

AC 2008-658: A PRE-ENGINEERING CLASS TO RETAIN STUDENTS INTO AN ENGINEERING MAJOR

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A Pre-Engineering Class to Help Students Gain Admittance Into an Engineering Major

Abstract

In the fall of 2001, the Bagley College of Engineering at Mississippi State University instituted admissions criteria into the college. Prior to fall 2001 any student admitted to the university who expressed a desire to major in engineering was admitted directly to the college. Since this time, students who are admitted into the university expressing an interest in engineering who do not meet these criteria are admitted as undecided majors with a pre-engineering concentration. The admissions criteria were established by studying the graduation rates of students entering the college. The admissions criteria are a combination of high school GPA and ACT scores. Students in this designation are advised by a special advisor in the academic advising center and can be admitted to engineering upon successful completion of English Composition I, Calculus I, and Fundamentals of Chemistry. Approximately 100 students annually are admitted with this designation.

From 2001-2005 these students were studied to determine the rate at which they matriculated into engineering from this designation. This study determined that very few of these students ever successfully gained admission into engineering. While not all of these students were capable of being successful in engineering, some of these students could be successful if they made up deficiencies in their backgrounds (generally deficiencies in mathematics). More troubling to the college was the disproportionate number of minority students who were represented in this group.

In the spring of 2006 the college instituted a one-hour Introduction to Engineering class for this group of students. This class has enrolled 65-85 students in three offerings since this time (spring 2006, fall 2006, and fall 2007). All students who are in the pre-engineering designation who have not had the course are strongly encouraged to enroll. This course includes an overview of each of our engineering majors as well as personal development topics such as study skills, time management, technical communications and learning styles.

This paper will discuss the topics covered in the course and level of expectation for the students, and feedback from the students on the benefits of this class.

Background

Mississippi State is a public, land-grant, doctoral, research university classified as Doctoral/Research-Extensive by the Carnegie Foundation. Enrollment is approximately 17,000 students. The Bagley College of Engineering enrolls approximately 2,500 students, 2,000 of which are undergraduates. The College awards approximately 370 B.S. degrees per year through ten engineering programs (aerospace, biological, chemical, civil, computer, electrical, industrial, mechanical, software, and computer science). Demographically, approximately 12 percent of the Bagley College of Engineering undergraduates are African-American and 18 percent are female. Also, the Bagley College of Engineering ranks in the top 10 percent among U.S. colleges of engineering in research expenditures (~\$58M).

In the fall of 2001, the Bagley College of Engineering at Mississippi State University (MSU) instituted admissions criteria into the college. Prior to fall 2001 any student admitted to the university who expressed a desire to major in engineering was admitted directly to the college. Since this time, students who are admitted into the university expressing an interest in engineering who do not meet these criteria are admitted as undecided majors with a pre-engineering concentration. These admissions criteria were established by studying the graduation rates of students entering the college. The admissions criteria are a combination of high school GPA and ACT scores. Currently the criteria for admission to the college are: 23 or higher composite ACT score; or ACT of 20, 21 or 22 with a high school core GPA of 3.0 or better; or a high school core GPA of 3.5 regardless of ACT score as long as the student meets the university criteria for admission. Students who take the SAT rather than the ACT have their SAT score converted to an equivalent ACT and the same criteria apply. These students are admitted to engineering upon successful completion of 30 semester hours with a 2.0 or better GPA and grades of C or better in English Composition I, Calculus I, and Fundamentals of Chemistry. Transfer students who would not have been eligible for admission as new freshmen are also given this designation unless they have satisfied the requirements above with their transfer course work. Approximately 100 students annually are admitted with this designation.

Students in this designation are advised by a special advisor in the academic advising center. Personnel in the Bagley College of Engineering work closely with this person in the advisement of these students. College of Engineering personnel actually advise these students during Mississippi State's summer orientation sessions. The college of engineering has also published an advising guide which covers the initial set of courses that students in the pre-engineering designation should take based on the particular engineering major they wish to pursue and their math and English ACT sub-scores which determine placement in early math and English classes. Students in this designation are usually deficient in their math backgrounds and are advised to enroll in the appropriate math class each semester until they satisfy the math requirements of their intended engineering major.

From 2001-2005 a total of 546 students were studied to determine the rate at which they matriculated into engineering from this pre-engineering designation. This study determined that only 8% of these students moved to an engineering major one-year following admission and a mere 12% had moved to an engineering major after two years. While some of these students had unrealistic expectations about what their chosen engineering discipline actually involved and some did not have sufficient mathematics and reasoning skills to be successful in engineering, some of these students could be successful if they made up deficiencies in their backgrounds. More troubling to the college was the disproportionate number of minority students who were represented in this group.

Pre-Engineering Class

In the spring of 2006 the college instituted a one-hour Introduction to Engineering class for the students in the pre-engineering designation. This class has enrolled 65-85 students in three offerings since this time (spring 2006, fall 2006, and fall 2007). This course is taught in one large lecture section. This course was established with several goals in mind. First, the course was

designed to give these students a better idea of the nature of the different engineering disciplines. The course was designed to provide students with more information about what types of opportunities are available in each of our ten engineering majors so these students make earlier decisions about the appropriateness of their major choice. Secondly the course attempts to help students realize the magnitude of the academic challenge they were undertaking. About 1/3 of these students start in our pre-college intermediate algebra class upon entry to Mississippi State. These students have three semesters of mathematics that must be completed before they can even begin the calculus sequence required of engineering majors. Although the intent is not to scare these students off, the students do need to have realistic expectations about the time to degree implications of starting at this level in mathematics. During the initial study of the students in the pre-engineering designation it was discovered that not only were many students not successful in moving into an engineering discipline, but that by the time they decided that they needed to pursue alternative majors, their GPA's were such that they were not eligible for admission into other majors on campus. This course would be considered successful if it helped those students who were capable of succeeding in engineering to make the transition and those that need to seek other majors to make the transition before they got into academic difficulty.

When this course was designed, similar classes at other institutions was considered as models. Hagenberger, Engerer and Tougaw⁴ provide a survey of the common philosophies behind current Introduction to Engineering classes at other institutions. Although the MSU class is closely aligned with the category that they identify as providing the basic survival skills for college students, the MSU course also covers engineering specific topics as well. A conscious decision was made not to develop a project-oriented course (e.g., Elzey¹; Lo, Lohani and Griffin⁷) due to the significant investment of faculty resources for such a course. Typically students in these types of courses have been admitted into engineering and the goal of such courses is to develop their design skills and pique their interest in engineering. The faculty have a vested interest in putting the required effort into these courses in order to retain these students in engineering majors. However, many of the students in the MSU class, approximately 90%, will decide not to major in engineering. While this is a beneficial outcome for the students involved, it limits the amount of faculty effort that the college is able to invest in this course. Other pre-engineering courses (e.g., Howard and Musto⁵; Pazos, Drane, Light, and Munkeby⁸) use peer team projects or software that students will use in follow-on engineering classes to motivate students to continue in engineering. The typical student in MSU's pre-engineering designation is not mature enough to successfully navigate this type of project. In addition, the one-hour format of the course limits the types of in-class projects that can be undertaken and the amount of time students are willing to commit outside of class. Further, students in this class often cite that they wish to major in engineering because they like to build things or are good with their hands—we wish to stress to them that the major obstacle between them and an engineering degree is academic preparation, not hands-on courses. The end result is that our class is a combination of several different types of classes at other institutions.

Course Content

MSU's class, Introduction to Engineering for Pre-Engineers (GE 1011), is a one-hour, lecture format course. The one-hour format was chosen so that the course would not interfere with the academic courses that students needed to take to gain admission into the engineering major of

their choice. The course is graded (rather than pass/fail) to help make sure that students take the assignments in the class seriously enough to benefit from completing them correctly. The assignments in the class are designed to be beneficial to the students without requiring significant time investments that would detract from other courses. This class does not apply towards graduation for any of our engineering majors.

The lecture material in the course can be divided into two basic categories (see Table 1). The first part of the course deals with general college success strategies applicable to any major. Lectures are presented on study skills, learning styles, communication skills and time management. In addition, students are required to examine the required courses in their intended engineering major and develop a semester-by-semester schedule indicating which courses they will take until they can graduate. The students are required to pay particular attention to course pre-requisites and consider the pre-requisites in planning their course of study. This schedule is used during an in-class advising session to help students plan their following semester of coursework.

The second category of class lecture deals with introducing each of MSU's ten engineering majors. Department heads and/or undergraduate coordinators for each department are invited to come and share with students information about their particular degree program(s). These are generally 20 minute lectures by the department head but some departments also have students talk about their experiences in the cooperative education program. Approximately 25 minutes per academic major is allocated and speakers are encouraged to focus on the types of things that students will do with that major after they graduate. Guest speakers are asked not to talk about the degree requirements but instead to focus on the types of experiences students will have in the work force following graduation. In addition, a representative from the Career Services office presents the final lecture in the course after all engineering majors have been presented. This speaker gives students information on majors which are related to engineering as well as providing information on career services programs designed to help students find appropriate majors. This information has proven to be timely for the students in the class who decide not to pursue engineering majors but do not know how to go about finding another major which is appropriate for them.

Table 1 – Weekly Schedule of Class Topics and Assignments

Date	Topic	Assignment Due
Week 1	Course Introduction, Syllabus review, Preliminary questionnaire	
Week 2	Study Skills	
Week 3	Time Management	Initial one- to two-page paper on intended major
Week 4	Communication Skills	
Week 5	Communication Skills	Learning Styles Assessment
Week 6	Learning Styles	
Week 7	Chemical & Mechanical Engineering	Time Management Assignment

Date	Topic	Assignment Due
Week 8	Aerospace & Biological Engineering	
Week 9	Pre-registration advising	Plan of coursework to complete degree
Week 10	Civil & Industrial Engineering	
Week 11	Electrical & Computer Engineering	
Week 12	Computer Science & Software Engineering	
Week 13	Alternative majors related to engineering	
Week 14	Wrap-up; Evaluations	Three-page paper on major

The course grade is based on the assignments that the students submit as well as class attendance (see Table 2). Class attendance is weighted fairly heavily (25%) so that students are encouraged to be in attendance to hear about all of the ten engineering programs and not just the one that they think they are interested in. Many students would attend only the overview of their chosen major without this requirement. Since many of these students have misconceptions about what their chosen major entails, this requirement helps to make sure they had been exposed to all fields in case they decided their initial major choice was not appropriate for them.

The final three-page paper that the students write is also worth 25% of the course grade. By this time in the semester students have had two lectures on communication skills, including the appropriate way to cite references, and have had more exposure to what their chosen major entails. This paper requires students to discuss the particular type of job they wish to have upon completing their degree and requires them to research the professional society in their chosen field. Students who have decided not to major in engineering write this paper on whatever major they are considering at that point in the semester.

Table 2 – Grading

Assignment	Weight
Initial paper on intended major	15%
Learning styles assessment	10%
Time Management Assignment	15%
Plan of coursework to complete chosen degree	10%
Final three-page paper on chosen major	25%
Attendance	25%

Several textbooks (Gomez³, Landis⁶, and Schiavone⁹) were considered for use in this class. Each of these books provides an overview of different engineering disciplines as well as general college success strategies. In the end, Gomez was not selected due to a concern that the students would be turned off by the fact that the textbook indicates it is for upper elementary and lower-level high school students. The Landis book covered all of the material that was needed but also had extraneous material. The Schiavone text has been used for the last two course offerings. However, comments from the students indicate that they are not making use of the text. For the

fall 2008 offering the textbook will be reevaluated and either the textbook will be integrated more into the class to encourage students to read the material or it will be dropped.

During the latest class offering (fall 2007) the class also made use of Mississippi State's university standard audience response system from eInstruction (www.einstruction.com). Each student was required to buy and register a transmitter that they brought to class each day. These were used to take attendance in the class as well as to provide opportunities for student feedback during the lectures on the general college success skills. Although there were issues initially with students getting their transmitters, in general this system did provide greater interaction with the students during those sessions. This system is also used in other required courses for engineering students such as freshman chemistry.

Student Feedback

Student feedback on course evaluations has been uniformly positive. Comments such as "Every engineering student should take this class" and "[the class] Reinforced my decision to pursue my major" are quite common on the evaluation forms. The aspect that students said they enjoyed most was the lectures by the different department representatives on their majors. A good number of students indicate that the course has either confirmed their choice of engineering major or introduced them to another engineering major which was more interesting to them. Even the students who decide not to major in engineering value the course for helping them to make that decision. One student wrote on his evaluation form "I learned a great deal about the major I chose. And I also learned that I didn't want to do engineering but am thankful that you helped me make up my mind." The most common comment from students on what improvements could be made to the class were suggestions dealing with having hands-on projects, segregating the class at times to focus on particular majors, and having actual visits to the departments to see facilities and laboratories rather than having the departmental representative come and make a presentation in class. The suggestions will be incorporated into future class offerings.

Assessment Results

A review of students admitted to the undecided pre-engineering program from its inception shows that these students, on average, possess test scores and high school grades that are not indicative of success in engineering. Those admitted to the undecided pre-engineering (UND PREE) program have an average ACT score of 19.33 compared to an average ACT score of greater than 27 for those admitted directly to an engineering major. These UND PREE students averaged 19.13 on the English portion of the ACT and 19.42 on the math portion of the ACT. They had an average high school GPA of 2.68. The typical student admitted directly to engineering has an average high school GPA greater than 3.00.

Of those students who were admitted to UND PREE as entering students, 62.1% remained in the UND program one year later, while 29.4% had moved out of UND into a major other than engineering, and only 8.4% had moved to an engineering major. These numbers are somewhat different when looking two years after admission where 45.1% remained as UND students, 42.7% had declared a major other than engineering, and 12.3% had been accepted into an engineering major. These results are summarized in Table 3 below.

The number of students included two years from admission is less than the number included one year from admission due to some students having not returned to the university and some having been admitted less than two years ago. These data clearly indicate that a small portion of these students actually transfer into engineering and further, a sizeable percentage remain undeclared students two years after being admitted. Those remaining undeclared have either not attempted to transfer to a specific major or their GPA is too low to be admitted to a specific major.

Table 3 – Distribution of Students One and Two Years after Admission

Years from Admission	% in Engineering	% in non-engineering major	% in UND	Total
1	8.4 n=55	29.4 n=192	62.1 n=405	100 n=652
2	12.3 n=67	42.7 n=233	45.1 n=246	100 n=546

Being admitted to engineering is obviously one goal of the pre-engineering program, but the ultimate goal is to be successful in, not merely admitted to, engineering. Table 4 below details the average GPA of those students initially admitted as UND PREE one and two years after admission as a function of their selected major. Those admitted to engineering have a higher average GPA than those who have moved into non-engineering majors. Those remaining in UND have the lowest average GPAs of any of the students and their low GPAs may well be the reason they are still classified as UND.

Table 4 – Grade Point Averages of Students in Majors One and Two Years after Admission

Years from Admission	GPA of those in an engineering major	GPA of those in a non-engineering major	GPA of those in UND
1	2.42 n=55	2.33 n=192	1.72 n=405
2	2.54 n=67	2.30 n=233	1.49 n=246

The goal of this class is primarily to yield successful college graduates and secondarily to ensure those who enroll in engineering majors will be prepared to complete their programs of study. There does not yet exist enough data to draw definitive conclusions as to the success of this course in those goals because it has only been taught since the spring of 2006. The data set of this subset of students is limited making it difficult to draw conclusions. There is also insufficient data on the specific effect on minority students.

As shown in Table 3, the distribution of students in majors is significantly different for those who are two years into their college education and those who are one year into college. Clearly many of the students are waiting until their second year of college to decide on a major. Anecdotal evidence gathered from helping these students register for classes indicates that a

sizeable portion have significant math deficiencies. They are often two or three semesters away from beginning their first calculus course which must be completed with a grade of C or better before they enter engineering.

Future Work

One of the limitations in evaluating the effectiveness of this course is the fact that many of the students have not had sufficient time after completing the class to complete the necessary requirements to enter engineering. This is coupled with the difficulty of separating the students who took the class from those who did not (since not all students in the pre-engineering designation took the class). A collaborative effort to obtain this level of detail for further analysis is currently being undertaken. Having this information combined with more students being into their second year of college after taking the course will allow for additional data analysis. Additional analysis of correlation between the specific grades made in this course and the students' GPAs and majors is also underway. There are some students who do not succeed in this class as a result of their lack of effort and/or class attendance. To perform an accurate assessment of the class these students will either need to be removed from the data set, or at least considered as a subset of data.

Class instruction on learning styles has revealed a wide variety of styles among the students. These are often in stark contrast to the learning styles preferred by engineering, science, and mathematics faculty. Learning styles have already been shown to be important in how engineering students learn material.² In addition, engineering students are typically capable of adapting to various learning styles. Correlating learning styles to success, and specifically to success in engineering, would provide useful information regarding changes that may be needed in how engineering is taught in order to attract a greater number of students who are not admitted directly to engineering and may lack the ability to easily adapt to different learning styles.

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