Does Problem Solving Recitation Session Improve Student Retention and Success?

Amir Karimi
The University of Texas at San Antonio

Abstract

The University of Texas at San Antonio (UTSA) is an urban, state-supported university and the engineering programs at this institution have been instrumental in providing educational opportunities for under-represented groups of minorities. The engineering curricula for BS degree programs were recently revised. The major objectives of the curriculum revisions were to enhance the educational quality of the program and to improve student retention and success. Recitation hours have been added to a number of foundation engineering courses having large failure rates in the past. The implementation of the recitation sessions began in Fall 2000. The recitation hours have been are conducted in a small classroom setting to help student learn problem solving techniques and encourage cooperative learning. The enrollment for each recitation section is limited to 20-25 students. No new materials are covered in the recitation periods. Instructors use this time to answer questions, solve example problems, involve students in cooperative learning, and introduce application of appropriate computer software. This paper will analyze student retention and success since the implementation of recitation sessions. It will compare the grade distributions for pre and post implementation of recitation hours.

I. Introduction

The University of Texas at San Antonio (UTSA), founded in 1969, is located in the eighth largest city (with a population of 1,114,000[1]) and 30th largest metropolitan area in the country. It serves the San Antonio metropolitan area and the broader region of South Texas. UTSA is the third largest component university in the University of Texas System and has been one of the state's fastest growing public universities for much of the last decade. In Fall 1982, the student enrollment was approximately 10,000 and in Fall 2000 that figure reached 19,883 (17,425 undergraduate and 2,458 graduate student), an increase of 5.6% over previous year. The University provide access and opportunity for large numbers of historically under-served students. More than 50 percent of UTSA's students come from groups underrepresented in higher education. Hispanics are the dominant group within the under-represented minorities. The undergraduate students at UTSA are typically older than the traditional students in other institutions. The average age of undergraduate students at UTSA is slightly over 25. Many students are the first in their family to attend a college or university.

The Division of Engineering was established in September 1982 offering BS degrees in Civil, Electrical, and Mechanical Engineering (CE, EE, and ME). The first graduating class was in

May 1984. Graduate programs offering MS degrees in CE, EE, and ME began in the Fall of 1989; the first MS degree was awarded in Spring 1993. Specialized engineering Ph.D. programs are in planning stages. The Division of Engineering, which was originally a part of the College of Sciences and Engineering, became an independent college in Fall 2000 as a result of the university-wide academic restructuring.

Over 1000 students were enrolled in the College of Engineering in Fall 2001; 955 (212 CE, 423 EE, and 320 ME) were identified as undergraduate students and 123 (44 CE, 57 EE, and 22 ME) were graduate students. In Fall 2001 approximately 88% of students were male. The minority student population constituted 59% of the total enrollment. Hispanics are the dominant group within the under-represented minorities (43% of total population).

The majority of engineering students at UTSA work while attending school. A large number are married and support a family. Some have been out of school for several years and are pursuing engineering education to qualify for a career change. The engineering programs at UTSA have been instrumental in providing educational opportunities for individuals who are bound to San Antonio through employment and family ties.

Freshmen Admission: As a public institution, UTSA has an open admission policy and all undergraduate programs, including the engineering programs, follow the same policy. Like most urban, public universities, the admission requirements are minimal. For example, for an entering freshman with a high school graduating class ranking in the bottom 25%, the SAT or ACT score requirements are 970 or 20, respectively. For entering freshmen in the top 25% (but not the top 10%) of their graduating class, the required SAT or ACT scores are 830 or 17, respectively. There is no SAT or ACT minimum requirements for entering freshmen who rank in the top 10% of their high school graduating class[2]. The low admission standards are designed to provide broader public access to higher education. As a result, many students enter the engineering programs with inadequate academic preparation. Without an adequate academic support system, many of these students failed to attain their educational goal.

Student Performance and Retention: For some time we have been aware of low student retention rates in our engineering programs. We have attempted to determine the underlying cause of the high attrition rate and to find remedies to correct the problem. Obviously, low admission standards is a contributing factor for the high attrition rates of the engineering students. In our opinion, other factors that have contributed to low student retention in the past are the student workload, lack of proper advising processes, and inadequate academic support systems for the students.

We also noticed that a large number of students were taking 16-18 semester hours of engineering course work while holding full-time jobs. As a result of the heavy work/course load combinations many of these students had difficulty attending classes or completing the required assignments for their courses. As a result, many of these students either failed or withdrew from courses before the end of the semester.

All engineering programs have agreed that a compulsory advising policy is necessary to remedy some of the existing problems. In Spring 1999 all engineering programs established a policy

requiring that all students obtain an approved program of study from a faculty advisor before registering for courses each semester. The faculty also believed that the lax enforcement of the prerequisites in the past might have been a contributing factor in student failure and high attrition rates. They agreed that a compulsory advising policy and strict enforcement of prerequisites are necessary to remedy some of the existing problems. Each faculty typically uses the first part of the advising session to gather information on the student that is necessary to offer proper advice. Students are asked to give an evaluation of their performance in the ongoing courses and the anticipated grades in each course. Other questions relate to student course load, workload, and their family obligations. Students also receive career advisement, which include discussions on membership in professional organizations, industrial opportunities, and graduate school.

All students in the University with fewer than 30 SCH are being advised by the Advisors at the Tomas Rivera Center. The center offers specialized services and programs designed for student retention and success. These include tutoring services, computer-based instruction, and presentations on study skills and services.

Academic Support System: Low admission standards are designed to provide broader public access to higher education. Unfortunately, not all students entering engineering programs have adequate academic preparation to succeed in their educational pursuit. Without adequate support systems, these students are doomed to failure. Many students entering engineering programs get bogged down with remedial course work, while those with poor study habits end up repeating courses. Student progress towards graduation also had been slowed down in the past due to the lack of resources needed to support students with weak academic background.

The engineering faculty had noticed that in recent years, students increasingly have more difficulty with the application of mathematics in their engineering courses. We realized that many of our students have not gained adequate problem solving skills in their introductory math, science, and engineering courses. We tried to identify those engineering foundation courses in which our students have had more difficulty. For example, Table 1 summarizes the statistical data on grade distributions in three introductory mechanical engineering courses which students often struggle to pass. The data represents the grade distributions for the period Fall 1994-Summer 2000. It shows that nearly 50% of students enrolled in these courses have either received a grade lower than "C" or withdrawn from the class. The data clearly indicates that students have difficulties with these classes.

II. Curriculum Revision and Motivations

In November 1998, the faculty in each engineering program began its deliberation of curriculum revision for the 2000-02 catalog. The major objectives of the catalog revisions were to improve the quality of the program offered, increase student retention, and offer a degree program that could be completed in four years. As we were revising our curriculum for the 2000-02 catalog, we considered implementing special academic support features to assist student success. We conjectured that an efficient way of providing academic support system would be to add mandatory recitation hours to those foundation courses with a high failure rate. The recitations were planned for a small classroom setting to help students learn problem-solving techniques and encourage cooperative learning.

Table 1. Grade distribution, in percentages, from Fall 1994 through Summer 2000 for three introductory courses in Mechanical Engineering.

Course	A	B	C	D	F	W
Dynamics	9.6	16.3	26.2	14.6	18.8	14.4
Solid Mechanics	11.1	14.8	23.9	13.1	19.0	18.2
Thermodynamics I	14.2	18.9	25.o	10.4	13.6	17.8

The implementation of a new state law[3-4] in 1999 requiring that a successfully completed 42-semester-credit hour (SCH) core curriculum be transferable as a block among all state supported institutions in Texas. This increased the minimum requirements for an engineering BS degree at UTSA from 129 SCH to 138 SCH in 1999. The Core course requirements for Engineering programs was different from other programs in the University, requiring reduced number of hours. One goal of the catalog revision was to keep the minimum SCH requirement for a BS degree under 130, without adversely affecting the quality of each program. All three programs successfully completed this task and proposed BS degree programs for the 2000-02 catalog that could be completed within 130 SCH (125 SCH for CE, 129 SCH for EE, and 130 SCH for ME).

The revised curricula offer specialization options within the EE and ME degree programs. The options in the EE program are: i) computer engineering, ii) communication and DSP system engineering, and iii) control system engineering. The ME program specialized options are: i) thermal/fluid systems, ii) structures and motions of mechanical systems, and iii) general mechanical engineering. The CE program does not identify a specialization option. However, eight required civil engineering courses provide students with the fundamentals in the areas of environmental engineering, geo-technical engineering, hydrology and water resources, structural engineering, and transportation/traffic engineering. In addition, the completion of 6 SCH of technical elective courses required by all CE degree candidates provides additional training in one or two areas of civil engineering.

Texas' new rule on the 45-hour undergraduate credit limit beyond the degree requirements might create additional problems for engineering students. During the 76th legislative session Section 54.068 of the Texas Education was amended (Senate Bill 345) to allow public institutions of higher education to charge resident students non-resident fees for semester hours attempted in excess of 45 hours beyond hours required for a degree program[5]. The attempted hours include all courses passed, failed, dropped or withdrawn while a student is paying a resident tuition at a public institution in Texas. The new rule applies to all new undergraduate resident students starting Fall 1999

III. New Curriculum Special Futures

The implementation of the new curriculum began in Fall 2000. The content of the curriculum contains many special features as described below. These features are designed to enhance the educational quality of the program and to improve student retention and success.

To improve student success in engineering foundation courses, one hour of recitation has been added in several EGR, EE, and ME introductory courses. The enrollment for each recitation section is limited to 20-25 students. No new materials are covered in the recitation periods. Instructors use this time to answer questions, solve example problems, involve students in cooperative learning, and introduce application of appropriate computer software.

The special features included in a number of basic courses required by engineering program. These courses are EGR 1303-Exploring the Engineering Profession, EGR 2323-Engineering Analysis I, and EGR 3323- Engineering Analysis II.

These are foundation courses in the mechanical engineering curriculum and strong preparation in these courses is essential for student success in the upper level courses. To improve student success, one hour of mandatory recitation has been added to the three courses listed above. Again the enrollment for each recitation section is limited to 25 students and the recitation hours are used to improve students' problem solving skills.

EGR 1303 – Exploring the Engineering Profession: This new course is required in all engineering degree programs at UTSA. The course format is a three-hour lecture, one-hour laboratory/recitation. The laboratory/recitation hour is limited to a small enrollment to allow student/instructor interaction in problem-solving techniques. The course is intended to begin the student's preparation for future engineering practice. A part of the course is used to advise students in proper course selection and prepare students for college life. Students are introduced to a number of subjects that are necessary tools of engineering. Topics include: study skills, time management, the concept of teamwork, professional ethics, and oral and written communication skills. The computer application aspect of the course is designed with the strength of current students in mind. Students are introduced to basic computer applications as well as more sophisticated software packages such as Matlab. The course instructor invites other faculty members in the college to give lectures describing various branches of the engineering profession. To instill the principles of teamwork, students majoring in different engineering disciplines are organized in a group to work together on reversed engineering design problems.

EGR 2323 and EGR 3323-Engineering Analysis I and Engineering Analysis II**:** These are applied mathematics courses, beyond calculus, which were previously by the math department. The addition of recitation hours was one of the main reasons for offering theses courses by college of engineering. All three engineering degree programs require EGR 2323 (previously MAT 3253). However, EGR 3323 (previously MAT 3263)is a degree requirement in the EE and ME programs. The first course covers topics in ordinary differential equations and linear algebra. The second course covers such topics as multivariable calculus, partial differential equations, and vector calculus. Each course has an emphasis on applied engineering problems and a recitation hour is attached to it to help students in problem solving techniques. Enrollment for the recitation hour is limited to 25 to allow student/faculty interaction.

To improve student success in other engineering, one or two hours of recitation is included in several EE and ME introductory courses. A study of grade distribution in EE and ME courses in the past had shown a high failure rate in the following courses:

EE 2423- Network Theory
EE 2513- Logic Design
EE 3313- Electronics Circuit I
EE 3413- Analysis and Design of Control systems
EE 3423- Signal and Systems I
ME 3103- Kinematics and Dynamics
ME 3293-Thermodynamics I
ME 3813-Solid Mechanics

Again the enrollment for each recitation section is limited to 25 students. No new materials are covered in the recitation period. Instructors use these periods to answer questions, solve example problems, and involve students in cooperative learning.

IV. Effect of Recitation Hours on Grade Distribution.

For a number of courses, Table 3 compares grade distributions for periods prior to and post implementation of recitation sessions. Only EGR 2323-Engineering Analysis I display a vast improvement in student success after the implementation of recitation hours. The number of students receiving grades of D, F, or W decreased by 12.4%. Table 3 shows moderate improvements for ME 3293-Thermodynamics I and ME 3813-Solid Mechanics after the implementation of recitation period; it shows the percentage of students receiving grades of D, F, or W decreased by 6.5% and 7%, respectively. No improvement is observed for EGR 3323-Engineering Analysis II and ME 3103-Kinematics and Dynamics.

Table 3. Grade distribution comparison, in percentages, for periods prior to and post implementation of recitation hours.

Course	Period	A	B	C	D	F	W	D, F, W
EGR 2323	Fall 1994-Summer 2000	28.2	24.3	17.8	7.2	10.5	12.0	29.6
	Fall 2000-Fall 2001	26.1	32.9	23.7	8.6	3.6	5.0	17.2
EGR 3323	Fall 1994-Summer 2000	22.1	21.1	25.3	9.5	8.9	13.2	31.6
	Fall 2000-Fall 2001	20.2	24.9	20.2	13.0	14.0	7.8	34.7
ME 3103	Fall 1994-Summer 2000	9.6	16.3	26.2	14.6	18.8	14.4	47.9
	Fall 2000-Fall 2001	12.7	14.3	25.4	9.52	23	15.1	47.6
ME 3293	Fall 1994-Summer 2000	14.2	18.9	25.0	10.6	13.6	17.8	41.9
	Fall 2000-Fall 2001	16.7	20.8	27.1	10.4	10.4	14.6	35.4
ME 3813	Fall 1994-Summer 2000	11.1	14.8	23.9	13.1	19.0	18.2	50.3
	Fall 2000-Fall 2001	11.5	25.0	20.2	15.4	15.4	12.5	43.3

The attendance for recitation hours has been encouraged in EGR 2323, ME 3293, and ME 3813. For example, attendance in recitation hours and participation in problem solving activities was counted as 10 % of grade. However, attendance for recitation hours has been optional for EGR 3323 and ME 3103, which has been taught by the same instructor. This might explain why student success has not been improved in these courses after the implementation of recitation sessions. The instructor has begun rewarding the attendance of recitation sessions.

Table 3 also shows a shift in grade distribution after the implementation of recitation sessions. It indicates that the percentage of students receiving grades of A and B has increased by 6.5% in EGR 2323, 1.9% in EGR 3323, 1.1 % in ME 3103, and 4.4% in ME 3293, and 10.6% in ME 3813.

There are important factors related to student success. Obviously, student motivation and effort are the main factors in student success. A careful examination of grade distribution within each course reveals that the semester grade is more directly related to student effort in completing homework assignment and attending class. Figure 1 shows the semester grade as a function of homework grade in ME 3293-Thermodynamics 1. The effect of attendance on semester grade is shown on Fig.2. The combined effect of student class attendance and completion of homework assignment is displayed in Fig. 3.

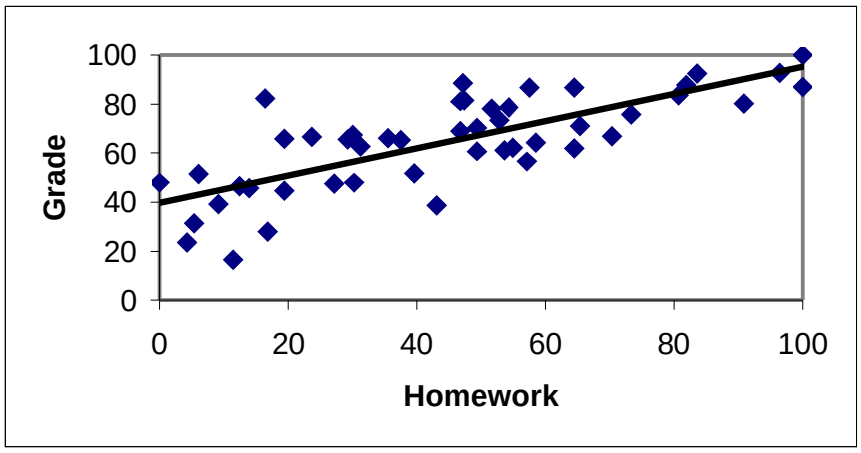

Fig. 1 Semester grade versus homework grade

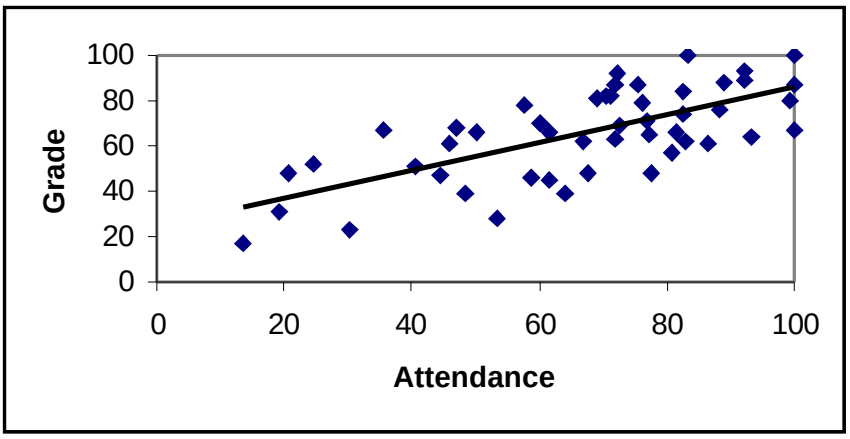

Fig. 2 Semester grade versus attendance

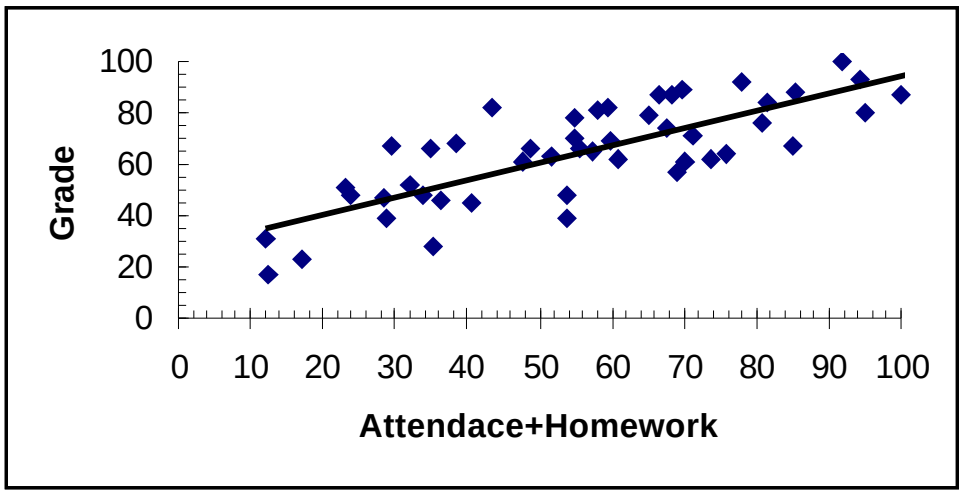

Fig. 3 Semester grade versus attendance and homework grade

IV. Summary

To improve student retention and success, recitation hours have been added to a number of foundation engineering courses having large failure rates in the past. The implementation of the recitation sessions began in Fall 2000. The recitation hours have been conducted in a small classroom setting to help students learn problem-solving techniques and encourage cooperative learning. In general, moderate improvements in student have been experienced after the implementation of the recitation session. However, it is shown that student motivation, class attendance, and student effort in completing homework assignments plays more important roles in student success.

References

1. U.S. Census Bureau, 1999.
2. 2000-01 UTSA Undergraduate Information Bulletin, USPS #982940, Vol. XIX, August 2000, Number 5, p. 64.
3. URL: http:/www.thecb.state.tx.us/divisions/ctc/ip/Core/background.htm; Core Curriculum in Texas: Introduction and Background.
4. URL: http:/www.thecb.state.tx.us/divisions/ctc/ip/Core/finalreport.htm; Report of the Advisory Committee on Core Curriculum, Texas Higher Education Board.

AMIR KARIMI
Amir Karimi is Professor of Mechanical Engineering at The University of Texas at San Antonio (UTSA). He received his Ph.D. degree in Mechanical Engineering from the University of Kentucky in 1982. His teaching and research interests are in thermal sciences. He has been the chair of mechanical engineering twice: the first time

between 1987 and 1992 and again from September 1998 to present. Dr. Karimi has served on curriculum committees at all university levels and has been a member of the University Core Curriculum (1993-95 and 1999-present). He is the ASEE Campus Representative at UTSA and is the current ASEE-GSW Section Campus Representative. He chaired the ASEE-GSW section during the 1996-97 academic year.