants (professors, instructors, and teaching assistants). To date, the evaluators have been impressed with the program design stating that "on a broad scale, E-MAP is a wonderful program" backed by an "able group of instructors, professors, and teaching assistants." During the past two years, CAE and the K-12 evaluators have outlined strengths and weaknesses in the program as guidance and as part of the continual quality improvement cycle. The areas of strength focus on several key assets of the program. First, the pre-calculus instructor Sam Evers was given very high marks for his teaching style, on-line homework and on-line tutorial program. Second, the program also included a module on how to study providing basic study skills needed for college. Third, the labs and community service project were held in high regards for the "hands-on" learning combination of project work, math skills, and basic engineering principals. Finally, the role models provided by the teaching assistants served as effective examples of the success students could obtain while at the College of Engineering.

CAE and the K-12 evaluators also noted areas for improvement. From year one to year two, program changes based on evaluator comments were made mainly in the areas of student recruitment, grading criteria, study skills, and program cohesiveness. In the area of recruitment, more mailers were sent to the schools themselves and more follow-ups were provided to interested students. In year two, the grading criterion was increased to deduct for students who did not attend classes, labs and events. Students were advised prior to starting the program that those who miss any three sessions would be asked to leave the program. A study skills session was added along with a themed service project used as the basis for the lab work and field events. Although these changes resulted in a lower percentage of participants being allowed to precede to Calculus I, the second year showed overall improvement in student deliverables and grades. Year two evaluation included most notably: more student participation in the math classes is needed, better use of teaching assistant time in the classroom, more use of computer networking, making the labs of "even greater quality", expanding the curriculum to address introductory science areas of concern such as physics, differentiated instruction in small groups with TAs, and determining need for assistance during the school year. Efforts were made in Fall 2005 and 2006 semesters to provide several tutoring sessions to monitor progress and to provide additional guidance as needed. Unfortunately, students have not show much interest in attending these sessions. They will be offered again in Spring 2007 semester and examined more closely to determine methods for increasing participation. Additional plans for 2007 are to further weave the themed project from the labs and events into the math lectures as well as to include more hands-on projects into each class. Students will be called on more to work problems, for general participation, and introduced to guest lectures by TAs and others to increase the level of

interaction and attention. Class materials from 2006 are currently being refined to address these modifications.

4.2 Internal Evaluation

The internal evaluation program provides an analysis of student feedback gathered through evaluations of labs, field trips, the math class itself, and the overall E-MAP program. Students evaluated each of their engineering labs, using grades of A – F (4 for an A, 0 for an F). Students in the first summer program had 9 labs with average ratings of the overall lab experience from a low of 2.3 (Mechanical) to a high of 3.8 (Electrical and Environmental) while students in the second summer program had 10 labs with average ratings of the overall lab experience from a low of 1.6 (Calculus) to a high of 4.0 (Environmental).

The average rating for the lab teacher was consistently higher than the average rating for the overall lab in the first year, but tracked relatively closely with the rating for the overall lab for the second year. The students' ratings of their own math preparation for each lab were noticeably lower in the second year than the first year with average ratings from a low of 1.7 (Calculus) to a high of 3.6 (Environmental and Hydrology) but were actually more in line with their ratings of the lab experience and the lab teacher. The first year students' ratings of their own math preparation for each lab were very good with average ratings from a low of 3.2 (Material and Mechanical) to a high of 4.0 (Environmental).

The most problematic lab was the Calculus lab which was added this year. The idea behind the lab was to give students a feel for the big ideas in calculus but given that the comments were almost uniformly negative, much thought needs to be given to retooling this lab. The most common negative student comments about the lower-rated labs seemed to be related to (1) confusion about what was going on in the lab, needed clearer explanations of what was to be done, (2) needing more preparation for the lab, (3) not enough 'hands-on' participation, (4) the use of Excel spreadsheets, (5) a belief that the lab was boring, (6) distractions (noise, the heat), and (7) having too much to do in the allotted time. By contrast, the higher-rated labs received much more positive feedback often related to the 'hands-on' quality of the lab. Additionally, E-MAP students were asked to 'grade' each of the summer events, using grades of A – F (4 for an A, 0 for an F). For second year students, there were 12 events with average ratings from a low of 2.41 (Pool) to a high of 3.56 (3-way tie: Lake & Hydro Plant, Lake Tuscaloosa, and Bowling). The comments were mostly favorable and 18 of the 33 E-MAP students completed the evaluations. (During the first year only 5 of the 28 students in the program actually evaluated these events.) Although the second year results in this area are an improvement over those of the first year, it would be useful in the future if evaluations could be obtained from all of the participants in the program to ensure representative results (Figure 5).

Students also evaluated their core math course along with some aspects of the overall E-MAP program. The results were quite positive and it was clear that the students thought highly of the overall E-MAP program and even more positively of their math instructor. The only disappointing result here was the students' frank acknowledgement that they were not taking advantage of the tutoring sessions outside of class.
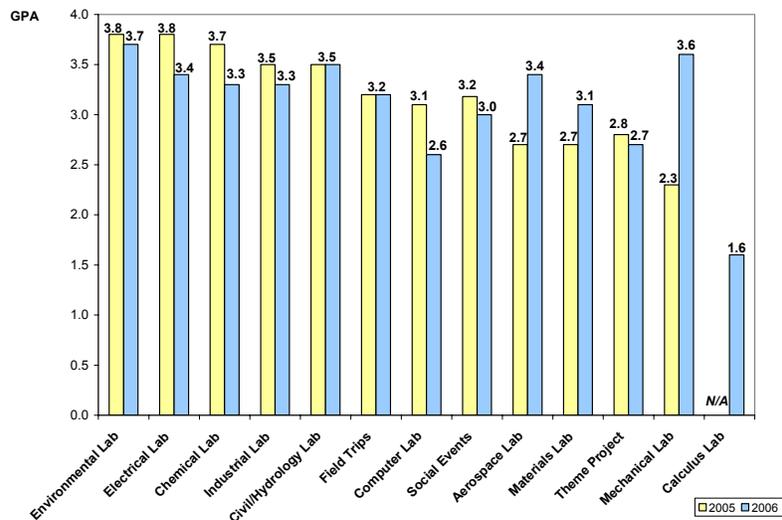
Figure 5. E-MAP Program Components Evaluation

4.3 Program Quality Improvement

At the end of each summer program, the student feedback was shared with the instructors. Suggestions and comments were discussed and addressed in group or in one-on-one meetings. The Internal Advisory Board meets twice yearly to discuss progress, new ideas, and improvements. Also, there are open discussions about student's feedback and plans for improvements for the next year.

5. Outcomes

The benchmarks that will be used to measure progress as the project moves forward are: 1) GPA, 2) retention rate, and 3) graduation rates between students who took the program and compared to a control group comprising of students not participating in E-MAP within the same initial math placement score range. Students in the program will be tracked during their college career. At least 20% of the students going through the course will be interviewed at the end of each semester to determine how they were impacted, and if they believe the program helped them during the prior semester. Additionally, each student in the program that may leave the COE or UA will be given an exit interview to determine what factors contributed to their decision to leave, and if math deficiencies still played a role.

From the total number of first year E-MAP students about 30% have been minority and/or women students. However, on the second year of E-MAP, about 40% of the participants were women and about 60% were minorities (Black or Hispanic) (Figure 6)
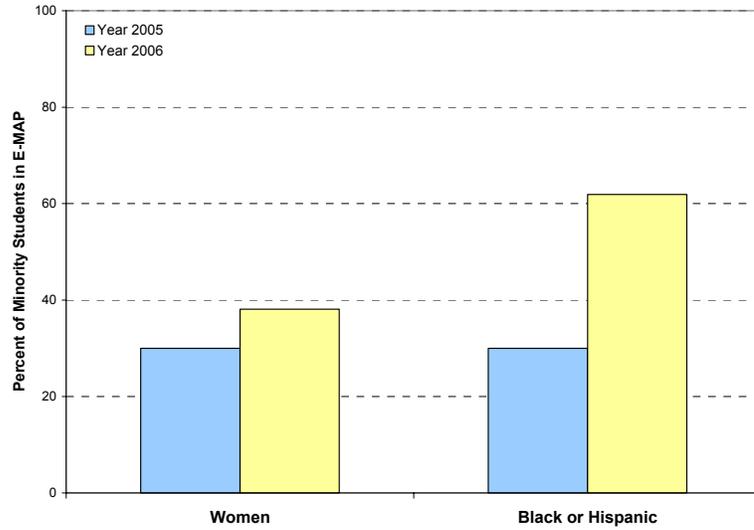
Figure 6. Demographic of E-MAP Students

5.1 Program Effectiveness

As mentioned earlier, an average 30% of freshmen place into calculus, 10% in remedial math and 60% are the target E-MAP group. Students who enroll in pre-calculus algebra or trigonometry are 2-3 semesters behind in the program of study. Figure 7 shows the Math Placement score of the E-MAP versus control group students. Each year of E-MAP has a control group selected from the students who did not participate in the program, but entered COE with the MPT scores in the E-MAP target range. From the graph it can be seen that year-one E-MAP students had lower MPT average scores before the beginning of E-MAP program. Later tests results indicate that E-MAP has helped a majority of students in engineering-math preparedness. Math Placement Test data from both years show that 84% of E-MAP participants skipped at least one math course and 41% 2-3 courses due to summer math preparation.
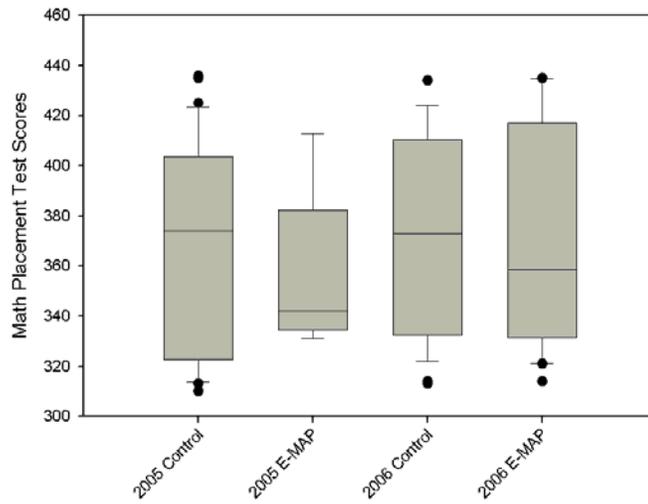

Figure 7. Math Placement Test Score of Control Groups vs. E-MAP Groups

Analyses confirm that the results are statistically significant and provide strong evidence to conclude that the mean of pre and post E-MAP students' grades are not equal. At this level of significance, the data proves that, on average, post-program grades (course grade 79.7) are greater than pre-program grades (course grade 56.6). Female averaged scores were higher compared to male scores, the first year showing a significant difference (up to 10 points) in math scores.

Year-One was a Pilot Program and information from it has been incorporated into Year-Two. Changes were made mainly in the areas of student recruitment, grading criteria, study skills, and program cohesiveness. Although these changes resulted in a fewer percentage of participants being allowed to proceed to Calculus I, the second year showed only slight improvement in student deliverables, grades and retention in engineering field (Figure 8). Of the 90% of year-one students who went on Calculus I, 67% passed the class which is close to the control group average of 68%, even though initial math placement grades for E-MAP students was on average 35 points below the control group.
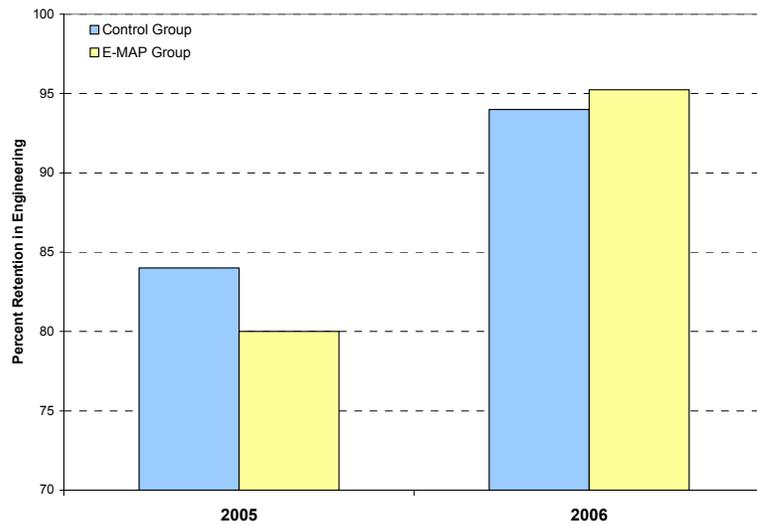

Figure 8. Student Retention in Engineering

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