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ATINER's Conference Paper Series
MAT2012-0096

Mathematics Tutoring and Course Completion

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URL Conference Papers Series: www.atiner.gr/papers.htm

Printed in Athens, Greece by the Athens Institute for Education and Research.

ISSN **2241-2891**
5/09/2012

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This paper should be cited as follows:

Navarra-Madsen, J. (2012) "**Mathematics Tutoring and Course Completion**" Athens: ATINER'S Conference Paper Series, No: MAT2012-0096.

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Abstract

Given the completion-based shift in fundingformula for higher education, there is an ever-increasing pressure to improve graduation rate. Colleges and universities around the world are finding innovative student programs such as tutoring and counseling services, to increase student success. This preliminary study was designed to determine the relationship between tutoring and course completion rate of students. Specifically, this study would like to answer the following questions: 1) what is the course completion rate of students who took advantage of tutoring and students who did not?; 2) is there a significant difference on the rate of course completion between these two groups?; and 3) zooming in on the tutored students, what relationship exists between the total number of hours spent in the tutoring lab and the final grade in the course tutored?

Keywords: Tutoring, Course Completion Rate, Degree Completion Rate

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Introduction

A recent Midwestern Higher Education Compact research has reported that enrollment-based funding formula is slowly being phased out in favor of completion-based funding formula (MHEC, 2009). In fact, more and more states in the United States (US) are starting to link higher education funding with actually-achieved measures such as graduation rates or degree completion rates. Unfortunately, degree completion rate is not an easy rate to track and measure. There is an ongoing debate whether degree completion rate gives a good picture of the quality of higher education institutions. Some states in the US, for example, Texas, turn to course completion rate to measure higher education institutions' effectiveness. Course completion rate is defined as the percentage of students who did not withdraw during the semester, i.e., students who obtained a grade of either A, B, C, D, F, or incomplete (I). Incomplete means that they have done enough for the semester but due to certain circumstances cannot finish the course and therefore have to sign a contract to complete the remainingcourse requirements within a semester or two. Does this completion rate definition justify the way a higher education institution's quality rating is judged? One can then consider a stricter rate, the passing rate (percentage of students with a grade of C or better). If this is the rate to be used, it is crucial to understand the factors affecting passing rate especially in the hard sciences (mathematics, physics, chemistry, etc.) courses (HERI, 2010). One of the hurdles faced by tertiary level students is passing required mathematics courses. The 472-page report from Organization for Economic Cooperation and Development saying that the US ranks 27th among 30 developed nations in the proportion of college students receiving degrees in science and engineering (OECD, 2009) is an illustration that more work must be done to ameliorate this degree completion deficit. One good question to ask is: What must be done to help these students pass required mathematics courses which count towards graduation? There are a number of student support and intervention programs implemented to increase course completion rates and hence increase degree completion rates. One of these programs is tutoring. In this paper, the author would like to determine the relationship between tutoring, in particular, mathematics tutoring, and course completion and passing rates. This study would like to answer the following questions: 1) what is the course completion and passing rates of groups of students who took advantage of tutoring and students who did not?; 2) is there a significant difference on the rate of course completion between these two groups?; and 3) zooming in on the tutored students, what relationship exists between the total number of hours spent in the tutoring lab and the final grade in the course tutored?

Background and Context

Universities and colleges usually offer free tutoring services to students with the intention of increasing student success rate (Young, 2011; Navarra-Madsen & Ingram, 2010; Cooper, 2010; Cain et al, 2006; Topping, 2006). Faculty members are usually encouraged to announce in their classes that this kind of service is being offered. Students will then have to decide whether they want to avail of this tutoring service or not. Several tutors are usually present at one time. The cohort of tutors is composed of upper level class and graduate students who have taken and excelled in courses they are assigned to tutor. The kind of tutoring done at Texas Woman's University (TWU) especially at the Mathematics and Technology Success Center (MTSC) is

modified peer tutoring. This means that peer tutors have completed the courses they are assigned to tutor andhence know the expectations of mathematics professors teaching these courses. These tutors can therefore help student tutees navigate the course and learn the material in a more meaningful fashion, i.e., share useful techniques on how to do well during quizzes and examinations and not just give the tutees ready answers of homework exercises. Peer tutoring is effective in increasing the success rate of students who are truly willing to learn the concepts and not just obtain the answers to the homework exercises (Topping, 1996).

Data and Findings

Data such as exam scores and grades from two upper level mathematics courses (Probability and Statistics, and Matrix Methods) for academic years 2010 and 2011were used. Probability and Statistics was taught during the fall semester only and Matrix Algebra during the spring semester only. These courses were all taught by the same instructor thereby facilitating the easy tracking of relevant data. Data from MTSC, relevant to the study include identification number (ID) of students who visited and therefore received tutoring services, total number of visits of each student and total number of hours spent per visit of each student.

Overview of MTSC Clientele

Table 1 shows that 33% of undergraduate students and 67% of mathematics majors availed tutoring services from MTSC the past four semesters (Spring 2010-Fall 2011) in the Denton Campus only.MTSC provided tutoring services to 74% of mathematics majors during the Fall 2010, Spring 2011 and Fall 2011 semesters, a 30% increase compared to 44% served during Spring 2010.

Table 1. Overview of MTSC Clientele (% of Students Availing Tutoring Services)

SEMESTER	PERCENTAGE* OF UNDERGRADUATE STUDENTS WHO VISITED	PERCENTAGE** OF MATHEMATICS MAJORS WHO VISITED
SPRING 2010	34%	44%
FALL 2010	27%	75%
SPRING 2011	35%	72%
FALL 2011	37%	75%

*Based on the total number of undergraduate students enrolled in mathematics classes per semester (Spring 2010-Fall 2011).

**Based on the TWU Factbook's total number of mathematics majors enrolled per semester. Note that TWU has three campuses: Denton, Dallas and Houston.The numbers used in this table are the Denton campus numbers only since MTSC is locally found in the Denton campus.

Table 2 shows that the two courses involved in this study, Matrix Methods and Probability and Statistics, have an increasing number of math majors who visitedd, number of visits and total number of hours spent in MTSC.

Table 2. Sample Lists of Mathematics Courses, Number of Math Majors who visited, Number of Visits and Total Number of Hours spent at MTSC

COURSES MATH MAJORS NEED HELP WITH	**NUMBER OF MATH MAJORS WHO VISITED**				**NUMBER OF VISITS**				**TOTAL NUMBER OF HOURS**			
SEMESTER	S10	F10	S11	F11	S10	F10	S11	F11	S10	F10	S11	F11
Elementary Statistics I	5	1	3	1	69	31	18	3	92	23	39	4
Calculus I	5	6	3	9	104	9	40	71	208	53	97	98
Calculus II	5	*	11	*	38	*	108	*	41	*	158	*
Calculus III	*	9	*	16	*	33	*	144	*	59	*	249
Discrete Mathematics	4	*	4	*	43	*	48	*	74	*	83	*
Abstract Algebra	15	12	6	12	155	135	28	88	226	90	56	120
Linear Algebra	*	2	*	5	*	10	*	32	*	9	*	16
Matrix Methods	9	*	11	*	47	*	50	*	71	*	104	*
Probability and Statistics	*	17	*	19	*	31	*	99	*	33	*	157
TOTAL	**43**	**47**	**38**	**62**	**456**	**249**	**292**	**437**	**712**	**267**	**537**	**644**

* not offered

Course completion rates of students who took advantage of tutoring and students who did not

In this study course completion rate is defined as the percentage of students who did not withdraw during the semester obtaining grades of A, B, C, D or F while passing rate is the percentage of students who obtained a passing grade (A, B, C) at the end of end of the semester. We don't consider students who did not complete the course, students who obtain an incomplete, "I" for short. Table 3 shows the course completion and passing rates of students who took advantage of tutoring and students who did not while enrolled in Matrix Methods and Probability and Statistics. Students who availed of MTSC tutoring in both courses had a slightly higher completion rate (by 2%) than the students who did not avail of tutoring at all. When one looks at the passing rates in these courses, mixed results follow. Students who availed of MTSC tutoring in Probability and Statistics had a higher passing rate (10% higher) than the students who did not avail of tutoring at all. This is not true in Matrix Methods. The passing rate of students who availed tutoring in Matrix Methods is 9% lower than the students who did avail of tutoring.What can explain this difference in passing rates? What makes tutoring effective for one course and not for another? One possible explanation is the tendency of a number of conscientious students from one course, in this case, Probability and Statistics, to naturally form a cohort of tutees discussing

questions related to course topics in a small round table facilitated by a peer tutor. This cohort formation leads to easy exchange of ideas and techniques in solving homework problems. This is only an observation and no quantitative data have been gathered so far. One future recommendation to the director of MTSC is to start tracking these tutees forming natural cohort and giving a survey to evaluate the pros and cons of cohort formation during tutoring hours.

Table 3. Comparing Completion Rates and Passing Rates of Students who visited MTSC and who did not.

	Matrix Methods		Probability and Statistics	
Rate	**No MTSC Usage**	**With MTSC Usage**	**No MTSC Usage**	**With MTSC Usage**
Completion Rate	93%	95%	90%	92%
Passing Rate	72%	63%	70%	80%

Comparison of Course Grades of Mathematics Majors who visited and did not visit MTSC

To compare the course grades of students who visited MTSC and those who did not visit, letter grades of all students in these courses were given weights, i.e., A, B, C, D, and F were given weights of 4, 3, 2, 1, and 0, respectively.

Table 4. Comparing Mean Number of Visits, Mean Number of Hours Spent in MTSC and Grades

MATH MAJORS with MTSC USAGE (Spring 2010-Fall 2011)	**GRADE**
Matrix Methods (n =18)	2.11
Prob. and Statistics (n = 33)	2.33
MATH MAJORS with NO MTSC USAGE	**GRADE**
Matrix Methods (n = 27)	2.31
Prob. and Statistics (n = 18)	2.23

Table 4 indicates that there are very small differences in grades of students who visited and those did not visit. This result coincides with the 2010 study conducted also at TWU (Navarra-Madsen & Ingram, 2010). However, the TWU 2010 study did not include details such as when did students start coming to the tutoring center, which is quite important in answering whether these students were motivated to avail of tutoring services by low scores in the first midterm exam or whether these students were self-motivated to succeed in a certain course. In this study, this paper sheds light on whether the "early warning" program is working. What is this early warning program? To retain more students, most colleges and universities require course instructors to give early warning to students who are in the danger zone, students with

grades D or F, after a few quizzes and/or one midterm exam in the first four weeks of the semester. One good question to answer is: Given the early warning and the motivation from instructors to seek tutoring as early as possible, is there a significant difference between midterm exam 1 scores and final exam scores among students who sought tutoring? Paired *t*-test (one-tailed) is then utilized at alpha = 0.05 to answer this question.

Table 5. Resulting P-values (alpha 0.05, one-tailed Paired *t*-test) in Comparing Midterm and Final Exam Scores

	Matrix Methods		Probability and Statistics	
Semester	SP 10	SP 11	FA 10	FA 11
With MTSC Usage	0.2495	0.2414	0.0289*	0.0335*

*significant

Table 5 shows that there exists a significant difference (in this case, an increase) between midterm exam 1 scores and final exam scores among students who sought tutoring in Probability and Statistics. Unfortunately, this is not true for Matrix Methods. This then leads to the question: Why is tutoring having a positive impact in terms of an increase in final exam scores in some courses only? We can surmise that student composition (in terms of educational background) and level of motivation are at least two factors to look at, i.e., how prepared these students are in achieving the student learning outcomes set in these upper level courses and how determined these students are in completing their degrees. A wide spectrum of educational preparation and motivation level is present and this teaching environment makes the life of professors very difficult. How does one find a solution to this problematic scenario? One possible recommendation relates to the work done by Hendriksen et al, 'Course-embedded tutoring programs have a positive effect on student completion and passing rates.' (Hendriksen et al, 2005). There is a need to align student learning outcomes progression across the whole degree program and implement course-embedded tutoring program to be qualitatively and quantitatively evaluated periodically.

Relationship between Course Grades of Mathematics Majors and Number of Hours Spent in MTSC

Focusing on the students who availed of MTSC tutoring, Pearson Product Moment Correlation Coefficient (*r*) was used to measure the whether there is a linear relation between amount of time spent at MTSC of students seeking tutoring and final grades in courses tutored in. Table 6 shows that there is a very weak but positive linear relation between number of hours spent in MTSC and course grades in the course.

Table 6. Correlation: Total Number of Hours Spent in MTSC for Two Mathematics Courses of Mathematics Majors and Grades

COURSE	CORRELATION COEFFICIENT (*r*)
Matrix Methods	0.34
Prob. and Statistics	0.21

Conclusion and Future Work

Does tutoring increase course completion and passing rates in tertiary courses and hence increase the overall degree completion rates of higher education institutions? This preliminary study gives conflicting results. Tutoring increases both rates (course completion and passing rates) in one course, Probability and Statistics, but not in the other course, Matrix Methods. The question that immediately follows is: What would have been the completion and passing rates in these two courses had there been no tutoring offered?

Students' age, students' full time status, university's faculty hiring practices, level of spending per student, and extent of interventions via student academic support services (tutoring, counseling, and other services) are some of the factors affecting completion rate. In this study, only one form of academic intervention, tutoring, in particular, mathematics tutoring, was utilized. This study focused only on two upper level mathematics courses. One possible future work is to increase the number of courses, perhaps include all science, technology, engineering, and mathematics (STEM) courses since these are courses some students struggle in. Additionally, the inclusion of other factors such as students' age, students' full time status, university's faculty hiring practices, and level of spending per student will definitely provide a better picture on how to utilize completion rate in justifiably measuring higher education institutions' rating. Achieving this more meaningful and better-defined completion rate will give education funding agencies a tool in appropriately allocating resources.

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