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Research

Program Evaluation

An Evaluation of the College Algebra Initiative at the University of Houston Spring, 2006

Maureen G. Croft, Ph.D.

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Executive Summary

An Evaluation of College Algebra Initiative at the University of Houston Spring, 2006

INTRODUCTION

Program Description

MATH 1310 or College Algebra has been is a component of the core curriculum at the University of Houston since 1983, the year a core curriculum was adopted by the University. The course covers the following math topics: quadratic equations, inequalities, logarithmic and exponential functions, graphs, elements of theory of equations and systems of equations. At the University of Houston, all undergraduate degree-seeking students must take MATH 1310 if they do not demonstrate eligibility for a more advanced course.

As the course and content are structured, instructors focus on teaching simple approaches to number manipulation rather than focusing on algebraic endeavors requiring creativity and advanced knowledge threads. As such, MATH 1310 is geared toward students who did not have the appropriate exposure in high school, students who do not wish, or need, to have a more advanced mathematics background in order to succeed in their chosen major, and students who may pursue careers in majors that require more advanced exposure to mathematics but who did not recognize that reality while in high school.

The Algebra Initiative

In the Fall of 2002, the mathematics department initiated a series of changes to the structure of MATH 1310 (termed the Algebra Initiative for the purposes of this report). These changes not only increased the support offered to students but also increased requirements for student accountability. This Algebra Initiative included: the standardization of course content and testing, online weekly quizzes (WebCT), administratively initiated course drops for students failing a screener test and for not maintaining a quiz grade, the collection and grading of homework, daily pop quizzes (termed "poppers"), and an improved and more accessible comprehensive tutoring and testing center (CASA). The Initiative components were designed to offer additional academic support to students and to encourage the attendance and regular exposure to mathematical concepts deemed necessary for success in College Algebra.

Purpose of the Evaluation

This evaluation is meant to serve as a follow-up to the initial evaluation of the Algebra Initiative conducted in 2003 and to provide a targeted analysis of select factors pertaining to the Algebra Initiative. The following research questions were identified:

- What are the prevailing staff attitudes about the success of the algebra initiative?
- What are the course enrollment, course sequencing and grade trends for Math 1310 now as compared to before the algebra initiative and compared to other gateway courses?
- Did Math 1310 students exposed to the Algebra Initiative do better in subsequent math courses than students taking Math 1310 prior to the development of the Algebra Initiative?
- Is Test 1 an effective determinant of student success in Math 1310? (Student success was operationalized as the score on the Final Exam.)

FINDINGS

- Instructors and staff who were interviewed provided overwhelmingly positive feedback about the Algebra Initiative.

- Since academic year 1996, between 3,097 and 4,400 students have enrolled in College Algebra each year amounting to between 12% and 17% of undergraduate students at UH.

- Student rates of withdrawal from Math 1310 ranged from 14.2% to 22.1% of students enrolled past the 12th class day during academic years 1996-97 through 2004-5. Failure rates ranged from 8.4% to 22.2% during the same time period. These rates are relatively higher than two other gateway courses reviewed as part of this evaluation (POLS 1336 and ENGL 1303).

- The charting of grade distributions for Math 1310 by academic year reveals a trend towards issuing more A's and fewer D's and F's since the Algebra Initiative was phased in.

- Many of the students taking MATH 1310 during academic year 2004 went on to Pre-Calculus (20.1%) and Finite Mathematics (19.6%), while 10.5% of the students repeated College Algebra. Most of the remaining students did not take a subsequent math course (34.2%), and less than 2% of the students took a math course outside of the expected sequencing such as remedial MATH 1300 or Calculus.

- The proportion of students receiving an A or B in a subsequent mathematics course over the past nine years ranged from 31.3% (1996) to 42.5% (2000) with the past 4 years fluctuating only slightly between 35-40%. A charting of success rates over time revealed no noticeable trend towards increased success in subsequent courses since the Algebra Initiative was launched.

- The proportion of students receiving an A, B or C in a subsequent mathematics course over the past nine years ranged from 33.4% (1996) to 54.0% (2000). A charting of success rates over time revealed no noticeable trend towards increased success in subsequent courses since the Algebra Initiative was launched.

- Of the 1,905 students taking both Test 1 and the Final Exam in the fall of 2005, the performance of 67% of the students on the final was accurately predicted by performance on Test 1. On the other hand, the performance of 33% of the students on the final exam was not predicted by Test 1 performance.

RECOMMENDATIONS

- The mathematics department should engage in on-going assessment of new program components and initiatives to assure the optimal academic success of students.

- The department should continue to develop methods to improve the predictive ability of instruments used to screen students into or out of MATH 1310. Resultant decision-making regarding placement in MATH 1310 should be reviewed regularly.

Introduction

Program Description

MATH 1310 or College Algebra has been a component of the core curriculum at the University of Houston since 1983, the year a core curriculum was adopted by the University. The course covers the following math topics: quadratic equations, inequalities, logarithmic and exponential functions, graphs, elements of theory of equations and systems of equations.

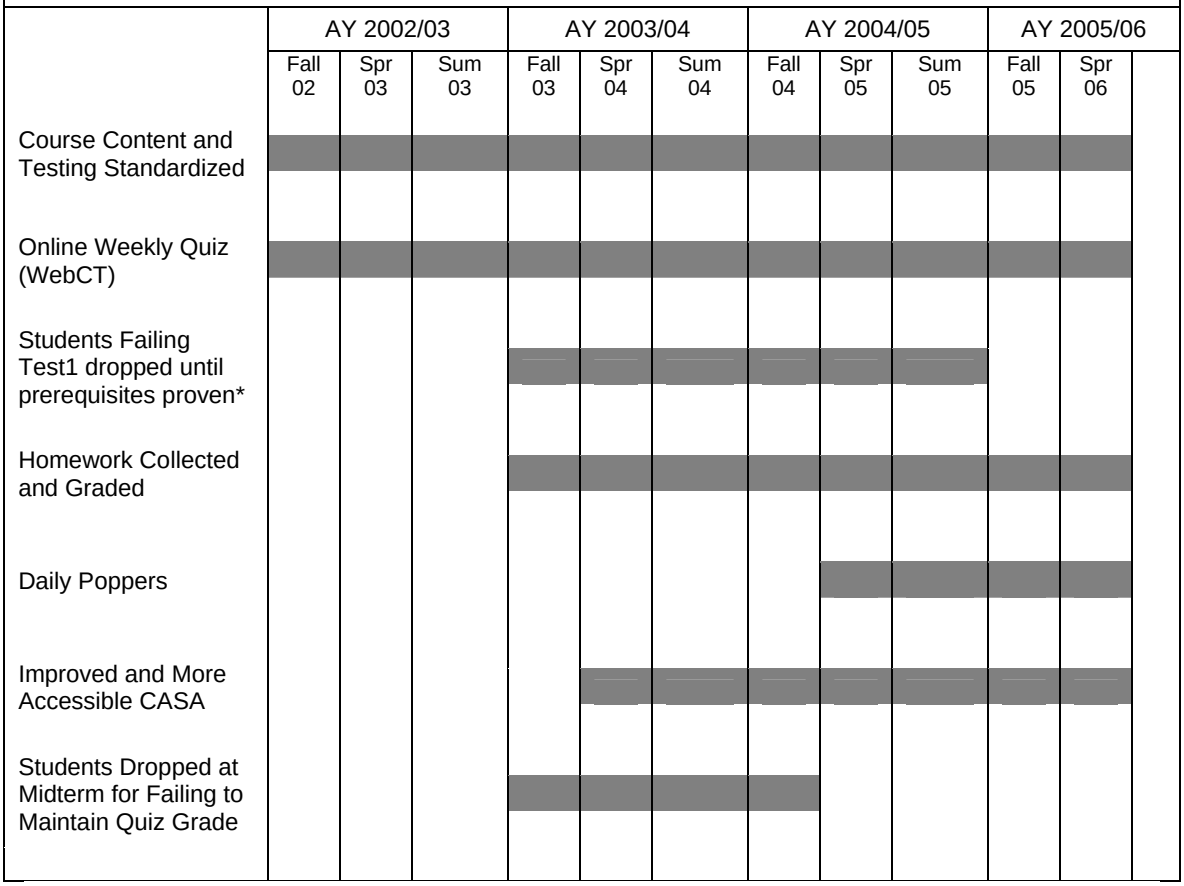
At the University of Houston, all undergraduate degree-seeking students must take MATH 1310 if they do not demonstrate eligibility for a more advanced course. In order to enroll in MATH 1310, students are asked to document one of the following prerequisites: a total SAT score equal to or greater than 900; a SAT mathematics subscore equal to or greater than 530; an ACT composite score equal to or greater than 21; a score equal to or better than 250 on the THEA math test; completion of MATH 1300 with a grade of "S"; or a score equal to or greater than 11 on the Basic Algebra (BA) section of the UH Math Placement Test. Students without the math background to successfully complete MATH 1310 can first take MATH 1300, Fundamentals of Mathematics; however, MATH 1300 is purely remedial and does not offer students the ability to receive credit or satisfy any degree requirements.

Math department staff members who were interviewed in the course of this evaluation tended to view College Algebra as covering standard, basic content that has been around, in one instructor's words, "since before the time of Christ". As the course and content are structured, instructors focus on teaching simple approaches to number manipulation rather than focusing on algebraic endeavors requiring creativity and advanced knowledge threads. There is also some belief on the part of departmental staff members that the concepts taught in college algebra should have been learned at the high school level. In fact, the concepts introduced in MATH 1310 are reportedly the same as those tested on the exit level Texas Assessment of Knowledge and Skills (TAKS) exam, which must be passed to meet graduation requirements in Texas. As such, MATH 1310 is geared toward students with enough algebra skills to pass TAKS but no real mastery of the concepts; students who do not wish, or need, to have a more advanced mathematics background in order to succeed in their chosen major; and students who may pursue careers in majors that require more advanced exposure to mathematics but who did not recognize that reality while in high school.

The Algebra Initiative

In the fall of 2002, the mathematics department initiated a series of changes to the structure of MATH 1310. These changes not only increased the support offered to students but also increased requirements for student accountability. **Figure 1** outlines the significant programmatic changes and their duration. Future reference to the series of program changes beginning in 2002 will be referred to in the body of this paper as the "Algebra Initiative".

Figure 1: Timeline of the Algebra Initiative



* While a test was not used to screen students during the 2002-03 academic year, the mathematics department did drop students who couldn't demonstrate that they had the necessary prerequisites.

Unsatisfied with what was considered to be too much variation between professors in the content taught and the grades given to students for differing amounts of knowledge of course content (including the tendency of some professors to curve substantially or to fail large numbers of students), the first programmatic changes consisted of standardizing course content and testing. This was accomplished in the fall of 2002. To prevent cheating, test items are now retrieved from a 'test bank' consisting of a variety of conceptually similar items. The computerized tests can be taken during specified time frames in the testing center located within the Center for Academic Support and Assessment (CASA). Practice tests are also available so that students can gauge their performance prior to taking the associated tests for credit.

It was also during 2002 that the math department began offering weekly quizzes on-line through WebCT. Students can take the weekly quizzes as many times as they want without penalty during the specified time frame with the highest score counting towards their final grade. The weekly quizzes can be accessed both at the testing center and from home, and they count for 15% of the student's grade.

In the fall of 2003, the math department began collecting and grading homework for Algebra 1310 students. This was done to encourage the practice and exposure deemed necessary to promote success in College Algebra. The collection and grading

of homework was made possible through the procurement of funding to hire additional graduate assistants to monitor and grade homework assignments.

In the fall of 2003, the math department initiated a policy by which students with scores below 70 on the first test (Test 1) and who had not provided proof that they had the required prerequisites to take MATH 1310 (prerequisites referenced above) were administratively dropped from the course. Because of the large number of students enrolling in MATH 1310, staff members indicate that they do not have time to check whether all students have the necessary prerequisites to enroll. Thus, the department has used an honor system with respect to checking prerequisites for many years. Some students without the necessary skill sets to succeed in College Algebra subsequently enrolled without heeding the departmental policy. The administrative drop policy initiated in 2003 was viewed as a workable solution, as only students failing Test 1 (by this means demonstrating a skill set deficiency) were asked to submit the necessary proof of prerequisites, thereby reducing the number of students whose prerequisites needed to be hand-checked by the instructor. Students failing Test 1 who did not submit proof of prerequisites (either because they did not have the necessary prerequisites, or because they did not do what was asked of them) were dropped, with an " * " showing in their grade file. Instructors believed that this was a fair practice, as the students were dropped in time to receive a tuition refund. There was also some belief that this practice served as a "wake up call" to students who had the necessary prerequisites but were not applying themselves in the course. All students received a letter by mail informing them of the drop. Every semester, some students ultimately returned with the necessary proof of prerequisites to be reinstated, thereby creating additional administrative within the department. In the fall of 2005, the practice of administratively dropping these students was discontinued.

In the fall of 2003, the math department also implemented a policy of administratively dropping students at midterm for failing to maintain a quiz grade (termed the "Web CT drops"), but this practice was discontinued in the fall of 2004. The reader may recall that students have a specified time period with which to complete each weekly quiz, but they may take the quizzes as many times as they would like during that specified time period. One requirement to pass MATH 1310 is that students maintain a quiz grade of a "C". Thus, students who were not taking the quizzes (resulting in "0"s in their quiz averages) or were failing their quizzes by midterm were in a position where it was mathematically impossible to achieve a passing grade in the class and were thus dropped administratively, resulting in a " W " in their course file. There was some thought within the department that a " W " was a better option for unmotivated students than the inevitable " F ". In some respects the quiz grade in MATH 1310 would be considered a proxy for motivation since students can literally retake the quiz until they get a satisfactory grade. According to a staff member, a failing quiz grade at midterm was almost universally due to students simply not logging on to take the quiz.

CASA is a tutoring and testing center that provides students with hands-on tutoring assistance with completing MATH 1310 assignments and studying for exams. CASA also provides a secure testing facility for exams and access to practice tests and online quizzes at one of 120 computer stations located in a separate, sound-controlled room. Students schedule a time to take exams at their convenience during a specified window of time. All in all, CASA employs approximately 75 graders, proctors and tutors to assist students and the math department. Tutors are hired only after scoring well on a screener test of skills; and, at any given time, between twelve and sixteen tutors are available to assist students. While some CASA program components had been offered

at UH for many years, the improved facilities and more technologically advanced and comprehensive tutoring and testing center at CASA became operational in the spring of 2004. This is when CASA moved into its new facilities in Rm. 222 in the Garrison Gym, and additional personnel were hired to assist students.

Finally, in an attempt to encourage attendance and thus increase exposure to course content, MATH 1310 instructors also initiated daily quizzes called "daily poppers" in the spring of 2005. All MATH 1310 students are required to bring Scantron sheets to every class, and the daily poppers account for 10% of the overall class grade. Instructors record attendance using the daily poppers.

MATH 1310 as a High Risk, Gateway Course

The problem of accommodating students entering universities with academic deficiencies is not unique to UH. Perceived declines in the level of academic skills of entering students coupled with the push to make postsecondary education more accessible to a broader range of students have led to new challenges for a large number of universities who must assess and design curriculum for these students. With high failure rates documented in many introductory courses (Gemignani, 1977; Parelius, 1992; Uribe, 2005), many universities are faced with the challenge of balancing the educational needs of entering students lacking in the necessary educational prerequisites to succeed in introductory courses with the desire to keep course content at a level befitting a college student (Gemignani, 1977; Parelius, 1992; Uribe, 2005).

Uribe (2005) defines introductory mathematics courses as being both "high risk", by virtue of having a failure rate of over 15% and 'gateway', meaning that they are critical for timely progress to graduation in many programs of study. Based on examination of factors associated with persistence at the University of Arizona, Uribe (2005) has surmised that failure to succeed in mathematics and other gateway courses greatly decreases student persistence. This framework can be helpful for viewing College Algebra at UH. It is the initial for-credit math course in the core curriculum, providing a gateway to higher level courses once it is completed successfully. And, as will be demonstrated in this evaluation, this course has been associated with higher failure and withdrawal rates than the other gateway courses reviewed as part of this evaluation.

Prerequisites and Course Placement Practices

Universities often attempt educated guesses about which students have the necessary knowledge base to succeed in gateway courses. This speculation often takes the form of universities establishing mandatory prerequisites such as cut scores on certain placement exams or standardized tests[1].

In 1990, the ACT issued a report on the study of how a sample of 900 postsecondary institutions with enrollments greater than 500 students make college placement decisions for English and math and how these institutions evaluate these placement decisions[2] (McNabb, 1990, October). This study found that the most selective institutions make more advanced placements in mathematics than less

[1] UH policy with respect to necessary prerequisites was reviewed in the Program Description section of this evaluation.
[2] Survey had a 64% response rate.

selective institutions. The most frequently reported sources for Math placement were local placements tests, followed by ACT and SAT test scores. The ACT survey also found that approximately 44% of the surveyed institutions conducted studies to assess the accuracy and effectiveness of their placement systems. Over 80 of these institutions conducted these studies annually. Finally, most institutions that participated in this study used multiple sources of information to make placement decisions.

It is possible to draw upon previous psychometric research when assessing the accuracy and effectiveness of placement screeners used to make course placement decisions. Since the pioneering psychometric work of researchers such as Cronbach (Lee J. Cronbach, 1965, 1967, 1970, 1976) and Cronbach and Gleser (L. J. Cronbach & Gleser, 1965) who employed decision theory to model testing predictions with respect to fairness in personnel selection, a few researchers have applied these and similar principles to the topic of college placement (Fujita & O'Reilly, 1970; Petersen & Novick, 1976; Sawyer, 1996; van der Linden, 1998). While a full review of this topic is beyond the scope of this evaluation, this topic is introduced because these authors offer some practical parameters with which to design screeners and to evaluate placement decisions and some particular content is discussed in the discussion portion of this evaluation.

Purpose of the Evaluation

Shortly after the first of the programmatic changes associated with the Algebra Initiative were introduced in 2002, a program evaluation was conducted by the UH Office of Institutional Research (Barlow, 2003). The evaluation employed a variety of techniques, including interviews, a focus group with students and multiple data extractions. The current evaluation is meant to serve as a follow-up to the initial evaluation of the Algebra Initiative and to provide a targeted analysis of select factors pertaining to the Algebra Initiative. Specifically, the following research questions were identified:

- **What are the prevailing staff attitudes about the success of the Algebra Initiative?**

- **What are the course enrollment, course sequencing and grade trends for MATH 1310 now as compared to before the Algebra Initiative and as compared to other gateway courses?**

With input from the Chair of the Department of Mathematics, two additional research questions of interest were identified:

- **Did MATH 1310 students exposed to the Algebra Initiative do better in subsequent math courses than students taking MATH 1310 prior to commencement of the Algebra Initiative?**

- **Is Test 1 an effective determinant of student success in MATH 1310?** (Student success was operationalized as the score on the Final Exam.)

Methods

Data Collection

Interviews and Observations

Information about College Algebra and the Algebra Initiative components were collected during interviews with the Chair of the Department of Mathematics and MATH 1310 Instructors. A site visit to CASA which included a tour, independent observations and individual interviews was also conducted. Course syllabi, departmental web sites and instructor web pages were also reviewed.

Enrollment and Course Grades

A database was created consisting of all students taking a math course at UH between the fall of 1996 and the summer of 2005, representing nine academic years of data. Enrollment data was then extracted. This file was then matched by social security number to the administrative system, which contains transcript information for UH students, and grade files were extracted. Grades were aggregated by academic year and by letter (e.g. B- and B+ are represented as a "B").

Performance in Subsequent Courses

Using the extracted grade file, course grades were rolled up by social security number so that it was possible to determine the sequence of math classes taken for each student and the subsequent grades in the classes.

Test 1 and Final Exam Scores

College Algebra instructors have been in the practice of maintaining Excel spreadsheets with the raw scores on tests and the final exam for the course sections for which they are responsible. The department was able to combine this information for all course sections taught in the fall of 2005. This information was then plotted to reveal patterns in the data.

Results

Departmental Input

Instructors and staff who were interviewed had overwhelmingly positive feedback about the Algebra Initiative. Standardization of course content and grading allowed instructors in subsequent courses to know what students had been exposed to mathematically prior to enrolling in their class and to gauge how much they had learned. Further, this standardization was perceived as enabling the math department to turn out a "consistent product" in terms of student aptitude. One instructor felt that the additional resources and clear expectations with respect to completing homework and attendance allowed students to more clearly see how their own effort contributed to their ability to succeed or fail in class.

While staff members who were interviewed were supportive of the Algebra Initiative components, they were equally vocal about administrative vetoes to some

programmatic changes. Specifically, staff members liked the use of Test 1 to weed out students without the necessary prerequisites to succeed in College Algebra and were disappointed when that practice was discontinued. The practice of administratively dropping students failing quizzes at midterm (Web CT drops) was also supported by the staff members interviewed because they questioned the motivation of students who were failing the quizzes, since students could take the quizzes as many times as they wanted until they achieved the score they wanted. One staff member indicated anecdotally that the students who were dropped at midterm had not bothered to take the necessary quizzes (even though one quiz grade can be dropped) resulting in quiz averages at or close to "0". While some concern was voiced about how interference in policies affected program outcomes, most concern was for the student in terms of level of learning and perceived fairness. Additionally, the department Chair indicated that most major universities have automated prerequisite enforcement processes built into their electronic registration systems and speculated that if U of H were to have the same capacity much of the need to screen students using Test 1 could be eliminated.

Finally, the instructors interviewed described a new, concerted departmental effort in the past several years to assist students in identifying the next math course in which to enroll. They stated that their knowledge of what students had learned in Algebra 1310 and the relative meaningfulness of the grades students achieved had become better since the mathematics department standardized course content and grading as part of the Algebra Initiative. Consequently, they felt more confident assisting students with identifying a subsequent mathematics courses commensurate with student skill and aptitude. The reader may want to bear this in mind when examining the sequencing of, and grades obtained in, subsequent courses explored later in this evaluation.

Enrollment

Table 1 showss the student enrollment count for the past nine academic years (fall, spring and summer semesters combined) for MATH 1310[3].

Table 1: MATH 1310 Enrollment 1996 – 2005

1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06 (fall only)
3,097	3,157	3,269	3,357	3,553	3,837	4,400	3,346	3,309	2,505

This enrollment is significant because during any given year, between 12% and 17% of undergraduate students at UH enroll in MATH 1310.[4] A successful MATH 1310 program (i.e. one with positive student outcomes) can significantly impact the knowledge base of students in subsequent math courses and the aptitude of students graduating from UH. And, overall student attitude about their UH experience is likely influenced by their perceptions of MATH 1310.

[3] Student count obtained from the UH grade file.

[4] Based on total undergraduate enrollment (excluding Post Baccalaureate students) between 2000 and 2005. Count includes students retaking MATH 1310 after failing or withdrawing.

Course Grades

Although there is some evidence that grades assigned by faculty members tend to be generally valid measures of student learning (Smith, 1992), course grades are also commonly considered to be imperfect indicators of student learning. This is because of the possibility that a given grade represents not only the actual level of student achievement but also any systematic biases of instructors (Young, 1993). Nevertheless, course grades can provide important information about programs, especially when grades are used in conjunction with other indicators of student learning. Patterns of grades over time can also offer insight into the consequences of changes within the teaching or program structure in educational institutions.

In the study of MATH 1310, grades were examined for two purposes. The first purpose was to examine failure and withdrawal rates for students taking MATH 1310 prior to, and after, the Algebra Initiative. This was in response to concerns relayed by staff in the math department that others in the university perceived the failure and withdrawal rate as high and not improving with the Algebra Initiative. The second purpose was to examine the trend in grades over the past 10 years for MATH 1310 and two other gateway courses at UH to explore whether any patterns emerge.

Figure 2 presents the percent of students who have withdrawn from MATH 1310 past the 12th class day (last date for tuition refund), represented by a " W " and a " * " in the grade file[5] as well as those students who received a final course grade of " F " for the past nine years. Withdrawal rates ranged between 14.2% and 22.1% of students enrolled past the 12th class day during those years. Failure rates ranged between 8.4% and 22.2% during the same time period. As will be demonstrated later, these ranges are relatively larger than other gateway courses reviewed as part of this evaluation. Additionally, both indicators spiked up in 2002, the year the Algebra Initiative was launched, but both tapered off rather significantly over the following two years. Several explanations are plausible. First, students may have reacted to change in expected course format in 2002 by withdrawing. Over time, the new expectations were institutionalized and accepted. A similar argument could be made for the percent of students failing. In 2002, students may have had different expectations about the amount of work required to pass MATH 1310. Over time, students may have been able to adjust to the new expectations in a favorable way. Instructors may have also gotten better at relaying the new expectations in a way that benefited student learning. The most favorable explanation is that the course requirements instituted between 2003 and 2004 (e.g. homework grading, daily poppers to encourage attendance, improved CASA facilities and accessibility) achieved the desired results of improving the level of exposure students had to College Algebra and the amount of time students spent practicing math skills[6].

[5] Withdrawing from MATH 1310 after the 12th class day and before the first drop deadline listed in the academic calendar is represented in the grade file as an "*". Withdrawing after the first drop deadline and before the final, is represented in the grade file as a "W". Students receiving a "W" are considered to be passing the course at the time of withdrawal. Students failing the course at the time of withdrawal receive an "F". In this analysis, withdrawals are defined as those occurring after the 12th class day (both the '*' and the 'W'), because it represents students who paid for the course and are no longer eligible for a tuition refund.

[6] In the fall of 2003, the math department at UH began administratively dropping students who had not completed mandatory Web CT quizzes satisfactorily. This practice continued through the

Figure 2: Percent of Students Failing and Withdrawing from MATH 1310 by Academic Year

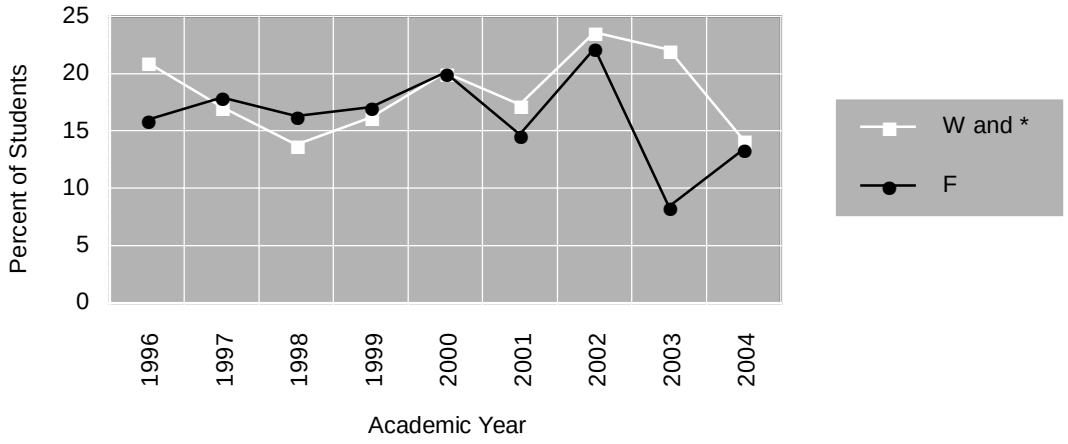
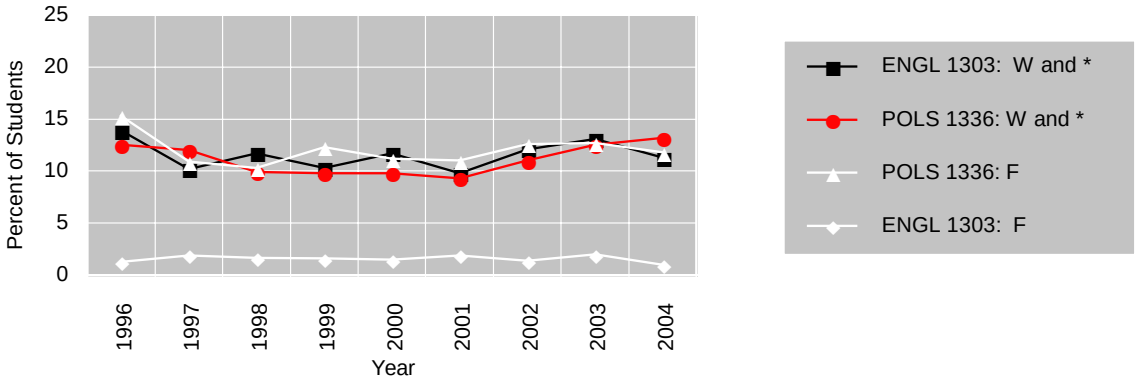


Figure 3 contains comparison data for English 1303 (ENGL 1303) and Political Science 1336 (POLS 1336), two other gateway courses at UH. Overall, withdrawal and failure rates are lower for both courses but to differing degrees. Withdrawal rates in these two classes have also fluctuated within a relatively small range (10–15% of students) over the past nine years. Failure rates have also fluctuated within two separate but relatively small ranges over the past nine years. Between 1996 and 2004, only 1-2% of ENGL1303 students have failed the course. Failure rates are much higher for POLS 1336, as between 10.3% and 15.3% of students failed the course during the same time period. Interestingly, withdrawal and failure rates for MATH 1310 in academic year 2004 decreased to be proportionally similar to POLS 1336.

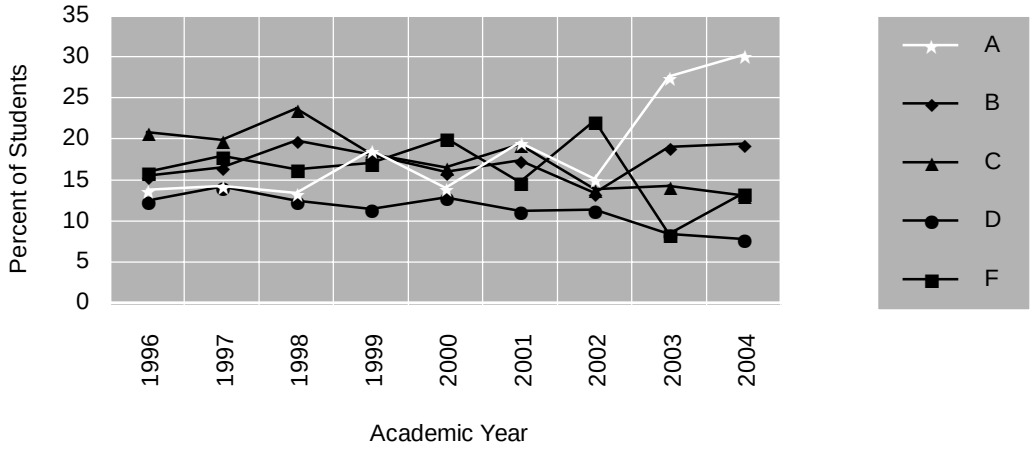
Figure 3: Percent of Students Failing or Withdrawing from ENGL 1303 and POLS 1336 by Academic Year



fall of 2004. Students who were dropped received a "W". Thus, in 2003 and 2004, the number of withdrawals is higher than would be expected with only voluntary student activity.

Figure 4 presents the grade distribution for MATH 1310 by academic year. The charting of grade distributions reveals a trend towards more A's and fewer D's and F's being given out to students after the standardization of course content and testing was achieved with the Algebra Initiative.

Figure 4: Grade Distribution for MATH 1310 by Academic Year



Alignment with Subsequent Courses

In order to examine the sequencing of mathematics courses after MATH 1310, students who took MATH 1310 as their first math course in each of the academic years of interest (1996-2004) were extracted from the grade file. Subsequent math courses taken by each student and the resulting grades were then identified. As **Table 2** demonstrates, many of the students taking MATH 1310 in 2004 went on to Pre-Calculus (20.1%) and Finite Mathematics (19.6%), while 10.5% of the students repeated College Algebra. Most of the remaining students did not take a subsequent math course (34.2%), and less than 2% of the students took a math course outside of the expected sequencing such as remedial MATH 1300 or Calculus. In relation to grades, 82.3% of students who went on to pre-calculus (MATH 1330), received an A or B in MATH 1310. Likewise, 83.5% of students who went on to Calculus for Business and Life Sciences (MATH 1314), 71.7% of students who went on to Finite Mathematics (MATH 1313) and 77.8% of students who went on to Introduction to Probability and Statistics (MATH 2311) made an A or B in College Algebra.

Table 2: Top 5 Subsequent Courses for MATH 1310 Students (2004)

Course ID	Title	N	%
MATH 1330	Pre-Calculus	440	20.1
MATH 1313	Finite Mathematics	431	19.6
MATH 1310	College Algebra	230	10.5
MATH 1314	Calculus for Business and Life Sciences	212	9.7
MATH 2311	Introduction to Probability and Statistics	54	2.5

Grades in Subsequent Courses

The reader may recall that one research area of interest identified by the Chair of the Department of Mathematics was to determine whether or not students exposed to the program components associated with the Algebra Initiative did better in subsequent math courses than students who took College Algebra prior to the Initiative. It was hypothesized that students exposed to the newly established course structure and add-on programs associated with the Algebra Initiative would do better in subsequent courses than their predecessors. To test this hypothesis, the grades in subsequent courses over time were examined. This was accomplished by creating two new dichotomous variables representing success and failure in College Algebra and subsequent math courses. The first variable consisted of a dichotomy of students receiving an A or B in their next mathematics course and students receiving a grade other than an A or B. The second variable consisted of a dichotomy of students receiving an A, B or C in their next mathematics course and students receiving a grade other than an A, B or C. The percent of students receiving an A or B (variable 1) and the percent of students receiving an A, B or C (variable 2) in MATH 1310 as well as in subsequent courses were then calculated and studied over time. **Figure 5** shows a graphical representation of the percent of students receiving an A or B in the mathematics course taken directly after MATH 1310 for each academic year between 1996 and 2004. The proportion of students receiving an A or B in a subsequent mathematics course ranged from 31.3% (1996) to 42.5% (2000) with the past 4 years fluctuating only slightly between 35-40% and no noticeable trend towards increased success in subsequent math courses since the Algebra Initiative was launched.

Figure 5: Percent of Students Receiving an A or B in a Subsequent Course

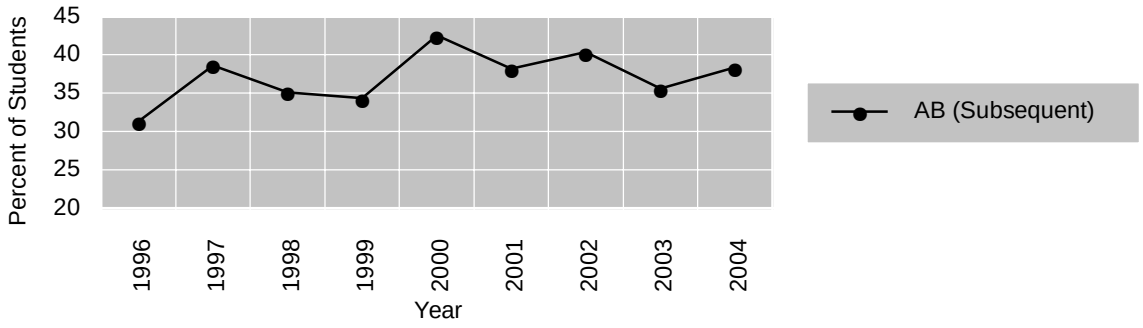
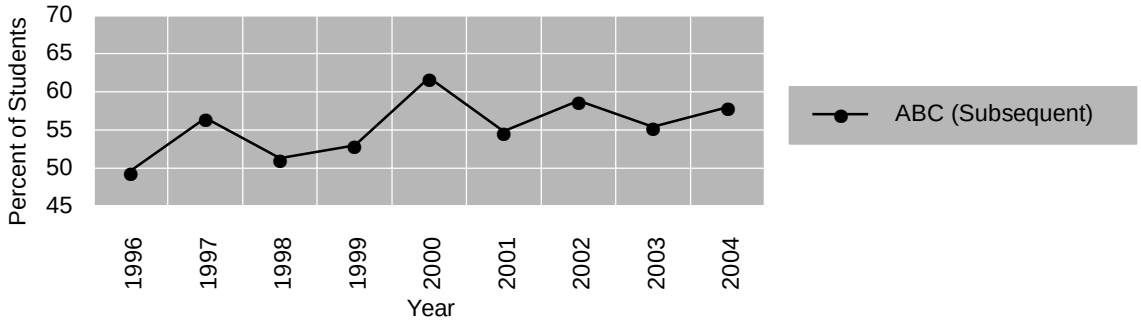


Figure 6 shows a graphical representation of the percent of students receiving an A, B or C in the math course attempted immediately after MATH 1310. While the success rate has varied from 33.4% (1996) to 54.0% (2000), the range has narrowed since 2001 with no noticeable trend towards increased success in subsequent math courses since the Algebra Initiative was launched.

Figure 6: Percent of Students Receiving an A, B or C in a Subsequent Course



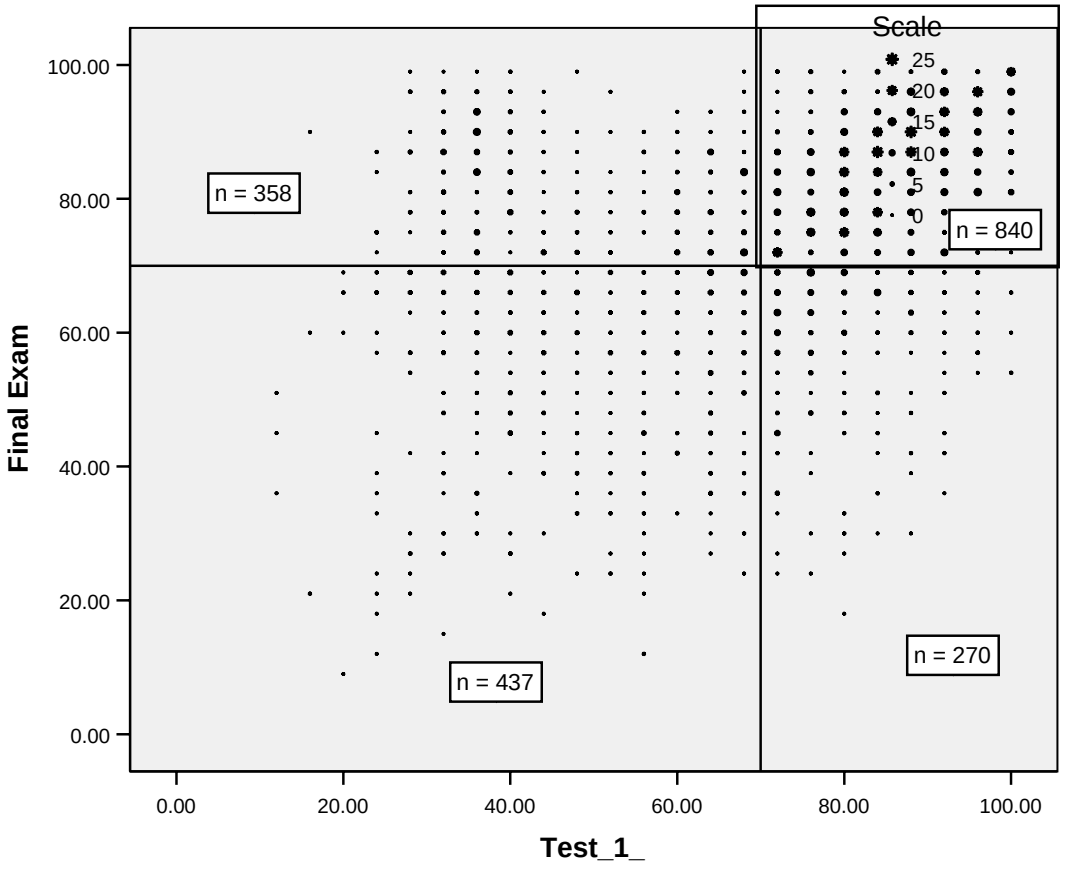
The Use of Test 1 Scores to Predict Success in MATH 1310

The second research question identified in consultation with the Chair of the Department of Mathematics attempted to ascertain whether Test 1 was an effective determinant of student success in College Algebra. For the purposes of this analysis, success in College Algebra was operationalized as the score on the Final Exam, since students must pass the Final Exam to pass the course. **Figure 7** shows a scatter plot of student scores on Test 1 and on the Final Exam for students taking MATH 1310 in the fall of 2005. The X axis represents scores on Test 1, while the Y axis represents scores on the final exam. A line is drawn at a score of 70 to represent the cut point used previously by the math department to drop students not demonstrating the necessary prerequisites to continue in MATH 1310.

The uppermost right quadrant (Quadrant 1) denotes students who passed Test 1 and the final exam (n=840). Using a pass/fail framework, Test 1 would be considered to have accurately predicted the outcome on the Final Exam. The upper left quadrant (Quadrant 2) denotes students who failed Test 1 but passed the final exam (n=358). This is potentially the most problematic quadrant, as it contains students with the potential to pass the class who may have been dropped from the course under the previous drop policy if they did not demonstrate that they had the necessary prerequisites[7]. In short, this quadrant represents the most costly errors in the ability of Test 1 to accurately predict performance on the Final Exam. The bottom left quadrant (Quadrant 3) denotes students doing poorly on Test 1 and the final (n=437). Finally, the bottom right quadrant (Quadrant 4) denotes students who passed Test 1 but failed the final (n=270). Like Quadrant 2, Quadrant 4 also contains predictive failures, as these students passed Test 1 but failed the final.

[7] Some of the students in this quadrant would be allowed to remain enrolled after demonstrating that they had the necessary prerequisites under the administrative drop policy, but the exact number was not able to be quantified by the math department because such data was not collected under the honor system.

Figure 7: Scatter plot of Test 1 and Final Exam Scores
Math 1310: Fall, 2005



As Figure 7 demonstrates, of the 1,905 students taking both Test 1 and the Final Exam in the fall of 2005, the performance of 67% of the students on the final was accurately predicted by performance on Test 1 (students falling in Quadrants 1 and 3). On the other hand, the performance of 33% of the students on the final exam was not predicted by Test 1 performance (students falling in Quadrants 2 and 4). Nevertheless, the Pearson Product Moment Coefficient demonstrates a moderate but significant linear relationship between Test 1 scores and scores on the Final Exam (r = .36, p = <.01, two-tailed). The significant correlation is not surprising since the two tests could be expected to have a certain amount of content overlap or collinearity. What is surprising is that the coefficient only reflects a moderate relationship. The College Algebra Program Evaluation conducted in 2003 (Barlow) reports a higher linear relationship between quiz means and final grades (r = .62, p < .01).

It should be noted that perfect prediction is not possible with placement tests. The goal in this analysis is primarily to quantify the predictive ability and to serve as a

baseline to judge the relative improved or worsened predictive ability of future placement screeners used by the mathematics department.

It should also be noted that students who do not have the necessary course prerequisites to take MATH 1310 should not be in MATH 1310. The prerequisite policy is stated clearly, and those who enroll without heeding the policy do so at the risk of failure. The use of an administrative drop policy is defensible in that respect. The issue at hand is whether Test 1 in its present form serves as an appropriate and accurate screening tool that minimizes the chances that students who can pass the course are discouraged from continuing with the course. It may appear at first blush that the use of Test 1 as a screener is linked to an administrative drop policy, but these issues should be considered separately.

Discussion

College Algebra at UH appears to be awkwardly situated. On the one hand, course content is just a step up from remediation and just a step below achieving respect by faculty as being truly college level. High failure rates and the need to succeed to progress though the mathematics curriculum render this course in one author's terms a 'high risk', 'gateway' course (Uribe, 2005). Furthermore, with as much as 17% of the undergraduate population at UH enrolling in MATH 1310 in any given academic year, the course has the potential to affect student attitude about the university, matriculation through the math curriculum and rates of persistence.

Despite utilizing several approaches to the study of student outcomes subsequent to commencement of the Algebra Initiative, the evaluation was unable to identify any strong objective indicators of success. One area of potential concern is the inability to spot noticeable increases in student performance in subsequent courses as measured by student grades. This does not mean that student learning has not increased under the Algebra Initiative or that success on the individual level did not occur. Findings merely indicate that no positive growth was identified based on the charting of one indicator (grades) which can be an imperfect measure of student success and potentially lack the robustness with which to identify true differences in student learning. It is for this reason that no tests of significance were conducted. Further, it is important to note that the Algebra Initiative is viewed positively by staff members. Several factors that may have suppressed the manifestation of positive student outcomes, some of which are inter-related, are now considered.

First, as the Algebra Initiative time line in Figure 1 demonstrates, it is more difficult to study the impact of the Algebra Initiative when program components are added and removed frequently. Of the seven identified program initiatives, there is no point in time where all run concurrently. In fact, two components have been discontinued, and one component is newly established. Of particular note is the discontinuation of the administrative drops at or around the same time that components like the daily poppers were added. On the one hand, the administrative drops weeded out some students who did not have the prerequisites deemed necessary to succeed in Algebra 1310. This may have improved student outcomes such as success in subsequent courses while it was in effect, as conceivably more qualified students were enrolled in College Algebra. When this was discontinued beginning in the fall of 2005, students without the necessary prerequisites were then allowed to enroll and continue based on the honor system, thereby potentially deflating student success. On the other

hand, the daily poppers, which began in the spring of 2005, became well-entrenched, coordinated and standardized among instructors in the fall of 2005. Much information could be gathered about the success of the daily poppers by measuring student outcomes prior to initiation of the daily poppers and after implementation of the daily poppers in an "O X O" one group pre-test/post-test design. Unfortunately this design is flawed by the historical threat to internal validity created when the practice of administrative drops was discontinued. This is not to say that the decision to start or stop a certain program component was right or wrong, but that the timing was unfortunate for the study of the effectiveness of program components on student outcomes.

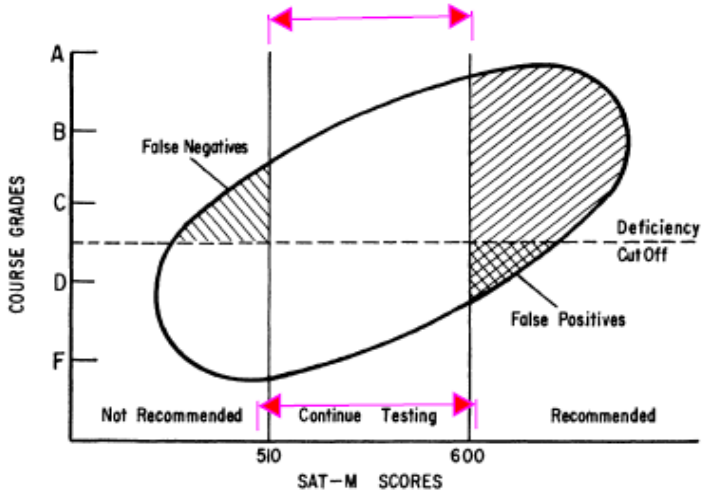
It is important to note that the results of the analysis of Test 1 as a predictor of success in College Algebra are currently being used by the math department as a catalyst for improving the factors used to make decisions about placement in MATH 1310. Shortly after receiving the results, the department began work on revising Test 1 and developing a plan for additional analysis of student level data. This topic was clearly of interest to departmental faculty and staff, and the topic was explored as part of their continuing commitment to program improvement. The results now serve as a baseline from which the department can measure relative improvement in the ability of newly identified indicators to assist in the placement of students in College Algebra. With that in mind, some additional considerations in the use of placement tests are now considered.

One area that was not explored in this analysis is the possibility that the predictive ability of Test 1 differs based on the characteristics of various subpopulations of students. Peterson and Novick (1976) point to many permutations of score distributions and their possible differential effects on the predictive ability of tests. Differing regression slopes or intercepts for differing subpopulations of students could be explored should such additional analysis be warranted.

Secondly, the literature does provide some support for using a two-stage decision-making strategy for the testing and placement of students in transitional courses such as MATH 1310. Fujita and O'Reilly (1970) used a modification of the two-stage sequential selection model first proposed by Cronbach and Glaser (cited in Fujita & O'Reilly, 1970) to demonstrate that screening students based on a two-stage selection process can help selection models gain predictability of course performance and the most efficient administration of placement tests[8]. **Figure 8** presents Fujita and O'Reilly's model conceptualization using a visual extrapolation of the scatter plot presented in Figure 7. As delineated by the middle area inside the arrows in Figure 8, adding a second selection test could theoretically help reduce the number of false positives and negatives generated with just a one stage screening process.

[8] It should be noted that selection based on classical test theory and decision-making strategies that use selection results should be conceptualized as different processes.

Figure 8: Two-Stage Selection Process (Fujita and O'Rilley, 1970)



It could be argued that the math department did develop and institute a two-stage decision-making strategy for placement in College Algebra without the necessary manpower and decision-making authority with which to follow-through appropriately. First, the department's prerequisite policy requiring students to have demonstrated certain mathematical achievement in order to enroll could be considered the first stage. Students who did not demonstrate proof of the necessary prerequisites then became eligible for exclusion for the course based on scores on Test 1 (but only if they failed). Nevertheless, the model was sloppy because stage 1 was based on the honor system and stage 2 worked only for students who failed Test 1. In fact, the 358 students found in Quadrant 2 in Figure 7 (scatter plot of Test 1 and Final Exam) probably is an overestimate because many students in this quadrant may have been weeded out if the first stage was not based on an honor system. With very little modification, the math department could institute a two-stage decision-making strategy and could test the strategy to determine the best set of test score items and the best set of policies that maximize departmental decision-making ability and student success in College Algebra.

Finally, as Sawyer (1996) notes, accurately classifying students is a necessary, but not sufficient, requirement for a placement model to be effective. The model must also effectively allocate students to remedial instruction, and the remedial instruction must assist in achieving in the larger goal that students succeed in college. College Algebra may also benefit from the mindset that programmatic strength comes from (i) accurate classification of students into MATH 1310, (ii) accurate classification of students into the remedial course Math 1300, and (iii) strong remedial instruction that achieves the larger goal that students ultimately succeed in MATH 1310 (Sawyer, 1996).

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