

Transition to a New Freshman Engineering Policy

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Abstract - Enrollment in freshman engineering courses at our university increased by 110% from the 2001-2002 to the 2010-2011 academic years and by an additional 24% from the 2010-2011 to the 2012-2013 academic years (i.e., 162% increase from 2001-2002 to 2012-2013). Historically, no additional entrance requirements, beyond acceptance to the university, existed for declaring an engineering major and enrolling in freshman- and sophomore-level engineering courses. We needed to move identification of at-risk students from the end of the 4th semester to the end of the 2nd semester. A new engineering admission policy was crafted, based on analysis of ten years of student data. The new policy requires students to declare Pre-engineering as their major in their first two semesters. Requirements for engineering program admission are: 1) math plus verbal SAT ≥ 1110 or composite ACT ≥ 24 ; 2) B or higher in each freshman engineering course; 3) C or higher in first 2 math courses. The roll-out of the complete policy was accomplished in stages due to time required for administrative approval and inclusion in the undergraduate catalog. The first transitional phase was enforced in the 2011-2012 and 2012-2013 academic years. The prerequisite for the second-semester freshman engineering course was changed to a grade of B or higher in the first-semester freshman engineering course. The prerequisite for first-semester sophomore engineering courses was changed to a grade of B or higher in the second-semester freshman engineering course. Students who earned less than a B in either course could submit a waiver request to the freshman advisor. Assessment of SAT/ACT scores, math grades, and other personal factors were used to support the decision to approve or deny the waiver. In this report, we present data from these two transitional years, which provide strong support for the validity of our new engineering admission policy.

Index Terms – Enrollment management, Retention, SAT/ACT scores, Success indicators.

INTRODUCTION

Enrollment in the freshman engineering courses at our university has increased by 110% from the 2001-2002 to the 2010-2011 academic years and by an additional 24% from the 2010-2011 to the 2012-2013 academic years (i.e., 162% increase from 2001-2002 to 2012-2013). Our first-semester freshman engineering course is EGR1301 – Introduction to

Engineering, and our second-semester freshman engineering course is EGR1302 – Introduction to Engineering Analysis. Historically, no additional entrance requirements, beyond acceptance to the university, existed for declaring an engineering major and enrolling in lower division (i.e., freshman- and sophomore-level) engineering courses. Students were required to apply for upper division admission before they were allowed to enroll in upper division (i.e., junior- and senior-level) engineering courses. Students qualified for upper division admission by earning a minimum 2.25 grade point average in all freshman- and sophomore-level STEM courses required for their degree program and attempted at our university. We could not require a student to change their major. The upper division admission policy simply prevented students from moving forward in the engineering course sequence. No mechanism for enrollment management existed, and our uncontrolled growth in student enrollment placed a severe burden on our infrastructure and faculty resources.

Analysis of data on students who attempted EGR1301 and/or EGR1302 from 2001-2002 to 2010-2011 was performed, and a new engineering admission policy was crafted. This study was based on the analysis of three risk factors: 1) math plus verbal SAT < 1110 or composite ACT < 24 ; 2) grades less than B in EGR1301 and EGR1302; and 3) grades less than C in the first 2 math courses taken at our university. Students with 2 or 3 risk factors were considered to be “at-risk”. Logistic regression analysis to select the optimum set of admission criteria determined that of the three admission criteria, the weakest correlation was with respect to SAT scores, but the grades earned in the first two semesters in engineering and math courses were more strongly correlated [1]. Our new engineering admission policy was defined as:

- Incoming students declare the Pre-engineering major. A math plus verbal SAT ≥ 1110 or composite ACT ≥ 24 is required for students to declare Pre-engineering.
- Students must earn a B or higher in EGR1301 and EGR1302.
- Students must earn a C or higher in the first two math courses taken at our university.

The prerequisite for EGR1301 was changed to the same SAT/ACT requirement for declaring the Pre-engineering major. This allows students in other majors who wish to pursue a minor in engineering to enroll in EGR1301.

Pre-engineering majors will apply at the conclusion of successful completion of EGR1302 to one of our three

programs: 1) BSE – Engineering, 2) BSME – Mechanical Engineering, and 3) BSECE – Electrical and Computer Engineering. Students may remain in the Pre-engineering major for a maximum of 4 semesters before they must declare a major. The four semester limit allows students time to repeat only one of the freshman engineering courses before they must declare a major.

Unfortunately, the process to formalize this new policy took longer for administrative approval and inclusion in the undergraduate catalog than desired. Because our freshman course series is common to all engineering majors, the faculty of both departments met numerous times to agree upon exactly what criteria to use in the new policy. For example, some engineering faculty expressed concern that students might meet the requirements in the freshmen year, be accepted to an engineering program, and then fail to keep their grades high enough to qualify for graduation. This concern was addressed by proposing a C or higher grade requirement for sophomore and higher-level engineering courses before a student is allowed to enroll in the following engineering course.

The new Pre-engineering major required approval by a variety of units, including the Office of the Provost, the university-wide Undergraduate Curriculum Committee, and University Admissions. For example, policies had to be developed for admission of transfer students, as well as for students who wish to change their major to engineering from another major at Baylor. By the time all parties agreed upon the final policy, University Admissions had already begun accepting freshmen who did not meet the SAT/ACT requirement for the 2013-2014 academic year.

Thus, the adoption of our new engineering admission policy was accomplished in stages. In the 2011-2012 and 2012-2013 academic years, we applied the “B or better” rule for the freshman engineering course series. The new prerequisite for EGR1302 was a grade of B or higher in EGR1301. The new prerequisites for first-semester sophomore engineering courses (*i.e.*, ME2320 – Statics, taken by BSE and BSME majors, and ELC2337 – Digital Logic Design, taken by BSECE majors) was a grade of B or higher in EGR1302. These prerequisite changes required only approval by the Undergraduate Curriculum Committee. This transitional policy did not require students to change their major from one of the three engineering majors. It simply prevented students from moving forward in the engineering course sequence.

Students who earned less than a B in EGR1301 or EGR1302 were allowed to submit a petition for a prerequisite waiver in order to enroll in the following course. Students had to provide an essay addressing why they should be allowed to continue to the next engineering course and what they intended to change in their personal behavior to guarantee their academic success. The freshman academic adviser and department chairs assessed the student’s statement, SAT/ACT scores, math grades, and other personal factors to support their decision to approve or deny the petition.

Additional findings from the previous study were related to the math course series [1]. A large number of our students arrive with either AP credit, dual credit, or transfer credit for Calculus 1 and sometimes for both Calculus 1 and Calculus 2. Their level of preparation for college Calculus varies. This appears to be an issue that other programs encounter [2]. In the 2001-2002 through 2010-2011 academic years, fewer than half (*i.e.*, 44.9%) of first-semester engineering students enrolled in Calculus 1 (Calc1). Of the remainder, 32.9% enrolled in Pre-Calculus (PreCalc), 14.8% enrolled in Calculus 2 (Calc2), and 7.4% enrolled in Calculus 3 (Calc3) [1]. Almost 25% of the students who took Calc3 in their first semester earned either a grade of D or F, which required them to repeat the course. As a result of the Calc3 finding, academic advisers who worked with students during Freshman Orientation presented this data to students who expected to earn AP Calculus credit. These students were strongly advised to forfeit one semester of AP credit in order to give them the best opportunity for success in their first semester.

The objective of the current study is to analyze student data from the first two transitional years after roll-out of the “B or better” rule for EGR1301 and EGR1302 to determine if this data supports the validity of our new engineering admission policy.

METHODS

Data was supplied by the Department of Institutional Research and Testing. The freshman adviser kept records of all students who enrolled in EGR1301 and/or EGR1302 during the transitional years and for all those who submitted petitions for prerequisite waivers during this time. This data was compared against data from the previous ten years under the old policy. Students were classified into two categories, based upon their current status and using the same criteria used in the previous study of students from the 2001-2002 through the 2010-2011 academic years [1]. The successful category includes students who enrolled in EGR1301 and/or EGR1302 and who either graduated from our university with an engineering degree or are current engineering majors in good academic standing. The unsuccessful category includes current students who changed their majors from engineering, current students who are on academic probation, and students who left the university without earning a degree. The successful term for both the old policy and transitional policy merely denotes students who are retained in engineering majors and who either earned an engineering degree or who continue to pursue their engineering degree in good academic standing.

SAT/ACT Scores

The records of students with SAT/ACT scores less than the minimum required were closely examined with regard to their academic record.

Freshman Engineering Course Series

Histograms were generated by letter grade for EGR1301 and EGR1302. In order to compare old policy to transitional policy with different numbers of students, frequency counts were converted to percentages. Detailed analysis was performed to look for trends that distinguished successful from unsuccessful students.

Beginning in Fall 2011, students who earned less than a B in EGR1301 or EGR1302 were allowed to submit a petition for a prerequisite waiver for the following course. Students were limited to one such petition. Detailed analysis was performed on data for students who received these waivers. Students who earned less than a B in EGR1302 in Spring 2013 were classified as unsuccessful because the outcome of their waivers are not yet known.

Math Course Series

The four math courses most commonly taken by engineering students in their first semester at Baylor include PreCalc, Calc1, Calc2, and Calc3. A histogram was generated to ascertain what percentage of incoming engineering students enrolled in each of these four math courses for students under the old policy vs. the transitional policy. Frequency counts were converted to percentages.

RESULTS

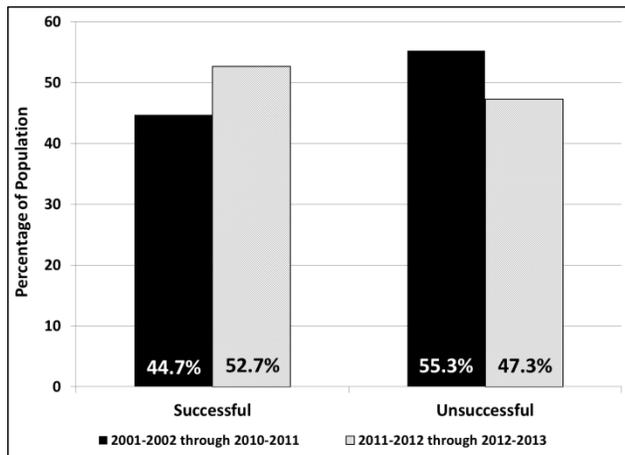


FIGURE 1
STUDENT POPULATION BY CATEGORY

Students enrolled in their first engineering course numbered 535 during the transition years and 1,603 under the old policy. The percentages of students in the successful and unsuccessful categories are presented in Figure 1. There was an 8.0% increase in the percentage of successful students from the old to the transitional policy. All successful students under the transitional policy are currently rising sophomores or rising juniors.

SAT/ACT Scores

Thirty-three (6.2%) students would have been prevented from enrolling in EGR1301 based on SAT/ACT scores. Of

these, 6 remain as engineering majors, but only 3 of those can be classified as successful.

- **Successful:** In 2011-2012, 3 students, all female, earned a B or higher in both EGR1301 and EGR1302 and have an average cumulative GPA of 3.14 after 2 years at Baylor.
- **Unsuccessful:** The 3 remaining engineering majors, two male and one female, enrolled as freshmen in 2012-2013. One earned a B in EGR1301 and a C+ in EGR1302. This student’s petition was granted to continue to the sophomore-level engineering course. The second student earned a C in EGR1301, was denied a waiver to enroll in EGR1302, and plans to repeat EGR1302 in Fall 2013. The third student earned a B in EGR1301 and a C in EGR1302 but did not petition for a waiver. The remainder of the 33 students are no longer engineering majors. Three were placed on academic suspension, 19 switched major, and 5 left Baylor.

Freshman Engineering Course Series

The histogram of grades earned in EGR1301 is presented in Figure 2. Under the old policy, 39.8% of students earned a B or higher in EGR1301 and were successful engineering students. Under the transitional policy, that percentage increased to 44.5%. The “N/A” designation includes transfer students who did not take this course at Baylor plus students who either dropped the course or withdrew from the university prior to completion of the course.

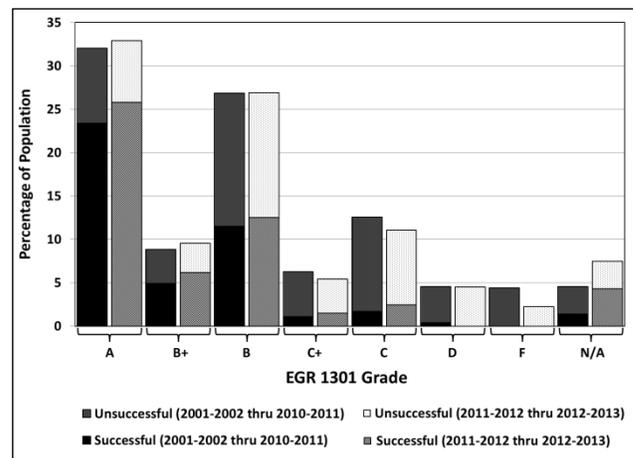


FIGURE 2
EGR1301 GRADES – COMPARISON OF PERCENTAGES OF POPULATION BY GRADE FOR DATA FROM OLD POLICY VS. TRANSITIONAL POLICY

The histogram of grades for EGR1302 is presented in Figure 3. Under the old policy, 38.6% of students earned a B or higher in EGR1301 and were successful engineering students. Under the transitional policy, 46.0% of students earned a B or higher and were successful engineering students. The number of unsuccessful students in the “N/A” category increased from 24.3% under the old policy to 27.5% under the transitional policy. This category includes students who took EGR1301 and changed their major or left

the university without taking EGR1302. The successful students in the “N/A” category did not meet the requirement for concurrent enrollment in Calc1 in order to enroll in EGR1302.

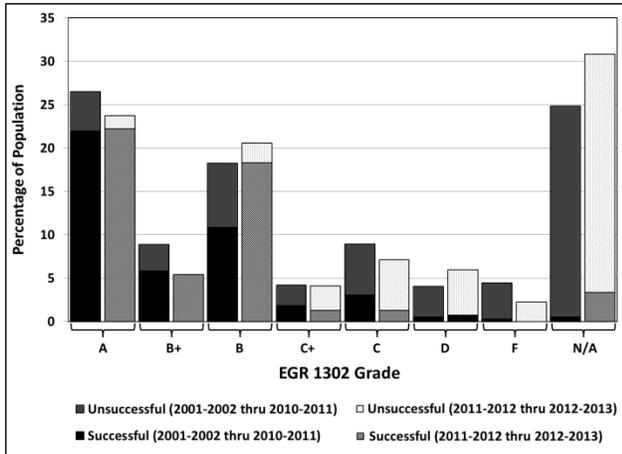


FIGURE 3

EGR1302 GRADES – COMPARISON OF PERCENTAGES OF POPULATION BY GRADE FOR DATA FROM OLD POLICY VS. TRANSITIONAL POLICY.

We then analyzed the data for students who attempted the freshmen engineering course series in the standard order (i.e., EGR1301 before EGR1302). Under the old policy 1,514 (94.4%) of 1,603 and under the transitional policy 493 (92.1%) of 535 students fit this category. Table I contains results for: 1) students who earned grades of B or higher in both courses; or 2) students who earned a grade of B or higher in EGR1301 but did not attempt EGR1302 (i.e., changed major or left Baylor). Under the old policy 898 (59.3%) of the 1,514 students and under the transitional policy 229 (46.5%) fit this criteria. The percentage of these students who are classified as successful engineering students increased considerably under the transitional policy, and the number of students who changed their majors or who left the university was greatly reduced.

Of the 229 students under the transitional policy who earned grades of B or higher in both EGR1301 & EGR1302 (Table I), only 10 displayed one risk factor, and none displayed 2 risk factors (described above in the introduction). Four of the 10 students had low SAT scores. Two of the students with low SAT scores transferred to Baylor from a community college and scored well in their freshman engineering and first two math courses, but their average cumulative GPA at Baylor is 2.66. Two students with low SAT scores began at Baylor as freshmen. One took advantage of the Summer Bridge Program and earned an A in PreCalc in the summer and an A in Calc1 in the fall. These two students have an average cumulative GPA of 3.25. The other six students are considered at risk because of their first-year math grades, but only one changed major from Engineering to Pre-business.

Results for students who attempted the freshmen engineering course series in the standard order and who did not earn a B or higher in both courses are presented in Table

II. The percentage of successful engineering students was modestly reduced under the transitional policy. The percentage of students who changed their majors or who are on academic probation increased, and the percentage of students who left the university dropped.

TABLE I
STUDENTS WHO ATTEMPTED EGR1301 & EGR1302 IN THE STANDARD ORDER AND EARNED A B OR HIGHER IN BOTH COURSES.

Category	Old Policy	Transitional Policy
Successful	564 (62.8%)	213 (93.0%)
Unsuccessful		
Changed Major	191 (21.3%)	12 (5.2%)
Academic Probation	0 (0.0%)	1 (0.4%)
Left Baylor	143 (15.9%)	3 (1.3%)
	898	229

TABLE II
STUDENTS WHO ATTEMPTED EGR1301 & EGR1302 IN THE STANDARD ORDER AND EARNED LESS THAN A B IN ONE OR BOTH COURSES

Category	Old Policy	Transitional Policy
Successful	120 (19.5%)	43 (16.3%)
Unsuccessful		
Changed Major	170 (27.6%)	92 (34.8%)
Academic Probation	9 (1.5%)	67 (25.4%)
Left Baylor	317 (51.5%)	62 (23.5%)
	616	264

Upon completion of EGR1301 in Fall 2011, 14 of 23 petitions for prerequisite waivers for EGR1302 were approved. The results of the approved petitions were:

- Three earned a B or higher in EGR1302. Current average GPA is 2.47.
- One earned a B and one earned a C and switched to Pre-business. Current average GPA is 2.42.
- One earned a D and switched to Environmental Science. Current GPA is 2.42.
- Eight earned less than a B and left Baylor.

Upon completion of EGR1302 in Spring 2012, 14 of 20 petitions were approved for Statics or Digital Logic Design (Logic). The results of the approved petitions were:

- Ten students earned a C or higher in Statics or Logic, depending upon their major. Average GPA is 3.07.
- One changed to Pre-business before Fall 2012.
- One earned a B in Logic, earned poor grades in other courses, and withdrew from Baylor the next semester.
- One earned a D in Statics, failed two math courses, was placed on academic probation, and has a 2.29 GPA.
- One student fell under the old admissions policy. After failing EGR1302 in Spring 2011 and being placed on

academic probation, this student took a semester off, returned in Spring 2012, performed well until becoming ill, persisted despite the illness, and earned a C in EGR1302. The student’s waiver petition was approved, earned a B in Logic, and has a current GPA of 2.24.

Upon completion of EGR1301 in Fall 2011, 12 of 25 petitions were approved. The results of the approved petitions were:

- Three students earned a B or higher in EGR1302. Current average GPA is 2.72.
- One earned an A but switched to Pre-business. Current GPA is 3.56.
- Six earned less than a B and are ineligible for a prerequisite waiver to enroll in their sophomore-level engineering course without repeating EGR1302. Current average GPA is 1.98.
- One student fell under the old admissions policy. This student initially enrolled in EGR1301 in Fall 2010, was suspended, and reinstated. The student earned a C in EGR1302 and was suspended again. GPA is 1.53.

Fifteen of 23 petitions were approved based on Spring 2013 EGR1302 grades. These students are in the unsuccessful category because they have not yet attempted the following course.

Math Course Series

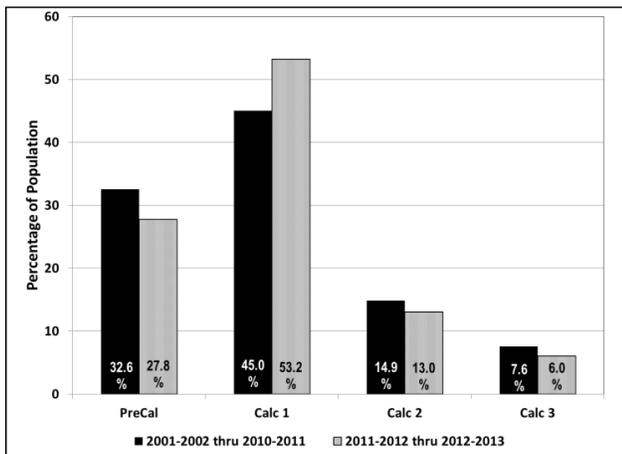


FIGURE 4

FIRST-SEMESTER MATH COURSES TAKEN BY INCOMING ENGINEERING STUDENTS – COMPARISON OF OLD POLICY VS. TRANSITIONAL POLICY.

A histogram of first-semester math courses taken by incoming engineering students in their first semester at Baylor is presented in Figure 4. The percentage of students enrolling in Calc1 increased 8.2%. There was a 4.8% drop in PreCalc, a 1.8% drop in Calc2, and a 1.5% drop in Calc3. Further analysis of data for first math courses follows:

- **Pre-Calculus:** Most PreCalc students who earn less than a B+ are unsuccessful engineering students at Baylor [1]. Students who earned a B+ or higher in PreCalc and were successful engineering students made up 8.8% of successful engineering students under the

old policy and 6.4% of successful engineering students under the transitional policy. The percentage of students taking PreCalc who earned a D or F was 22.8% under the old policy and increased to 29.6% under the transitional policy. Regardless of their grade for EGR1301, these students are prevented from enrolling in both Calc 1 and EGR1302 because Calc1 is the co-requisite for EGR1302.

- **Calculus 1:** Students who earned a C or higher in Calc1 and were classified as successful engineering students made up 46.7% of successful engineering students under the old policy and 54.6% of successful engineering students under the transitional policy.
- **Calculus 2:** Students who earned a C or higher in Calc2 and were classified as successful engineering students made up 18.1% of successful engineering students under the old policy and 17.7% of successful engineering students under the transitional policy.
- **Calculus 3:** Students who earned a C or higher in Calc3 and were successful engineering students made up 7.9% of successful engineering students under the old policy and 6.7% of successful engineering students under the transitional policy. Students who earned a D or F made up 24.3% of Calc3 students under the old policy and decreased to 19.4% under the transitional policy.

DISCUSSION

SAT/ACT Scores

Of the 43 students who would have been prevented from enrolling in EGR1301 based upon their SAT/ACT scores, only 9 (20.9%) were successful. An avenue remains open for students such as these to enroll in EGR1301. They may submit a petition for a waiver of the SAT/ACT prerequisite for EGR1301 to the academic adviser. However, no further petitions for prerequisite waivers will be considered. Additionally, the new engineering admission requirement may encourage determined students to improve their SAT/ACT scores by retaking the exam.

Freshman Engineering Course Series

Students governed by the transitional policy are still early in their academic career as either rising sophomores or rising juniors. There may be additional melt, but we believe that the transitional policy allowed us to quickly identify successful students in their first two semesters. Successful engineering students are 52.7% of the transitional students, compared with 44.7% under the old policy (See Figure 1). We are pleased with the outcome of the transitional policy.

In Table 1, 93.0% of students who took EGR1301 and EGR1302 in the standard order and met the “B or better” rule were retained as successful engineering majors, which is much higher than 62.8% of similar students under the old policy. In Table 2, 25.4% of students who took EGR1301 and EGR1302 in the standard order and did not meet the “B or better” rule remain as engineering majors on academic

probation. These students will resolve their academic careers over time by changing their major or by leaving the university, but they are unlikely to earn a degree in engineering at Baylor. We have been and continue to advise these students to change their major in order to retain them to graduation at Baylor. We expect the percentage of unsuccessful students who leave Baylor without earning a degree to remain less than the percentage under the old policy.

Few students who were granted prerequisite waivers under the transitional policy based on their EGR1301 grade continued as successful engineering students after taking EGR1302 (21.4% in 2011-2012 and 25.0% in 2012-2013); however, 92.9% of students who were granted prerequisite waivers based on their EGR1302 grade Spring 2012 were retained as successful engineering students. This surprisingly large difference is perhaps due to the increased rigor of EGR1302, in which students learn computer tools and programming in MATLAB. EGR1302 may prepare students for the increased difficulty in sophomore-level engineering courses. Or perhaps students mature and adapt to the rigor of college coursework by the end of their freshman year. In any case, advisers and department chairs will likely be more generous with future prerequisite waivers based on EGR1302 grades rather than on EGR1301 grades.

Students earning a B or higher in EGR1302 in both populations (82% under old policy and 81% under transition policy) were very close. We are encouraged by this because we want to increase retention of students who are capable of successfully completing their engineering degree. Detailed analysis is not presented here on the 10% increase in unsuccessful students in the "N/A" column in Figure 3, but a large component of these students earned a B or higher in EGR1301 but did not attempt EGR1302. They are also contained in Table 2, which indicates an increased percentage of students who changed their majors along with a reduced percentage of students who are left Baylor.

Math Course Series

We are pleased with the modest 1.5% drop in engineering students enrolling in Calc3 in their first semester at Baylor. Previously, we noted that 24.3% of students under the old policy earned a D or an F in Calc3. In the transitional years, that percentage decreased to 19.4%. Students with AP credit are highly motivated and prepared for the pursuit of a challenging college degree [3-4]. This modest decrease in students earning a D or F in Calc3 may be due to aggressive advising that encouraged incoming students to waive one semester of AP Calculus credit in order to ensure a smoother transition to college. This may also account for the increase to over 50% of first-semester engineering students starting in Calc1.

We are also pleased by the reduction in the percentage of students enrolled in PreCalc in their first semester. In the transitional years, academic advisers who worked with incoming students during Freshman Orientation informed

students with low SAT/ACT scores that we considered them to be at risk and recommended that these students take a lighter load in their first semester and enroll in a study skills course. Perhaps this frank discussion during Freshman Orientation caused students with low SAT/ACT scores to reconsider engineering as a major. We continue to see that, in order to be a successful engineering major, students need to earn a B+ or higher in PreCalc.

CONCLUSIONS

We are pleased with the outcome of the transitional policy and look forward to the first academic year under our new freshman admission policy. We expect this policy to allow us to retain more students at Baylor to graduation, whether they earn their degrees in engineering or not. We are able to identify at-risk students earlier in their academic career and provide them with career counseling that will allow them to be successful in a major that is a better fit for their interests and academic skills.

For 2013-2014, all but the SAT/ACT requirements will be applied to incoming engineering students. The full engineering admissions policy will be in effect for incoming students in the 2014-2015 academic year.

FUTURE WORK

A large number of engineering students in good academic standing under the old policy chose to leave Baylor without earning a degree. We plan to develop a survey instrument to determine why these promising engineering students left. We also plan to study which majors our students change to that lead to the highest retention to graduation Baylor to help academic advisors who counsel at-risk students.

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