Systems Management. Currently, he teaches Radio and Television production courses at Henderson State University and completed an M.F.A. in Digital Filmmaking from the University of Central Arkansas in 2011. He has produced several documentaries for the Hot Springs Documentary Film Festival and directed a short narrative, "On My Trail", about blues musician Robert Johnson.

MyMathLab Effectiveness in College Algebra

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Abstract

A study from the fall of 2012 at Henderson State University provided evidence that students using MyMathLab in College Algebra did slightly better, on average, than those who did not. Also, the conversion of all the sections to MyMathLab for subsequent semesters will be discussed.

Introduction

Approximately 55% of Henderson State University (HSU) students who enroll in College Algebra finish with a grade of A, B, or C [1], which is within the range of success rates nationwide, typically 40-60%. [2] The HSU mathematics and computer science department adheres to state and national standards for College Algebra. This course is challenging because we adhere to the Arkansas Higher Education Coordinating Board policies, [4] which requires that the following topics must be covered in College Algebra:

1. Quadratic equations and inequalities with applications.
2. Polynomial rational, exponential, logarithmic functions, graphing functions, combining functions, inverse functions solving problems whose mathematical models are polynomial, exponential and logarithmic functions. Finding zeros of polynomial and rational functions including the use of methods of approximation.
3. Solving systems of linear equations, including solution by matrix methods and determinants. Systems of linear inequalities; applications of both systems of equations and systems of linear inequalities. Systems of non-linear equations. [4]

We teach row-reduction, in College Algebra, instead of determinants, because it allows the student to write the parametric form when a system has an infinite number of solutions and has other applications in subsequent courses. Some of the College Algebra instructors may not have time to cover linear inequalities, especially linear programming, and systems of nonlinear equations. The coordinating board recommends the following topics, however we decided to put them in the courses Discrete Mathematics I or Pre-Calculus Mathematics instead:

Mathematical induction, Binomial Theorem, arithmetic and geometric sequences and series, counting techniques and probability. [4]

While maintaining high standards for College Algebra, HSU has several tutoring programs in place, namely, mathematics-departmental tutors, Student Support Services, the First Year Experience Program, and the Supplemental Instructional Program. We also have the alternative course, Mathematics for the Liberal Arts, which is as sophisticated as College Algebra, but avoids symbolic manipulation. We believe that students underutilize these programs and the alternative course.

Design and Results

Near the beginning of the Fall 2012 semester, Pearson Publishing offered to supply free MyMathLab (MML) [3] codes for three sections of College Algebra; the value for the ninety affected students was about $7000. (MML is an online learning system.) In return, the author agreed to send Pearson the final exams grades indicating whether the students used, or did not use, MML. HSU's Institutional Review Board [5] granted permission to gather this data,email it Pearson, present this paper at the regional Mathematics Association of America meeting, and publish it in the Academic Form. To ensure the privacy of both students and instructors, all of their names were removed from the data and the students' scores were sorted in increasing order.

There was one online class already using MML, and two of the instructors, who were familiar with MML, enthusiastically volunteered to use it as a supplement while the remaining instructors taught the course traditionally. All College Algebra students took a common final exam; their scores on this exam and the course completion rates were compared for the three teaching methods. Here is a summary of the counts for the teaching methods versus how the student completed the course:

	Took final exam	Enrolled, but missed final exam	W, WP, WF	Sample size
Hybrid	53	10	27	90
Online	13	0	8	21
traditional	121	25	68	214

There were no no-shows for the online course because that instructor dropped all students who stopped participating after a few weeks. Hence, when comparing the three teaching methods, the no-show and dropped students were combined. As the following circle graphs illustrate, the course completion rate does not appear to depend on the teaching method. In fact, a 2-way chi-squared test of association confirmed this (p = 0.9, df = 2).
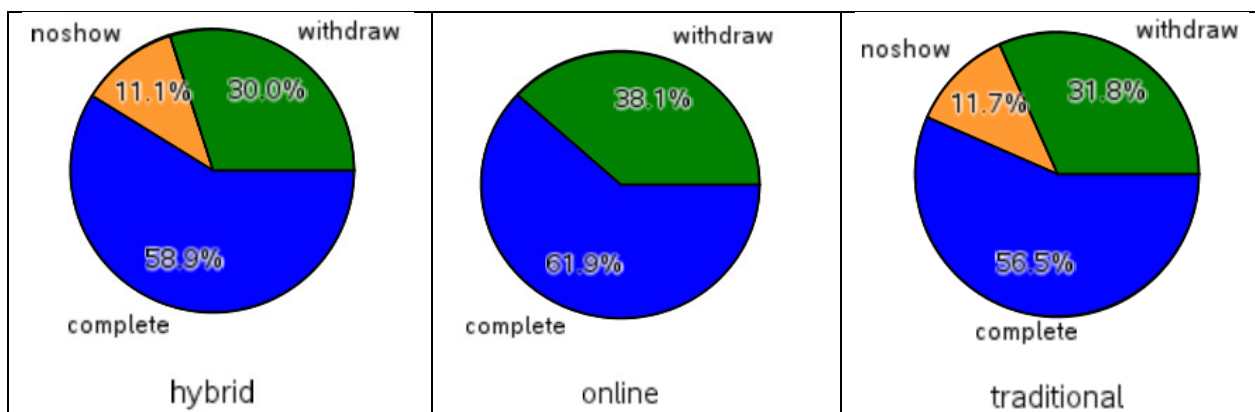
The rest of the analysis will focus on comparing the mean performance on the final examination for those students who stayed with the course. A summary of their performances is as follows:

	Sample size (n)	Mean (%)	Median (%)
Hybrid	53	46.2	50
Online	13	44.4	43
Traditional	121	40.7	43
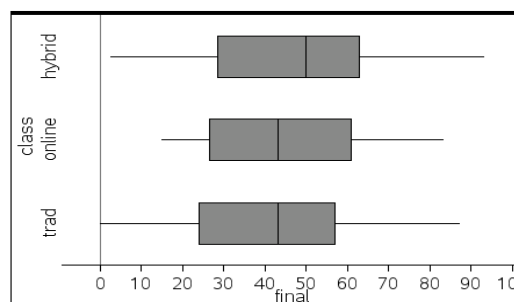
We interpreted applications and mathematical models in the state board policies as story problems, a topic most students struggle with. The common final examination was a bit lengthy at 26 questions and had 8 required application problems and 2 extra credit problems. The emphasis on word problems contributed to the students tending to score worse than expected, but they were not significantly lower on average than the Spring-2011 semester. Some of the hybrid sections were added later to the schedule and probably contained weaker students, so it is encouraging that they appeared to do better on average than the traditionally taught courses. The instructors graded their own final exams, but since each problem was worth very few points, it was assumed that this would have little influence on the final exam scores. The pass rates were not examined because the instructors' grading assessment and grading policy could have affected that variable. Here is an ANOVA summary table for the final examination score responding to the three teaching methods:

| Factor	SS	df	MS	F stat	P-val
Teaching methods	1,155	2	577	1.14	0.32
Error	92,838	184	505		
Total	93,992	186			

Hence, there was not a significant dependence of the final exam means on the three teaching methods. It may have been inappropriate to include the online course with the other courses, especially since the number of students taking the online course was small. It was nearly significant that the hybrid classes scored higher on average than the traditional classes (p-val = 0.08, df = 94.1).

Power Analysis

The mean difference between the hybrid and traditional classes was 5.6%, but only a mean difference of 9.5% can be detected with 80% power. This computation was done assuming that the difference between the sample hybrid and traditional sample mean final exam scores was Normally distributed ($d = \bar{x}_H - \bar{x}_T \sim N(\mu, \sigma_d)$). The population standard deviation for this statistic was estimated using the sample-standard deviations:

$$\sigma_d \approx \sqrt{\frac{s_H^2}{n_H} + \frac{s_T^2}{n_T}} = \sqrt{\frac{23.5^2}{53} + \frac{22.1^2}{121}} = 3.80\%$$

This was a right-tail test, and the boundary of critical region was 6.26% because $P(d \geq 6.26\% | \mu = 0) = 0.05$ assuming a significance level of 5%. In this context, the power function is defined by power$(\mu) = P(d \geq 6.26\% | \mu)$. The detectable difference of 9.5% at 80% power was found by locating the intersection of this curve with 0.8 as shown in the accompanying graph.
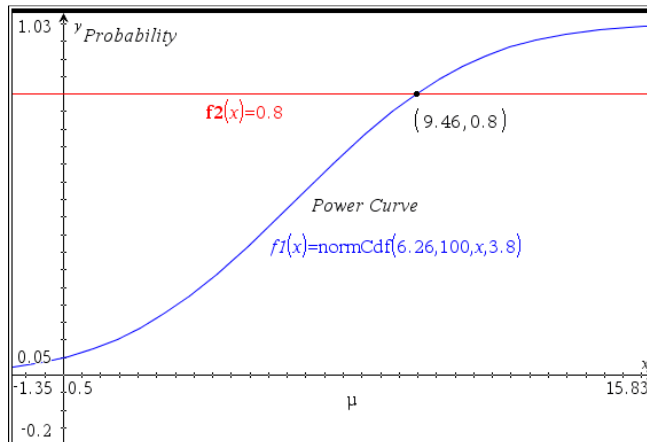
Epilogue

Because of the encouraging Fall-2012 results, all of the sections started using MML in the spring of 2013. All of the instructors of the traditionally taught courses in the spring of 2013 verified that twenty percent of the students' course grades were to come from MML assessments. (83% of the course grade is from MML assessments for the online algebra students.) We plan to do an internal study on the students' performance on the final exam in the spring of 2013, but it cannot be revealed outside our department because permission was not requested from the HSU internal review board. I suspect that the efficacy of MML will depend on how comfortable the instructor is with this learning system. We also plan to try MML again in the fall of 2013 to allow the instructors to learn the system better and then do another internal study of its effectiveness.

References

- [1] Fred Worth, Statistics of success rates for mathematics service courses at Henderson State University since Spring 2000
- [2] Don Small, *An Urgent Call to Improve Traditional College Algebra Programs*, MAA Focus, May/June 2002
- [3] MyMathLab, http://www.mymathlab.com/
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Biographical Sketch

Michael Lloyd received his B.S in Chemical Engineering in 1984 and accepted a position at Henderson State University in 1993 shortly after earning his Ph.D. in Mathematics from Kansas State University. He has presented papers at meetings of the Academy of Economics and Finance, the American Mathematical Society, the Arkansas Conference on Teaching, the Mathematical Association of America, and the Southwest Arkansas Council of Teachers of Mathematics. He has also done mathematical and statistical consulting, and has been an Advanced Placement statistics consultant since 2002.