Comparison of the Effectiveness of a Traditional Intermediate Algebra Course With That of a Less Rigorous Intermediate Algebra Course in Preparing Students for Success in a Subsequent Mathematics Course

by

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Abstract

An experimental two-track intermediate algebra course was offered at Saddleback College, Mission Viejo, CA, between the Fall, 2002 and Fall, 2005 semesters. One track was modeled after the existing traditional California community college intermediate algebra course and the other track was a less rigorous intermediate algebra course in which the practice and examination exercises were generally less involved than those found in the traditional course. Students who planned to enroll in College Algebra for Brief Calculus (Math 8) or Trigonometry (Math 124) were encouraged to take the traditional intermediate algebra track. Students who planned to enroll in College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), or Mathematics for Liberal Arts Students (Math 105) were encouraged to take the less rigorous intermediate algebra track. The success of students in their subsequent mathematics class was observed. Students who pursued the less rigorous intermediate algebra track had success rates in College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), and Mathematics for Liberal Arts Students (Math 105) comparable to students who completed the traditional intermediate algebra class at Saddleback College. Students enrolled in the two-track intermediate algebra course who participated in the more rigorous track had success rates in College Algebra for Brief Calculus (Math 8) and Trigonometry (Math 124) that were comparable to students who completed the traditional intermediate algebra class at Saddleback College. It was recommended that a separate intermediate algebra course be established at Saddleback College that was modeled on the less rigorous track of the two-track experimental intermediate algebra class. Students who planned to subsequently enroll in College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), or Mathematics for Liberal Arts Students (Math 105) should be encouraged to take this less rigorous intermediate algebra course.

Introduction

Saddleback College, located in Mission Viejo, California, is one of two community colleges that comprise the South Orange County Community College District. Many students attend Saddleback College in order to prepare for transfer to a 4-year college or university. The Mathematics Department at Saddleback College offers numerous courses that students can apply to their bachelor degree program. Intermediate algebra is the prerequisite for the first level of these transferable courses. This first level of transferable courses includes: College Algebra (Math 7), College Algebra for the Brief Calculus (Math 8), Finite Mathematics (Math 9), Introduction to Statistics (Math

10), and Trigonometry (Math 124). Saddleback College students can also take Mathematics for Liberal Arts Students (Math 105) at Irvine Valley College in Irvine, California.

Although the intermediate algebra prerequisite is enforced for each of the transferable courses listed above, student success in these courses is not uniformly dependent upon completion of the learning objectives for the intermediate algebra course. Both College Algebra for the Brief Calculus (Math 8) and Trigonometry (Math 124) place significant demands on the student's comprehension of intermediate algebra concepts and techniques. Neither of these courses has class time available for the repeated instruction of intermediate algebra topics. Students, who enter these courses with poor intermediate algebra skills, are unlikely to successfully complete either course.

The topics presented in College Algebra (Math 7) are a direct extension of the concepts developed in intermediate algebra. However, a significant amount of review of the intermediate algebra topics is included in the College Algebra (Math 7) course in order to insure that student understanding of these concept extensions rests on a solid mathematical foundation. Finite Mathematics (Math 9), Introduction to Statistics (Math 10), and Mathematics for Liberal Arts Students (Math 105) include only an occasional reference to the topics of intermediate algebra. Consequently, motivated students with only a marginal understanding of intermediate algebra topics can be expected to successfully complete Finite Mathematics (Math 9), Introduction to Statistics (Math 10), and Mathematics for Liberal Arts Students (Math 105).

Nature of the Problem

The traditional intermediate algebra course at Saddleback College is designed to prepare students for future success in College Algebra for the Brief Calculus (Math 8) and Trigonometry (Math 124). Generally, students who enroll in either of these transferable classes plan to also complete a calculus course and they are among the most mathematically motivated students at Saddleback College. However, two-thirds of the intermediate algebra students do not intend to take either College Algebra for the Brief Calculus (Math 8) or Trigonometry (Math 124) and a number of these students have a weak background in beginning algebra and only enough motivation to acquire a minimally acceptable level of understanding of the intermediate algebra course learning objectives. These students often have difficulty participating in class discussions and understanding examples presented in class. Further, these students are often not able to complete the full range of practice exercises included in the assigned homework. They struggle on the examinations and may either withdraw from the class or earn a course grade below a C even though their acquired intermediate algebra skills are probably sufficient to allow them to be successful in College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), or Mathematics for Liberal Arts Students (Math 105).

Grossmont College, a community college in El Cajon, California, has addressed this situation by offering two distinct intermediate algebra courses. One is a 3 semester units course entitled Intermediate Algebra (Math 103) and the other is a 5 semester units course entitled Intermediate Algebra for Business, Math, Science and Engineering Majors

(Math 110). The 3 units course serves as the prerequisite for Elementary Statistics (Math 160), Mathematics for General Education (Math 120), Structure and Concepts of Elementary Mathematics I (Math 125), and Introduction to Computer Programming with FORTRAN (Math 150). The 5 units course serves as the prerequisite for Analytic Trigonometry (Math 170), College Algebra (Math 175), Precalculus: Functions and Graphs (Math 176), and Calculus for Business, Social and Behavioral Sciences (Math 178).

The Saddleback College Mathematics Department discussed the Grossmont College model for intermediate algebra and considered creating a second intermediate algebra course that would specifically serve the needs of students who intended to enroll in College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), or Mathematics for Liberal Arts Students (Math 105). Because Grossmont College did not offer a terminal college algebra course such as Math 7 at Saddleback College or a finite mathematics class such as Math 9 at Saddleback College, it was felt that any curriculum change in this area required more study. In order to investigate the appropriateness of applying the Grossmont College model to the Saddleback College mathematics curriculum, a research project was begun in Fall, 2002.

Purpose

The purpose of this study was to compare the effectiveness of a traditional 5 semester units intermediate algebra course with that of a less rigorous 5 semester units intermediate algebra course in preparing Saddleback College students for success in College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), and Mathematics for Liberal Arts Students (Math 105).

Procedure

A full-time tenured mathematics instructor at Saddleback College designed a two-track version of the existing 5 semester units course entitled Intermediate Algebra (Math 253). All students participated in the same inclass topic development, discussion, and practice. However, the homework exercises and student examinations were separated into two difficulty levels. Students individually decided whether to limit their practice to the more basic exercise level or to complete exercises covering both levels. Students faced a similar decision concerning the course examinations.

The two-track intermediate algebra class was offered each semester from Fall, 2002 through Fall, 2005. A total of 9 semester length classes were offered at various times between either 8 a.m. and 1 p.m. on Tuesday and Thursday or between 10:30 a.m. and 1:30 p.m. on Monday, Wednesday, and Friday. A total of 323 students received a grade (including W (i.e. withdrawal)) from these classes and 109 of these students received a grade of A, B, C, or CR (i.e. credit). The 109 students who successfully completed the two-track intermediate algebra class were eligible to move on to a transferable mathematics class at either Saddleback College or Irvine Valley College. The grade each student earned in their subsequent mathematics course was noted.

Homework Classification: Level 1 and Level 2

All students received the same inclass experience, but the homework exercises where divided into two levels. Level 1 exercises were designed for those who planned to take any of the less rigorous transfer classes: College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), and Mathematics for Liberal Arts Students (Math 105). Level 2 exercises were designed for those who planned to take either of the more rigorous transfer classes: College Algebra for Brief Calculus (Math 8) and Trigonometry (Math 124). Students who planned to take the more rigorous transfer classes were assigned both the Level 1 and Level 2 exercises. Two sets of homework exercises were placed in the Appendix and these examples show the difference in difficulty of the exercises between the two levels.

Examination Classification: Level 1 and Level 2

Five examinations were given during the semester. Each of the first four examinations covered one-quarter of the course content. The last was a comprehensive final examination. The student was not required to take the final examination, but, if taken, the final examination score was used in place of the student's lowest score on the first four examinations. If a student missed one of the first four examinations, the student was required to complete the final examination and the final examination score was used in place of that missing grade.

Two different versions of each examination were created and the students were free to choose either version. One version was only composed of exercises similar to the Level 1 homework exercises. The second version was composed of exercises similar to both Level 1 and Level 2 homework exercises. The first type of examination was referred to as a Level 1 examination and the second was called a Level 2 examination. Students, who intended to take any of the less rigorous transfer classes, College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), or Mathematics for Liberal Arts Students (Math 105), were encouraged to take the Level 1 examination. Students, who planned to take either of the more rigorous transfer classes, College Algebra for Brief Calculus (Math 8) or Trigonometry (Math 124), were encouraged to take the Level 2 examination. The Level 1 examination came in both free form and multiple choice formats. The only format available for the Level 2 examination was free form.

Each examination contained exercises with a total point value of 100, however the maximum score for the Level 1 examination in Fall, 2002 was capped at 75 points (a grade of C) and the maximum score for the Level 1 examination in Spring, 2003 was capped at 85 points (a grade of B). During Fall, 2003 and Spring, 2004 the maximum score on the Level 1 examinations was capped at 85 points (a grade of B) except for the last regular examination and the comprehensive final examination. The maximum score on these last two Level 1 examinations were allowed to be 100 points if the student would not otherwise receive a grade of C in the class. Beginning with the Fall, 2004 semester, the maximum score available on all examinations was 100 points (a grade of A).

Student Classification: Level 1 and Level 2

For the purposes of this study, students were divided into groups based on the level of the examinations they completed. If the majority of the examinations a student completed were of a particular level, the student was assigned to that level. If a student took the same number of examinations from each level, the student was assigned to the level of the last examination taken. For example, if the student took three Level 2 examinations and finished with two Level 1 examinations, that student was assigned to the Level 2 group. However, if the student took two Level 2 examinations and finished with two Level 1 examinations, that student was assigned to the Level 1 group.

Students assigned to the Level 1 group were further categorized by the type of Level 1 examinations they chose. The types available were free form and multiple choice. If a Level 1 student took a majority of the Level 1 examinations of a particular type, the student was assigned to the group for that type. If the student took the same number of Level 1 examinations of each type, the student was assigned to the type of the last examination taken. For example, if the student first took two Level 2 examinations, then a Level 1 free form examination and finished with a Level 1 multiple choice examination, that student was assigned to the Level 1 multiple choice group.

Results

Classification of Students: Level 1 or Level 2

The total number of students who received a grade of A, B, C, CR (credit), NC (no credit), D, F, or W (withdrawal) in the 9 class sections of the two-track intermediate algebra class offered from the Fall, 2002 through the Fall, 2005 semesters was 323 and 96% of these students took at least one examination. Of the 310 students who took at least one exam, 56% were in the Level 1 multiple choice group, 27% were in the Level 2 group, and 17% were in the Level 1 free form group. The distribution of students over the examination levels was placed in Table 1.

Table 1
Distribution of Students Over the Examination Levels

Semester	Level 2 Free Form	Level 1 Multiple Choice	Level 1 Free Form
Fall, 2002 (N=35)	46%	54%	This Option Was Not Available
Spring, 2003 (N=98)	27%	61%	12%
Fall, 2003 (N=42)	43%	40%	17%
Spring, 2004 (N=34)	29%	50%	21%
Fall, 2004 (N=36)	3%	72%	25%
Spring, 2005 (N=26)	35%	54%	12%
Fall, 2005 (N=39)	10%	54%	36%

Distribution of Student Grades in Intermediate Algebra

The total number of students who received a grade of A, B, C, CR (credit), NC (no credit), D, F, or W (withdrawal) in the 9 class sections of the two-track intermediate algebra class was 323. The distribution of grades among these 323 students was placed in Table 2.

Table 2
Distribution of Grades Received by Students in the Two-Track Intermediate Algebra Course

Grade in Intermediate Algebra	Number of Students with this Grade	Percent of Students with this Grade (N = 323)
A	21	7%
B	19	6%
C	52	16%
CR	17	5%
NC	41	13%
D	12	4%
F	90	28%
W	71	22%

Students who received a grade of A, B, C, or CR were considered to have successfully completed the class and the proportion of students in this category was shown in Table 3. The rate of student success in the two-track intermediate algebra course categorized by the level and type of exams chosen by the student was placed in Tables 4 through 7.

Table 3
Student Success Rate in the Two-Track Intermediate Algebra Course

Grade in Intermediate Algebra	Number of Students with this Grade	Percent of Students with this Grade (N = 323)
A, B, C, CR	109	34%
D, F, NC	143	44%
W	71	22%

Table 4
Success Rate for Level 2 Students in
Intermediate Algebra

Grade in Intermediate Algebra	Number of Students with this Grade	Percent of Students with this Grade (N = 84)
A, B, C, CR	26	31%
D, F, NC	29	35%
W	29	35%

Table 5
Success Rate for All Level 1 Students in
Intermediate Algebra

Grade in Intermediate Algebra	Number of Students with this Grade	Percent of Students with this Grade (N = 226)
A, B, C, CR	83	37%
D, F, NC	108	48%
W	35	15%

Table 6
Success Rate for Level 1 Free Form Students in
Intermediate Algebra

Grade in Intermediate Algebra	Number of Students with this Grade	Percent of Students with this Grade (N = 52)
A, B, C, CR	29	56%
D, F, NC	19	37%
W	4	8%

Table 7
Success Rate for Level 1 Multiple Choice Students in
Intermediate Algebra

Grade in Intermediate Algebra	Number of Students with this Grade	Percent of Students with this Grade (N = 174)
A, B, C, CR	54	31%
D, F, NC	89	51%
W	31	18%

Rates of Student Success in the Subsequent Mathematics Class

Eighty-three percent of the 109 students who successfully completed the two-track intermediate algebra course received a grade (including W) in a subsequent mathematics class at either Saddleback College or Irvine Valley College through the Fall, 2006 semester. Thirty-two percent of the 91 intermediate algebra students, who received a grade (including W) in a subsequent mathematics class, selected a subsequent mathematics class that was not recommended for students taking the examination level they had chosen. Nine percent of these 91 students selected an examination level higher than recommended for the subsequent course in which they later enrolled. On the other hand, 23% of these 91 students selected an intermediate algebra examination level that was lower than that recommended for the subsequent mathematics course in which they later enrolled. The distribution of the subsequent courses selected by students categorized by the level of examinations selected by the student was placed in Table 8.

Table 8
Distribution of Subsequent Mathematics Course Enrollment for Students
Who Earned a Grade of A, B, C, or CR in the Two-Track
Intermediate Algebra Course

Title of Subsequent Course	Proportion of Level 1 Students (N=70)	Proportion of Level 2 Students (N=21)
College Algebra (Math 7)	17%	14%
College Algebra for Brief Calculus (Math 8)	17%	10%
Finite Mathematics (Math 9)	3%	0%
Introduction to Statistics (Math 10)	46%	19%
Mathematics for Liberal Arts Students (Math 105)	4%	5%
Trigonometry (Math 124)	13%	52%

The distribution of the subsequent mathematics courses selected by the 91 two-track students who earned a grade (including W) in a subsequent mathematics course was placed in Table 9 along with the proportion of students who successfully completed that subsequent mathematics class.

A total of 83 Level 1 students successfully completed the two-track intermediate algebra course and 70 of these students received a grade (including W) in a subsequent mathematics class by the end of the Fall, 2006 semester at either Saddleback College or Irvine Valley College. The distribution of the subsequent course taken by these students and their success in that subsequent course was placed in Table 10.

Table 9
Distribution of Subsequent Mathematics Course Enrollment and Success
for Students Who Earned a Grade of A, B, C, or CR in the
Two-Track Intermediate Algebra Course

Title of Subsequent Course	Number of Students Who Received a Grade (including W) in the Subsequent Course	Percent That Received an A, B, C, or CR in the Subsequent Course
Mathematics for Liberal Arts Students (Math 105)	4	100%
Finite Mathematics (Math 9)	2	100%
College Algebra (Math 7)	15	93%
Trigonometry (Math 124)	20	65%
College Algebra for Brief Calculus (Math 8)	14	64%
Introduction to Statistics (Math 10)	36	55%

Table 10
Distribution of Subsequent Mathematics Course Enrollment and Success
for Level 1 Students Who Earned a Grade of A, B, C, or CR in the
Two-Track Intermediate Algebra Course

Title of Subsequent Course	Number of Students Who Received a Grade (including W) in the Subsequent Course	Percent That Received an A, B, C, or CR in the Subsequent Course
Mathematics for Liberal Arts Students (Math 105)	3	100%
Finite Mathematics (Math 9)	2	100%
College Algebra (Math 7)	12	92%
College Algebra for Brief Calculus (Math 8)	12	58%
Introduction to Statistics (Math 10)	32	56%
Trigonometry (Math 124)	9	44%

Level 1 students in the two-track intermediate algebra course self-selected the format for their examinations. The examinations were available in both a free form and a multiple choice version. A total of 29 Level 1 free form students successfully completed the two-track intermediate algebra course and 27 of these students received a grade (including W) in a subsequent mathematics class by the end of the Fall, 2006 semester at either Saddleback College or Irvine Valley College. The distribution of the subsequent course taken by these students and their success in that subsequent course was placed in Table 11.

Table 11
Distribution of Subsequent Mathematics Course Enrollment and Success for Level 1 Free Form Students Who Earned a Grade of A, B, C, or CR in the Two-Track Intermediate Algebra Course

Title of Subsequent Course	Number of Students Who Received a Grade (including W) in the Subsequent Course	Percent That Received an A, B, C, or CR in the Subsequent Course
Finite Mathematics (Math 9)	2	100%
College Algebra (Math 7)	5	80%
College Algebra for Brief Calculus (Math 8)	6	67%
Introduction to Statistics (Math 10)	12	50%
Trigonometry (Math 124)	2	50%

A total of 54 Level 1 multiple choice students successfully completed the two-track intermediate algebra course and 43 of these students received a grade (including W) in a subsequent mathematics class by the end of the Fall, 2006 semester at either Saddleback College or Irvine Valley College. The distribution of the subsequent course taken by these students and their success in that subsequent course was placed in Table 12.

Table 12
Distribution of Subsequent Mathematics Course Enrollment and Success for Level 1 Multiple Choice Students Who Earned a Grade of A, B, C, or CR in the Two-Track Intermediate Algebra Course

Title of Subsequent Course	Number of Students Who Received a Grade (including W) in the Subsequent Course	Percent That Received an A, B, C, or CR in the Subsequent Course
Mathematics for Liberal Arts Students (Math 105)	3	100%
College Algebra (Math 7)	7	100%
College Algebra for Brief Calculus (Math 8)	6	50%
Introduction to Statistics (Math 10)	20	60%
Trigonometry (Math 124)	7	43%

A total of 26 Level 2 students successfully completed the two-track intermediate algebra course and 21 of these students received a grade (including W) in a subsequent mathematics class by the end of the Fall, 2006 semester at either Saddleback College or Irvine Valley College. The distribution of the subsequent course taken by these students and their success in that subsequent course was placed in Table 13.

Table 13
Distribution of Subsequent Mathematics Course Enrollment and Success for Level 2 Students Who Earned a Grade of A, B, C, or CR in the Two-Track Intermediate Algebra Course

Title of Subsequent Course	Number of Students Who Received a Grade (including W) in the Subsequent Course	Percent That Received an A, B, C, or CR in the Subsequent Course
Mathematics for Liberal Arts Students (Math 105)	1	100%
College Algebra (Math 7)	3	100%
College Algebra for Brief Calculus (Math 8)	2	100%
Trigonometry (Math 124)	11	82%
Introduction to Statistics (Math 10)	4	50%

Discussion of the Results

Distribution of Student Grades in the Two-Track Intermediate Algebra Course

The overall distribution of grades earned by the 323 students in the two-track intermediate algebra class between the Fall, 2002 and Fall, 2005 semesters was shown above in Table 2 and Table 3. This information was repeated below in Table 14 and Table 15 along with the grade distribution for the 23 traditional intermediate algebra class sections offered at Saddleback College during the Fall, 2002 semester.

Table 14
Distribution of Grades Received by Students in the Two-Track and the Traditional Intermediate Algebra Courses

Grade in Intermediate Algebra	Proportion of Students in the Two-Track Classes (N=323)	Proportion of Students in the Traditional Classes (N=951)
A	7%	10%
B	6%	17%
C	16%	24%
CR	5%	2%
NC	13%	1%
D	4%	8%
F	28%	14%
W	22%	24%

Table 15
Success Rate for Students in the Two-Track and the Traditional Intermediate Algebra Courses

Grade in Intermediate Algebra	Proportion of Students in the Two-Track Classes (N=323)	Proportion of Students in the Traditional Classes (N=951)
A, B, C, CR	34%	53%
D, F, NC	44%	23%
W	22%	24%

All of the two-track class sections were taught by the same full-time tenured mathematics instructor. The proportion of these students who successfully completed the course with a grade of A, B, C, or CR was 34%. This success rate was lower than the 52% success rate for the 951 students who received a grade (including W) in the 23 sections of the traditional intermediate algebra class offered at Saddleback College for the Fall, 2002 semester.

The 34% success rate for students in the two-track intermediate algebra class was also lower than the 41% success rate achieved by students in the 7 traditional intermediate algebra class sections offered between Fall, 1996 and Spring, 2002 by the same instructor who taught all of the two-track class sections. This difference may have been due to the fact that this instructor created a completely different class lecture/discussion format for the two-track intermediate algebra class sections than had been used with this same instructor's traditional intermediate algebra classes prior to the Fall, 2002 semester.

Revised Course Format

The two-track intermediate algebra instructor created a set of overhead projector transparencies that were used with the lecture portion of the class presentation and the students purchased copies of these transparencies at the beginning of the semester as part of a packet of class learning materials. These overhead projector transparencies included the definitions, rules, and figures for the daily lecture with blank spaces where the many class examples were added by the instructor during the class presentation. The students wrote these examples onto their own copies of the transparencies along with other notes and observations that helped them better understand the topic under discussion. Following the presentation of these class examples, each student was handed a set of inclass practice exercises that were similar to those in the class presentation or that allowed the student to extend that topic or explore a related topic. Each student received the same set of inclass practice exercises and these included both Level 1 and Level 2 examples. The students were encouraged to work in groups to complete these exercises, but students were allowed to work alone if they preferred. The class was given sufficient time to complete these exercises and then attention was returned to the instructor, who solicited the correct answer for each exercise from the class. In addition, the instructor led a discussion concerning any of the exercises about which students still had questions. When no more questions remained, the entire process was repeated with the next topic.

In general, a normal class day involved two of these instructor led presentation, student group work, and instructor led review cycles.

When this class format was originally selected for the two-track intermediate algebra course, it was expected that students would create a well organized sets of notes and examples that would help them understand the various concepts and act as a guide when completing the homework exercises. It was thought that students would have less difficulty completing the homework exercises because they could build on their success after having completed similar exercises in class. Further, it was thought that student class attendance would improve because the worked-out examples on the overhead projector transparencies were only available to the students who attended class. Because the hardbound textbook available to the traditional class sections was relegated to a backup role in the two-track intermediate algebra course and because the order in which the course topics were studied and tested followed the sequence of class overhead projector transparencies, the students had been expected to recognize the need to attend class regularly so that they would receive the necessary instruction and practice that was key to their success in the two-track intermediate algebra course.

Frequently the actual student response to the class format described above was not that anticipated. No improvement in class attendance was observed. Students were not dropped by the instructor for lack of attendance and so examination days were much better attended than regular class days. Students, who had missed a class, simply copied the lecture notes and group work examples from another student during class time while they seemed to ignore the new material that was under current discussion. Also it was not uncommon for a student to refuse to work on the inclass practice exercises. They simply sat quietly and did nothing until the answers were noted by the instructor and the questions other students had about these exercises were addressed. A number of students would leave class early once the second set of inclass exercises had been distributed. The course topics tended to build on previous work completed and it was difficult for students to do the inclass practice exercises if they were not somewhat current with the homework. Because of the chosen participatory nature of the course format; it was possible that some students, who were not successful in the two-track intermediate algebra course, may have successfully completed the typically more passive traditional intermediate algebra course.

Level 1 Examination Grading Policy

The distribution of course grades shown in Table 1 and Table 14 was affected somewhat by the fact that grades on Level I examinations were capped during the first four semesters that the two-track intermediate algebra course was offered. In Fall, 2002 the maximum allowed score on the 100 point Level 1 examinations was 75 points and this equated to a letter grade of C. In Spring, 2003 the maximum allowed score on the 100 point Level 1 examinations was 85 points and this equated to a letter grade of B. For the Fall, 2003 and Spring, 2004 semesters, the maximum allowed score on the 100 point Level 1 examinations was 85 points except for the last regular examination and the final examination. The maximum allowed score on these 100 point examinations was 100 points if this change allowed the student to earn enough points for a course grade of C.

The result of these grading policies prior to Fall, 2004 was a decrease in the probability that a student taking the Level 1 examinations would earn an A or a B in the

course. Initially, it was thought that students taking the more difficult Level 2 exams should have their extra effort rewarded with the sole opportunity to earn a course grade of A or B. Further, it was thought that those taking the Level 1 examinations were more concerned about simply moving on to a transferable mathematics class than earning an A or a B in intermediate algebra. Level 1 students were encouraged to enroll in the two-track intermediate algebra course on a Credit basis (rather than for a letter grade) so that their intermediate algebra grade would not affect their college grade point average. However, it was observed that some students selected the Level 2 exams simply because there were more points available on them. Students who had done poorly on a previous Level 2 examination continued to take Level 2 examinations rather than changing to a Level 1 examination that was more reflective of their level of preparation. These students often felt that they needed the higher number of points available on the Level 2 examination to compensate for an earlier poor examination grade, but few were successful on these subsequent examinations. This behavior was also observed for Level 1 students who switched to Level 2 examinations simply because more points were available on those examinations. However, these Level 1 students rarely included actually doing the Level 2 homework exercises in preparing for the Level 2 examinations.

Course Withdrawal Rate

The proportion of students withdrawing from the class after the fourth week and, consequently, receiving a course grade of W was 22% for students in the two-track intermediate algebra class. This withdrawal rate was essentially the same as the 24% observed for the 951 students who received a grade in the 23 sections of the traditional intermediate algebra class offered during the Fall, 2002 semester at Saddleback College. However, this 22% withdrawal rate was significantly lower than the 40% withdrawal rate for the project instructor's 7 traditional intermediate algebra classes offered between Fall, 1996 and Spring, 2002. This much higher withdrawal rate for the instructor's traditional intermediate algebra classes resulted from the fact that the instructor frequently withdrew students who stopped attending class regularly. These students received a course grade of W. However, the instructor changed this withdrawal policy with the creation of the two-track intermediate algebra course and left the decision to withdraw up to the student. This change in withdrawal policy also increased the number of students who received an F and NC in the two-track course compared with the same instructor's traditional intermediate algebra classes. Many students, who would have been withdrawn under the old policy, simply stopped attending class and received a failing grade rather than a W.

Classification of Students: Level 1 and Level 2

The distribution of students into the Level 1 and Level 2 categories (see Table 1) was likely affected by the initial placement of caps on the maximum number of points that could be earned on the Level 1 exams. These grade caps, described above, were in place during the first four semesters of the project and during that time the proportion of students in the Level 2 category was rather cyclic. The fall semesters had the Level 2 category holding 43% to 46% of the students in the class and the spring semesters had the Level 2 category holding 27% to 29% of the students. The Level 2 category may have had a higher proportion of the students in the fall semester because there were more new students to the College enrolled in that semester than in the spring. Many of these new

students had just come from high school and may have held an unrealistic appraisal of their algebra skills as they entered the intermediate algebra class.

The proportion of the Level 2 students in the Fall, 2004 semester was the lowest for any semester. This may have resulted from a major change in grading policy. The previous grade cap on the Level 1 exams was removed beginning with that term. In another change of procedure that was effective only for the Fall, 2004 semester, all students were initially placed in the Level 1 multiple choice category. In each of the other semesters of this project, students were initially placed in the Level 2 category. Students only needed to advise the instructor if they wished to change the Level and Type of their examinations; but, if no request for a change was given to the instructor, the student received the Level 2 examination in every semester except Fall, 2004.

Another possible explanation for the small proportion of Level 2 students in both the Fall, 2004 and Fall, 2005 semesters was the day and times these particular class sections were scheduled. Both of these classes met on Tuesday and Thursday mornings. The only other two-track intermediate algebra class section that was offered on Tuesday and Thursday mornings was in Spring, 2003 when the grade caps on the Level 1 examinations were still in effect. The proportion of Level 1 multiple choice students in the Spring, 2003 Tuesday and Thursday class section was 78% at the same time that the proportion of Level 1 multiple choice students in the two Spring, 2003 Monday, Wednesday, and Friday sections was only 54%. It is possible that the type of students who enrolled in a 5 units mathematics class on Tuesday and Thursday mornings may have had a preference for multiple choice examinations.

Success of Level 1 and Level 2 Students in the Two-Track Intermediate Algebra

Tables 4 through 7 detailed the rate of success of students in the two-track intermediate algebra course categorized by the Level and Type of examinations they completed. From Table 4 and Table 5 it appeared that Level 1 students had a slightly higher success rate (37%) than Level 2 students (31%) and this may have been related to the fact that the Level 2 examinations were more difficult than the Level 1 examinations. Note, however, that the withdrawal rate for Level 2 students (35%) was significantly higher than that for Level 1 students (15%) and recall that, in all but one semester, students were initially placed in Level 2 at the beginning of the term. It may have been that a disproportionate number of students, who were only marginally interested in completing the intermediate algebra course, left themselves at Level 2, took an exam or two without doing much preparation and then withdrew from the course. Such students would have caused the success rate of the group of Level 2 students to be lower than if these students had thought about the level of the examinations that would best serve their needs and then selected that most appropriate level.

From the results displayed in Tables 6 and 7 it appeared that the Level 1 free form students had a higher success rate (56%) than did the Level 1 multiple choice students (31%). The two examinations formats differed only in the way the final answers were displayed and on the fact that no partial credit was available for responses on the multiple choice examinations. Use of partial credit grading allowed for an increase to the points earned on a problem in which the final answer was wrong and for a decrease to the points earned on a problem in which the final answer was correct. A student who was willing to

have their work read in detail by the grader and consequently wrote clearly and neatly while showing the reasoning that lead to the answer was more likely to gain points on the examination as a whole when partial credit was issued than when the grade was based solely on the final answers. Many students, who did not do the homework or otherwise prepare for the examinations, may have been drawn to the multiple choice format because of the ease in giving an answer for each exercise. All they had to do was mark a selection on the Scantron answer sheet. Generally these individuals turned in their examinations after just a small fraction of the time allotted for the examination had passed and their grades on these examinations were rarely satisfactory.

Rates of Student Success in the Subsequent Mathematics Class

Subsequent Mathematics Class Enrollment

Eighty-three percent of the 109 students who successfully completed the two-track intermediate algebra course received a grade (including W) in a subsequent mathematics class at either Saddleback College or Irvine Valley College through the Fall, 2006 semester. This rate of subsequent enrollment was comparable to that observed for the traditional intermediate algebra class. Eighty-six percent of the 502 students who successfully completed the 23 class sections of the traditional intermediate algebra class offered during the Fall, 2002 semester at Saddleback College received a grade (including W) in a subsequent mathematics course at either Saddleback College or Irvine Valley College by the end of the Fall, 2006 semester. It was likely that the rate of subsequent enrollment for the two-track intermediate algebra course would rise above 83% if that rate were recomputed after all two-track students were given the same number of semesters to take a subsequent course as the students in the Fall, 2002 traditional intermediate algebra classes.

The distribution of courses that the 91 two-track students chose for their subsequent mathematics class was displayed in Table 16 along with the distribution of subsequent courses chosen by the 434 students who completed the traditional intermediate algebra course in the Fall, 2002 semester. Although the choices for the subsequent mathematics class made by the students in these two groups appeared comparable, the two-track students were less likely to choose College Algebra (Math 7) and more likely to choose Statistics (Math 10) and Trigonometry (Math 124).

The distribution of the subsequent courses selected by the 91 two-track students categorized by the level of examinations taken by these students was displayed above in Table 8. It was noted in the narrative for Table 8, that 9% of the students selected examination Level 2 and then chose a subsequent course for which the Level 1 examinations were sufficient. These students were apparently motivated to acquire as much knowledge during their time in the intermediate algebra course as possible. Twenty-three percent of the Level 1 students chose a subsequent course for which the Level 1 examinations were not considered adequate preparation. However, these students did participate in the class presentations and inclass exercises that included Level 2 work and they may have been doing the Level 2 homework. These students may have simply selected the Level 1 exams to enable them to receive a higher grade in the intermediate algebra class than might have otherwise resulted.

Table 16
Distribution of Subsequent Mathematics Course Enrollment for Students Who Earned a Grade of A, B, C, or CR in either the Two-Track or the Traditional Intermediate Algebra Course

Title of Subsequent Course	Percent of Students in the Two-Track Course Who Enrolled in a Subsequent Math Course (N=91)	Percent of Students in the Traditional Course Who Enrolled in a Subsequent Math Course (N=434)
Mathematics for Liberal Arts Students (Math 105)	4%	3%
Finite Mathematics (Math 9)	2%	1%
College Algebra (Math 7)	16%	28%
Trigonometry (Math 124)	22%	17%
College Algebra for Brief Calculus (Math 8)	15%	18%
Introduction to Statistics (Math 10)	40%	33%

Over All Success Rates in the Subsequent Mathematics Class

The rates of success in the subsequent mathematics course for both the students who successfully completed the two-track intermediate algebra course (see Table 9) and the students who successfully completed the traditional intermediate algebra course during the Fall, 2002 semester were placed in Table 17. These success rates were very similar.

Sixty-eight percent of the students who successfully completed the two-track intermediate algebra course and then received a grade in a subsequent mathematics course, chose a subsequent course that was recommended for the level of examinations that they had completed in the intermediate algebra course. The success rates for Level 1 students in Mathematics for Liberal Arts Students (Math 105), Finite Mathematics (Math 9), and College Algebra (Math 7) were above 90%. This fact validated the adequacy of the preparation for these courses provided by the less rigorous track of the two-track intermediate algebra course.

The success rates for Level 2 students in College Algebra for Brief Calculus (Math 8) and Trigonometry (Math 124) were above 80% and this fact demonstrated that the presence of the less rigorous track did not distract Level 2 students from preparing for the more difficult transfer mathematics classes.

The 56% success rate in Introduction to Statistics (Math 10) was disappointing but was still comparable to the 54% success rate in Introduction to Statistics (Math 10) for students who took the traditional intermediate algebra class during the Fall, 2002 semester. Consequently, the less rigorous track of the two-track intermediate algebra course provided the same preparation for Introduction of Statistics (Math 10) as did the traditional intermediate algebra class.

Table 17
Distribution of Subsequent Mathematics Course Enrollment and Success for Students Who Earned a Grade of A, B, C, or CR in either the Two-Track or the Traditional Intermediate Algebra Course

Title of Subsequent Course	Percent of Students in the Two-Track Course Who Received an A, B, C, or CR in the Subsequent Course	Percent of Students in the Traditional Course Who Received an A, B, C, or CR in the Subsequent Course
Mathematics for Liberal Arts Students (Math 105)	100% (N=4)	92% (N=13)
Finite Mathematics (Math 9)	100% (N=2)	75% (N=4)
College Algebra (Math 7)	93% (N=15)	85% (N=121)
Trigonometry (Math 124)	65% (N=20)	51% (N=75)
College Algebra for Brief Calculus (Math 8)	64% (N=14)	65% (N=78)
Introduction to Statistics (Math 10)	55% (N=36)	54% (N=145)

Table 18
Distribution of Subsequent Mathematics Course Enrollment and Success for Students Who Selected the Recommended Examination Level for that Subsequent Course

Title of Subsequent Course and Recommended Exam Level	Percent of Students Who Received an A, B, C, or CR in the Subsequent Course and Who Selected the Recommended Exam Level
Mathematics for Liberal Arts Students (Math 105)--Level 1	100% (N=3)
Finite Mathematics (Math 9)--Level 1	100% (N=2)
College Algebra (Math 7)--Level 1	92% (N=12)
Trigonometry (Math 124)--Level 2	82% (N=11)
College Algebra for Brief Calculus (Math 8)--Level 2	100% (N=2)
Introduction to Statistics (Math 10)--Level 1	56% (N=32)

In a somewhat surprising result, the 56% success rate for the Level 1 students who took Introduction to Statistics (Math 10) course was higher than the 50% success rate achieved by the Level 2 students who took Introduction to Statistics (Math 10) (see Table 13). Based on this result, it was doubtful that the level of algebra preparation by a student was a good indicator of future success in Introduction to Statistics (Math 10).

The relatively low rate of success in Introduction to Statistics (Math 10) by students who earned a grade of C or higher in the two-track intermediate algebra course was consistent with an observation Sworder (2006) made concerning the entire group of students who successfully completed a course in intermediate algebra at Saddleback College during the Fall, 2002 semester. He noted that students who earned a grade of C in intermediate algebra where unlikely to be successful in Introduction to Statistics (Math 10). In fact, only 36 of 80 such students (i.e. 45%) successfully completed Introduction to Statistics (Math 10) when it was the subsequent course. This 45% success rate for students who earned a C compared with a success rate of 85% for A students and 58% for B students. These success rates in Introduction to Statistics (Math 10) were comparable to the success rates for students who completed the two-track intermediate algebra class. Six Level 1 students earned an A or B in intermediate algebra and enrolled in Introduction to Statistics (Math 10) as their subsequent mathematics course. Eighty-three percent of these students successfully completed that Introduction to Statistics (Math 10) class, while only 48% of the 27 Level 1 students who earned a C in intermediate algebra successfully completed Introduction to Statistics (Math 10) as their subsequent mathematics class. One Level 2 student earned a B in intermediate algebra, enrolled in Introduction to Statistics (Math 10) as their subsequent mathematics course, and successfully completed that course. Three Level 2 students earned a C in intermediate algebra, enrolled in Introduction to Statistics (Math 10) as their subsequent mathematics course, and only 1 student successfully completed that course. As noted above, competency in the topics of intermediate algebra was not enough to predict student success in Introduction to Statistics (Math 10).

Conclusion and Recommendations

Conclusion

Students who completed an intermediate algebra course that was less rigorous than the traditional Saddleback College intermediate algebra course and then enrolled in College Algebra (Math 7), Finite Mathematics (Math 9), Introduction to Statistics (Math 10), or Mathematics for Liberal Arts Students (Math 105) had comparable success rates to those students who had taken the traditional intermediate algebra course.

Recommendation

It is recommended that a separate intermediate algebra course be established at Saddleback College that corresponds to the Level 1 experience described in this report. Perhaps only one or two sections of this course should be offered initially and a study conducted to determine if the lack of the Level 2 portion of the class presentation and inclass exercises adversely affects the success of Level 1 students in their subsequent mathematics class.

References

Sworder, S. C. Subsequent Success in a Mathematics Course by Students Who Received a Grade in Intermediate Algebra (Math 253) for the Fall, 2002 Semester at Saddleback College. October, 2006. ERIC ED493586

Appendix

Sample Homework Exercises

Level I

Find the solution set for each of the following inequalities. Give the answer using interval notation.

1) $x + 4 \geq 2$

2) $x + 7 > 4x - 8$

3) $6x + 5 \geq x - 10$

4) $x - 3 \leq 1$ and $2x \geq -4$

5) $2x < 6$ or $x - 4 > 1$

6) $7x < 14$ and $1 - x < 4$

7) $3x + 7 < 10$ or $2x - 1 > 5$

8) $9x - 2 < 7$ and $3x - 5 > 10$

9) $3x - 11 < 4$ or $4x + 9 \geq 1$

10) $9 - x \geq 7$ and $9 - 2x < 3$

11) $5x + 12 \geq 2$ or $7x - 1 \leq 13$

Level II

Find the solution set for each of the following inequalities. Give the answer using interval notation.

12) $3x - 4(2x - 7) \geq 3$

13) $-13x - 2(5 - 7x) < -8$ or $3 - 5(4 - 2x) \geq 31 - (3 + 5x)$

14) $2x + 7 < 3 - 2(x + 3) \leq 5x + 18$

15) $6x - 7 \leq 8 + 3(2x - 1) < -3 - 4(3x - 2)$

16) $6 - 2(9 - 3x) \geq 3$ or $2x - 3(6 - x) < 9$

17) $15 + 3(9 + 2x) \leq 7$ and $16 + 3(2 - x) < 5(2 + x) - 9$

18) $8 - 7(5 - x) > 2x + 13$ and $3 + 5(2x - 1) \geq 6 - 3x$

19) $17 - 3(3x - 5) < 7x - 16$ or $3(2 - x) - 7(3x + 6) \leq 15 - 21x$

Appendix

Sample Homework Exercises

For each of the following quadratic functions, use the process of "completing the square" to convert the rule of correspondence to the form $y = a(x - h)^2 + k$. Identify the vertex and axis of symmetry of the corresponding parabola.

Level I:

1) $y = x^2 - 4x + 5$

2) $y = x^2 + 6x + 13$

3) $y = x^2 + 8x + 20$

4) $y = x^2 - 4x + 9$

5) $y = x^2 + 6x - 8$

6) $y = x^2 - 8x - 10$

7) $y = x^2 + 12x + 50$

8) $y = x^2 + 2x + 1$

9) $y = x^2 + 7$

10) $y = x^2 - 10x + 26$

Level II

11) $y = 2x^2 + 16x + 25$

12) $y = 3x^2 - 24x + 50$

13) $y = 2x^2 + 8x + 7$

14) $y = 3x^2 - 12x + 15$

15) $y = -5x^2 + 30x - 50$

16) $y = -2x^2 - 4x + 5$

17) $y = -x^2 - 6x + 1$

18) $y = -x^2 + 2x + 5$

19) $y = x^2 + 3x - 1$

20) $y = x^2 - 5x + 6$

21) $y = x^2 - 9x + 15$

22) $y = x^2 + 7x + \frac{1}{4}$

23) $y = x^2 + \frac{3}{4}x + \frac{1}{64}$

24) $y = 2x^2 + 3x + 1$

25) $y = -3x^2 - 3x + 1$

26) $y = -16x^2 + 24x + 1$