2006-1088: BACK TO BASICS: A STUDENT-TUTOR MATCHING PROGRAM

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Back to Basics: A Student-Tutor Matching Program

Abstract

The College of Engineering and Computer Science of the University of Texas at Tyler recognizes the value of peer-to-peer learning and has in recent years established an engineering "learning community" by reserving sections of freshman and sophomore courses like Calculus, Chemistry and English specifically for engineering students. The goal was that *ad hoc* alliances and support networks that promote peer-to-peer learning would form within the learning community. However, the learning community approach has well-known limitations. The very best students are typically self-motivated to study and are not consistently involved in the community. The remaining students, including those who most need help, can become "the blind leading the blind." It is our belief, however, that *structured* peer-to-peer mentoring can make up the deficiencies learning community. A formalized system for getting more-advanced students in our programs to tutor students in their lower level pre-engineering courses would be very attractive.

Such a structured peer-to-peer mentoring and tutoring program, known as the "Back-to-Basics (B2B) Tutoring Program," was launched in fall, 2005 at the University of Texas at Tyler with financial support of the Texas Workforce Development Commission (TWDC). The goal of the focused tutoring program was to provide support for engineering students in the basic areas of sciences, math and programming to help them survive the first two years of the program. The initiative under which B2B was funded by TWDC envisaged increasing the graduation rate of electrical engineers, but students in other engineering disciplines are welcome to use the services of B2B tutors as well.

This paper describes the structure and assessment methods of the B2B tutoring and mentoring program and gives preliminary results.

Introduction

The challenge of engineering education in the United States in the 21st century will be to produce sufficient numbers of qualified engineers from our higher-level educational institutions. This is necessary to keep the nation at the forefront of the technological innovation. In recent years, many engineering schools, including first-tier institutions, have observed a general downturn in enrollment. The student retention rate for the first and second years of engineering programs has been falling. Engineering students must be ready for university-level classes in math, physics, chemistry and computer programming. In an all-too-large percentage of cases, these students are not well prepared in high school for the four-year university programs on which they embark. The problems of recruiting and retaining students adequately prepared for engineering coursework are particularly acute in the region served by the University of Texas at Tyler. The proportion of the population holding baccalaureate degrees in East Texas is below both state and national averages. Based on experience at UT-Tyler, 50% of our entering students eventually drop out due to issues with the above-mentioned courses.

In recognition of this statistic, the College of Engineering and Computer Science of the University of Texas at Tyler has established an engineering "learning community" which consists of engineering students enrolled in common sections of courses like chemistry, calculus, and English. But the learning community has well-known limitations. The very best students are typically self-motivated and grasp the course material without the support of the learning community. The *ad hoc* peer-to-peer learning and mutual support derived from the learning community may not involve the most capable students. It is our belief, however, that structured peer-to-peer mentoring can be an effective supplement or substitute. A formalized system for getting more-advanced students in our programs to tutor students in their lower level pre-engineering courses was very attractive.

The peer-to-peer mentoring and tutoring program, known as the "Back-to-Basics Tutoring Program," (B2B) was launched in fall, 2005 with the financial support of the Texas Workforce Development Commission. B2B is a focused tutoring program for engineering students in the basic areas of sciences, math and programming to help them survive the first two years of the program. It is principally aimed toward electrical engineers (the grant under which B2B is funded was for increasing the graduation rates of electrical engineers), but engineering students in other disciplines are welcome to utilize the services of B2B tutors.

Retention approaches

Retention of engineering students in the early years of the undergraduate program has been a topic for serious discussion within the engineering education community. "One of the problems with having low admission standards is poor student retention."[1] Researchers on this issue have identified indicators that statistically portend whether the student is more likely to drop out of engineering. A short list of recently reported correlations that identify some of these indicators is described herewith. There exists statistical evidence that there is a correlation between grades in pre-engineering mathematics and physics and the engineering students first course in Circuits I [2]. Similarly there appears statistical evidence of a correlation link between success in the early science classes and retention.[3] Another proposed indicator for success in engineering is visual-spatial acuity.[4] At one institution, North Carolina State, the engineering student matriculates into the engineering program with a minimum 2.9/4.0 GPA. At this institution the retention after matriculation in the engineering program is 85%. Hence if the student qualifies for matriculation the chances of not graduating with an engineering degree is only 15%. First, data from this institution indicated that there is a strong correlation between qualifying for matriculation and their performance on the first math course. This "discriminator held regardless of which math course the student took". Second, students who had to postpone Calculus I and take a lower level math course first had a lower probability of matriculating.[5] Student performance in terms of final (overall) GPA at graduation has been correlated with GPA performance on engineering math courses.[1] One researcher indicates that their data do not support the influence of SAT scores affecting the probability of graduation.[2]

Notwithstanding the indicators for retention problems, other researchers have experimented with methods to improve retention. One researcher has suggested modifications in curriculum and pedagogy.[6] Another researcher has concluded that for their technology students the "real life" experience has on the average led to higher retention percentages.[7] At one institution a researcher

has created a student volunteer pilot program for intervention in which a student can be identified as "at risk" based on performance in the first Calculus I exam. The students in this group are then expected to meet with their College of Engineering advisors.[5] The applicability of tutoring to improve retention is being used extensively. In a "Survey of First-Year Programs" [8] it has been reported that out of 93 schools with engineering programs 68 (73.1%) have tutoring available to their students. Of the 93 schools only 44% have tutor programs that are run by their respective colleges of engineering. One fairly common tactic is to employ learning communities.[9] The original experiment can be traced back to the 1920s and is now employed by as many as 500 colleges and universities across the US.[10] The concept is that students can band together in groups that are devoted to cooperatively assisting one another in the goal of achievement in a particular class. A well-known example of a learning community is represented by the fictional story of a collection of law students at Harvard banding together to pass their class "contract law" in the film "The Paper Chase." [11] Although the story is fictitious, the problems that can arise with attempted collaboration among students with significant mismatch in academic skills, are not.

Solving retention problems for under-represented components of the student population has specifically received attention. One scheme, to keep underrepresented minorities in engineering engaged, has been to provide scholarship funds for students who keep their GPA above 3.0 combined with organized meetings for time management.[12] Another approach has to been to use undergraduate and graduate student mentors. [13, 14] With regard to women in science and engineering, one institution reported that the improvement since 2001 in the number of female students "has not been dramatic," and the "number of minorities has not changed during the same period." [10] The under-representation of women in engineering continues to be a problem, with the percentage of engineering enrollment observed to be around a 20% ceiling. [15]

School background

The University of Texas at Tyler was established in 1973 as Tyler State College. The institution was re-named Texas Eastern University in 1974 and became a component of the University of Texas System in 1979. The University of Texas at Tyler began to lay the groundwork in 1996 for a School of Engineering to fill the need for a baccalaureate-granting engineering program at a state-supported college in East Texas. The School was composed of the Electrical Engineering (EE) and Mechanical Engineering (ME) Departments. Engineering classes were first taught at the University of Texas at Tyler in summer, 1997, and the first BS degrees were granted in May, 1999. The School of Engineering was later re-named the College of Engineering.

The University of Texas at Tyler was founded as an upper-division school that depended upon transfer students for its enrollment. The University expanded in 1998 to become a four-year institution. This occasioned a major overhaul of the engineering curricula to include freshman and sophomore-level courses. A major restructuring took place in 2001 when both EE and ME introduced revised 128-hour curricula. The EE curriculum was modified again in 2003 as a result of findings of the accreditation process and in 2004 to begin establishing a distinct specialization in computer engineering within the broader scope of EE.

The EE and ME programs of the University began the process in 2000 of preparation to meet the requirements for accreditation by the Accreditation Board for Engineering and Technology (ABET) under its Engineering Criteria 2000 (EC2000). Both EE and ME programs hosted site visits in October, 2002. Both programs received accreditation retroactive to October, 2001. Changes to the EE curriculum and the EE Continuous Quality Improvement (CQI) process were made as direct results of findings of the accreditation process.

Any student meeting minimum entrance requirements can be admitted to the College of Engineering and Computer Science. Minimum SAT scores depend on class rank. The minimum is 950 for those in the top 25% of their graduating classes, while the minimum is 1100 for those in the lower 25%. Department records for academic year 2003–2004 were reviewed to determine how many EE students from that year either continued their enrollment into the 2004–2005 academic year or graduated in 2004. Thirty students continued their enrollments and 7 graduated, representing 51.5% of last year's students who progressed to the next year of study or completed their programs.

The enrollment statistics from fall 2004 show 34 Entering, 31 Progressing, 14 Advanced and 5 Graduated students, roughly corresponding to freshmen, sophomores, and upper-class students respectively. Of the 84 students there are 6 women (7%). The ethnic breakdown is as follows: 64 white non-Hispanic (76%), 4 black non-Hispanic (4.8%), 4 Hispanic (4.8%), 2 Asian/Pacific islander (2.4%), 7 international (8.3%) and 3 unknown (3.6%). Our projected goal is to increase the student population at a rate of 14.5% per year over the next two years. Another goal is to increase the underserved populations by an even larger margin. One of the characteristics of the local students in the East Texas regions is that they start work at an early age, typically after high school, and continue working through college. This can be attributed to societal pressures as well as local economics, the average family income of the area being quite low. The students often do not realize the rigors of school, especially in an engineering program and are inherently disadvantaged due to their off-campus work scenarios.

Program Implementation

A highlight of the tutoring program was intended to be the emphasis on hiring bilingual and female tutors to encourage underserved populations. The Electrical Engineering program is relatively new (opening in 1997) and the only ABET-accredited BSEE program in East Texas. This has put us in a unique situation with moderate enrollment growth over the last few years. We have seen students from underserved populations, but with few role models they seem to be especially vulnerable to quitting. A peer-to-peer tutoring service would be very beneficial in retaining such students. The program consists of focused student-to-student tutoring for engineering students in the basic areas of sciences (physics and chemistry), mathematics (calculus and differential equations) and computer programming (structured programming and MATLAB) to help them survive the first two years of the program. B2B employs 8 tutors from the science, engineering and computer science departments for up to 20 hours per week to provide support to freshmen and sophomores in these critical subject areas. This program falls under the "best practices" classification, since several other universities have successful tutoring programs in existence today. Special efforts are being made to hire tutors from underserved populations.

Figure 1. Marketing strategies: Tutoring website (left), Sample flier distributed on campus by postings, e-mail, and campus TV (right)

The tutor hiring process began in early fall 2005, focusing on juniors and seniors with good academic backgrounds (no academic probation). Table 1 provides the distribution of courses for the program in the freshman and sophomore years.

Table 1. The Electrical Engineering curriculum in the freshman and sophomore years at the University of Texas at Tyler.

Freshman Year

First Semester			Second Semester		
CHEM 1311	General Chemistry I	3	PHYS 2325	University Physics I	3
CHEM 1111	General Chemistry I Lab	1	PHYS 2125	University Physics I Lab	1
ENGL 1301	Grammar & Composition I	3	ENGL 1302	Grammar & Composition II	3
MATH 2413	Calculus I	4	MATH 2414	Calculus II	4
UNIV 1300	Freshman Seminar	3	( )	Fine Arts Elective	3
ENGR 1200	Engineering Methods	2	EENG 1201	Electrical Engineering I	3
			EENG 2101	MATLAB for Engineers	2
	Total	**16**		**Total**	**17**

Sophomore Year

First Semester			Second Semester		
HIST 1301	United States History I	3	HIST 1302	United States History II	3
MATH 3404	Multivariate Calculus	4	MATH 3305	Differential Equations	3
PHYS 2326	University Physics II	3	ECON 2302	Principles of Economics II	3
PHYS 2126	University Physics II Lab	1	EENG 3302	Digital Systems	3
EENG 2201	Programming for Engineers	2	EENG 3304	Linear Circuits Analysis I	3
ENGR 2301	Statics	3	EENG 3104	Linear Circuits Anal. I Lab	1
	Total	**17**		**Total**	**16**

For the fall semester, the emphasized courses were Chemistry I, Physics II, Calculus I, Multivariate Calculus, Programming for Engineers and Statics. Tutors in these areas were sought via teacher recommendations, Dean's List, and word-of mouth. Several applications were received. Only those students with grades of A in the subjects they were willing to tutor were considered, except applicants who had earned grades of B were considered if they had tutor certification or if they were from underserved populations. Within a few weeks, we had hired seven tutors at rates ranging from $7 to $9 per hour (based on experience). Two of them had tutor certification and two more had prior experience. One of the students was a woman and three were international students. We had to hire graduate students for the programming course due to the lack of availability of any undergraduate students with the requisite experience in this area. The tutors worked different schedules based on their academic schedules, but typically the tutoring times ranged between 10 and 15 hours per week. The program was marketed extensively with the help of a website and advertisements using fliers, campus TV and class presentations, as shown in Figure 1.

The team of investigators is responsible for the inception and overall management of the program including the following activities: advertising, hiring tutors, student-tutor matching, budget supervision, administrative duties, data analysis and report generation.

Results

The tutoring system involves tracking of data for continuous project assessment. Students are required to sign in for meetings by each tutor. This data is tabulated in a spreadsheet by each tutor on a bi-weekly basis. This makes the data amenable for analysis and report generation. The assessment process will hinge on extraction of the following data:

- Individual measures: (a) student usage history, (b) number of hours tutored, and (c) subject coverage breakdown;
- Group measures: (a) number of students, (b) number of hours, (c) subject coverage breakdown, and (d) level of student.

The data will be correlated to the student retention statistics that will be submitted to the Texas Higher Education Coordinating Board (THECB) each semester. A secondary measure of the tutoring system will involve feedback from the students and the tutors in the form of periodic surveys about the effectiveness of the program. The data analysis described above will be included in the reports generated throughout the course of the project.

The Back-to-Basics Tutoring Program has been in operation only since September, 2005. The data collected have so far are not extensive, and it would be premature to draw any conclusions. The usage of the program from fall, 2005 may be summarized as in Table 2 below. A total of 33 tutoring sessions took place during fall, 2005, with the average tutoring session having a duration of approximately one hour.

Table 2. Summary of tutoring program usage from fall, 2005

Student	Discipline	Gender	Year	Visits	Hours	Subject(s)
1	EE	F	Jr	21	19.25	Excel, matrix methods, C programming, physics (mechanics)
2	ME	M	Fr	1	1.25	Physics (mechanics)
3	EE	M	Fr	3	7.25	Calculus I, laboratory reports
4	Chem	M	Fr	2	1	Physics (mechanics)
5	EE	F	Jr	1	0.5	C programming
6	EE	M	Jr	2	2.0	C programming
7	EE	M	Jr	1	0.5	C programming
8	EE	M	Sr	1	1.0	Math–FE exam preparation
9	EE	M	Jr	1	1.0	Matrix mathematics
			Totals	**33**	**33.75**	

The majority of the students were juniors who were transfer students and not freshmen as envisioned. It has to be noted that the students were seeking tutoring for lower-level courses like programming and introductory engineering. This may call into question the hypothesis that providing help in calculus, physics, and chemistry—typically regarded as "weed-out" courses—would be of value in improving the retention of electrical engineering students. Our hypothesis is that the students who took advantage of the tutoring program were already spending a large part of their time in the engineering building, which was not the case with the freshmen. Other possible reasons could be that being the first semester, it is feasible that word about the program did not reach the students. A certain degree of self-selection was observed, as some students did not show up for either class or the tutoring program, whereas others who wanted to succeed sought help using different avenues.

Table 3 summarizes the subjects covered during visits with a tutor in fall, 2005. The sum of the visits does not agree with the sum in Table 1 because more than one subject may be taken up during a tutoring visit.

Table 3. Summary of tutor visits by subject for fall, 2005.

Subject	**Visits**
Calculus	2
Matrix mathematics	3
Other mathematics	1
Physics (mechanics)	5
C programming	19
Other (Excel)	2
Other (laboratory reports)	2

The apparent popularity of structured programming in C as a tutoring topic may be artificially high because the class was conducted by Electrical Engineering in their own building and lab,

thus allowing students to make extensive use of the tutoring program. Somewhat surprising is what is absent from the list. There were no tutoring visits for chemistry, although there was a tutor available for chemistry. This may be due, however, to the Department of Chemistry's formal Supplementary Instruction (SI) program; engineering students needing help with chemistry may well have sought help from that source.

The preliminary findings do pose questions whether the program is reaching those toward whom it is aimed. That it has involved so few freshmen does not necessarily mean that the "wrong" clientele is utilizing the program; all of the junior or senior EE students who have sought help from tutors entered the program as transfer students and sought help for freshman or sophomore classes. In other words, the program may be achieving its goals, although not as foreseen.

Conclusions

The "Back To Basics" program is expected to provide a strong boost to our momentum and help to bring the student population ethnic distribution in line with the local averages. The program offers an opportunity for qualified graduate students and upper-division undergraduate students to serve as tutors to assist freshman and sophomore engineering students with course-related questions.

Further data collection will take place as the program moves into spring, 2006, to determine whom the program is reaching and the benefits they derive from it.

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