Placement Tools for Developmental Mathematics and Intermediate Algebra

By William J. Donovan and Ethel R. Wheland

ABSTRACT: ***This paper investigates the placement of students at an urban Ohio college campus in developmental mathematics and Intermediate Algebra courses. We have found that the ACT Mathematics and COMPASS Domain I (Algebra) Placement scores both correlate well with success in the Intermediate Algebra course and that, although females have lower placement test scores than males, they have a higher success rate in the course. We determined that the existing cutoff for placement in the Intermediate Algebra course is accurate in predicting students to be more likely to succeed than fail the Intermediate Algebra course at this institution.***

Public focus on mathematical preparation of high school students is not new.

Much attention has been given to the readiness of high school students for college-level mathematics. The U.S. Department of Education's National Center for Education Statistics (NCES) reported that in Fall 2000, 71% of degree-granting institutions enrolling freshmen offered remedial mathematics courses (Parsad, Lewis, & Greene, 2003) and that 22% of entering freshmen at these institutions took a remedial mathematics course. The NCES report defined remedial courses (also commonly referred to as developmental or basic skills courses) as "courses in reading, writing, or mathematics for college-level students lacking those skills necessary to perform college-level work at the level required by the institution" (p. iii). A recent Ohio Board of Regents (OBR) report shows that 33% of Ohio's recent high school graduates enrolling as first-time freshmen at Ohio public colleges or universities in Fall 2003 took a remedial mathematics course (OBR, 2005). Our institution in Ohio sees comparable enrollments in developmental mathematics courses, called "remedial" by some, to sources including NCES and OBR. These high enrollments in developmental courses are of concern for many reasons.

First, public focus on the mathematical preparation of high school students is not new. One only needs to consider the nation's reaction to the launch of the Soviet satellite Sputnik in 1957. Within a year of that event, Congress passed the National Defense Education Act (NDEA) which emphasized the study of mathematics, science, and foreign languages (Fiske, 1982). But by the late 1960s, with the United States winning the "space race," the NDEA "was replaced as the focus of federal educational efforts at the precollege level by the Elementary and Secondary Education Act of 1965, which supported projects such as Head Start for disadvantaged students" (Fiske, 1982). According to Campbell, Hombo, and Mazzeo (2000), the average NAEP mathematics assessment score of 17-year-olds declined between 1973 and 1982.

> Since that time, however, a 10-point gain in average scores is evident, most of which occurred between 1982 and 1992. Because average scores have remained at or about their 1992 level, the average mathematics score of 17-year-olds in 1999 was higher than it was in 1973. (pp. 8-9)

Although this information seems encouraging, comparison to other countries shows room for improvement. The 2003 Program for International Student Assessment (PISA) results showed that "in 2003, U.S. performance in mathematics literacy and problem solving was lower than the average performance for most OECD countries" (Lemke, Sen, Pahlke, Partelow, Miller, Williams, Kastberg, & Jocelyn, 2004). (The OECD is the Organization for Economic Cooperation and Development, an intergovernmental organization of industrialized countries.)

By this standard, even 5 decades after Sputnik, the United States still seems to lag in the mathematical preparation of its students. But it's not as if the problem is being ignored. According to Young (2002) and Boggs and Shore (2004), student demographics and the varying levels of required college preparatory courses in high school, as well as the rigor and content of those courses, are shown to make an impact on student readiness for college. Gamoran, Porter, Smithson, and White (1997) have evaluated the success of "transition" mathematics courses as a remedy to the problem of low-achieving, low-income students being tracked into dead-end mathematics courses in high school. Desimone, Smith, Baker, and Ueno (2005) have examined conceptual teaching of mathematics as a way to better mathematics instruction in the U.S. Also,

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one certainly cannot ignore the intent of the No Child Left Behind Act of 2001 relative to mathematics.

A second reason for concern is the possible connection between the remediation required by students with low mathematics skills and their college attrition rates. Adelman (2006) states that "by the end of the second calendar year of enrollment, the gap in credit generation in college-level mathematics between those who eventually earned bachelor's degrees and those who didn't is 71 to 38 percent" (p. xix). However, Adelman (1996) also points out that this is a complex issue. He cites as a lesson findings from the NCES study *The Condition of Education, 1996* (Smith et al., 1996) that "the extent of a student's need for remediation is inversely related to his or her eventual completion of a degree," acknowledging that the persistence rate among students needing one remedial course is higher than that among those needing to take several remedial courses, particularly remedial reading courses. Ignash (1997) also states that studies have shown differences in success and persistence rates among students needing one remedial course versus those needing three or four. On the other hand, additional research shows that remediation has a positive impact on students' retention rates (e.g., Bettinger & Long, 2007).

A third reason for concern about high enrollment in developmental courses is that college tuition is rising (College Board, 2006), so the costs associated with remediation continue to rise for students who are underprepared for college-level work. Even though many universities in the state of Ohio agreed to a tuition freeze for 2007-08, other costs associated with college are not "frozen." Students are not the only ones bearing the costs of remediation; according to Breneman and Haarlow (1998), "remedial education costs the nation's public colleges and universities about $1 billion annually" (p. 2). However, Saxon and Boylan (2001) point out that there is a "limited amount of research available on this topic" and there are "considerable difficulties involved in collecting this kind of information" (p. 2). As they point out, "whether remediation is expensive or not is certainly debatable and probably depends a great deal more on one's philosophy of education than on the actual cost of remediation" (p. 2).

In addition, students receiving federal financial aid who enroll in a higher-level course or even in a developmental course for which they are unprepared run the risk of incurring additional expenses for themselves and their university if they must withdraw from the course, either officially or unofficially. According to the United States Department of Education (2007),

> Title IV funds are awarded to a student under the assumption that the student will attend school for the entire period for which the assistance is awarded. When a student withdraws, the student may no longer be eligible for the full amount of Title IV funds that the student was originally scheduled to receive. (p. 5.22)

An additional factor related to the cost of remediation is that students from lower-income families are more likely to need remediation (OBR, 2005) but in many cases can least afford the costs associated with it, regardless of paying out of pocket or with financial aid.

For these reasons and others, it is essential to place students into courses in which they have the maximum chance of success. This is particularly true for mathematics courses because the percentage of students needing mathematics remediation is higher than the percentage needing remediation in other subjects, as demonstrated on the state level (OBR, 2005) and nationally (Parsad, Lewis, & Greene, 2003). In addition, it has been shown that, although there have been calls for 4-year postsecondary educational institutions to stop offering developmental courses, many students who start at 2-year institutions to catch up on developmental work do not ultimately receive a baccalaureate degree (Duranczyk & Higbee, 2006). Thus, it is reasonable to continue to offer developmental courses at both 2-and 4-year schools.

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Purpose

The purposes of this study are:

(a) to investigate the relationship between the ACT mathematics score and the COMPASS Placement Test score and success in Intermediate Algebra and to evaluate the tests' effectiveness as predictors of success, including the appropriateness of the current cutoff scores for placement ("Success" is defined as completion of Intermediate Algebra with a final grade of C or higher);
(b) to examine success in Intermediate Algebra according to gender and according to the semester in which the course was taken (fall vs. spring); and
(c) to determine relationships between success in Intermediate Algebra and initial mathematics course placement.

Setting and Demographics

This study was conducted at a public, metropolitan, open-enrollment university in Ohio with an undergraduate population of 23,000 students, a high percentage (46%) of whom are first-generation students (OBR, 2005). Intermediate Algebra is a large-enrollment bridge-up course offered by the university's mathematics department and is designed for students who have not met the prerequisites for their general education mathematics course (e.g., College Algebra, Mathematics for Elementary Teachers). Students are placed into the course based on their ACT mathematics score, COMPASS Placement Test scores, or successful completion with a final grade of C or higher of prerequisite developmental mathematics course(s), Basic Mathematics I (covering arithmetic skills) and Basic Mathematics II (covering elementary algebra), offered through the university's Department of Developmental Programs.

As mentioned previously, two of the ways that students are placed into Intermediate Algebra are by their ACT mathematics score and by their score on the COMPASS Placement Test. The COMPASS Placement Test and the ACT are produced by the same parent company, ACT, Inc., and are designed for different purposes, but both are used by the university as placement tools. According to the ACT Web site (ACT, 2008a), "the ACT test assesses high school students' general educational development and their ability to complete college-level work." According to the COMPASS Web site (ACT, 2008b), "COMPASS placement measures are designed to assist the institution in placing students into appropriate 'standard' level courses or into developmental or preparation courses, as appropriate."

Students whose ACT mathematics score is 20 or lower must take the COMPASS Placement Test during orientation. Students are then placed into a developmental mathematics course, into Intermediate Algebra, or into their general education mathematics course by their COMPASS score.

The 1694 students under consideration in the study were divided nearly equally by gender with 49.1% female and 50.9% male. The variation by semester in gender distribution was not large: the highest percentage of females was 55% in Fall 2004 and the lowest percentage of females was 46% in Spring 2006. Concerning the age at which students made their first attempt at Intermediate Algebra, 3.9% were under 18 years of age, 84.6% were 18 through 21, and 11.5% were 22

Table 1

Placement Test Scores by Course Grade, Fall Semesters 2004–2006

Final Grade	ACT Math Score[a]			COMPASS I Score[b]		
	Mean	*SD*	*N*	Mean	*SD*	*N*
A	19.38	2.33	112	44.89	15.25	150
B	18.93	2.13	184	40.92	12.80	221
C	18.20	2.02	189	37.48	11.14	221
D	17.98	1.87	97	35.83	13.41	108
F	17.80	2.28	207	33.30	10.86	243

Note: The *N* values for the two placement tests are different because some students had a score for only one of the tests. [a] $df=4$; $F=13.98$; $p<.0001$. [b] $df=4$; $F=23.98$; $p<.0001$.

Table 2

Placement Test Scores by Course Grade, Spring Semesters 2005–2007

Final Grade	ACT Math Score[a]			COMPASS I Score[b]		
	Mean	*SD*	*N*	Mean	*SD*	*N*
A	18.53	1.94	53	39.67	16.57	79
B	17.68	1.85	104	30.53	10.41	120
C	17.49	1.90	122	28.38	9.29	144
D	17.16	1.81	79	27.94	9.47	95
F	17.34	2.22	177	29.37	11.29	216

Note: The *N* values for the two placement tests are different because some students had a score for only one of the tests. [a] $df=4$; $F=4.52$; $p<.0013$. [b] $df=4$; $F=39.17$; $p<.0001$.

or older, with little variation from these percentages by semester.

Method

In this study, we examined the records of students who took Intermediate Algebra for the first time in one of the 6 semesters Fall 2004 through Spring 2007 ($N = 1694$), which did not include records of students who received a final grade of WD (an indication that the student withdrew from the course at any time from the beginning of the 2nd week through the end of the 12th week of the 15-week semester). A grade of WD provides too little information about the student's attempt at the course, and thus has the potential to skew the findings.

Analyses: Placement Test Scores and Course Performance

To investigate the relationship between the ACT mathematics score and success in Intermediate Algebra and the relationship between the COMPASS Placement Test score and success in Intermediate Algebra, we looked at placement test scores and course grades. Tables 1 and 2 report the placement test scores versus final grades in the course in the fall and spring semesters respectively. An ANOVA was performed on the test scores by letter grade for the fall and spring semesters separately. Both the fall and spring semester data showed significance. In order to determine which specific means in each group differed significantly a Tukey HSD test was performed.

A logistic regression analysis on the students' scores, using success or failure in Intermediate Algebra as the dichotomous outcome, evaluates the effectiveness of these two tests as predictors of success in Intermediate Algebra. The logistic regression analysis of the ACT mathematics scores versus success gives an odds ratio at the 95% confidence level of 1.29, meaning that the odds of succeeding in Intermediate Algebra increase by 29% for each added ACT score point. The resulting function predicts a 50% probability of success in the course at an ACT mathematics score of 17. Logistic regression analysis of COMPASS scores gives an odds ratio at the 95% confidence level of 1.03, meaning that the odds of succeeding in Intermediate Algebra increase by 3% for each added COMPASS score point. The resulting function predicts a 50% probability of success in the course at a COMPASS I score of 31. That is, the analysis shows that with a COMPASS score of 30, the odds of success are nearly even and with a score of 31, the odds are even.

Findings

The mean ACT scores of students earning grades of A or B were significantly different ($p<.05$) from those of students earning grades of C, D, or F, whereas the scores of the students earning a grade of C in the fall semesters were not significantly different from those of students earning grades of D or F. However, in the spring semesters, only the ACT scores of students earning a grade of A were significantly different ($p<.05$) from those of students earning lower grades. The mean ACT scores of students earning any other grade were not significantly different from each other.

The mean COMPASS scores of the students earning a grade of C in the fall semesters were significantly different than those of students earning a grade of F ($p<.05$), but were not significantly different from those of students earning a grade of D. The scores of students earning grades of A or B were significantly different ($p<.01$) from those of students earning grades of D or F. However, in the spring semesters, just as for ACT scores, only the COMPASS scores of students earning a grade of A were significantly different ($p<.01$) from those of students earning lower grades. The mean COMPASS scores of students earning any other grade were not significantly different from each other.

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Table 3

Average ACT Math and COMPASS I Scores of Intermediate Algebra Students

Semester	Gender	Enrollment	ACT Math Score			COMPASS I Score		
			Mean	*SD*	*N*	Mean	*SD*	*N*
Fall 2004-2006	Female	495	18.10[a, e]	2.13	408	36.22[b, g]	12.47	468
	Male	502	18.73[a, f]	2.25	381	40.15[b, h]	13.35	475
	Total	997			789			943
Spring 2005-2007	Female	336	17.27[c, e]	1.92	272	29.19[d, g]	10.50	314
	Male	361	17.81[c, f]	2.09	263	31.52[d, h]	12.77	340
	Total	697			535			654

Note: Percentages with a common letter in the superscript were compared and found to be significantly different ($p<.001$). The *N* values for the two placement tests are different because some students had a score for only one of the tests.

Table 4

Success Rates by Gender and Semester

Gender	Success Rates		
	Fall Only	Spring Only	Fall + Spring
Female	65.7%[a]	55.1%[a]	61.4%[b]
Male	60.4%[c]	49.9%[c]	56.0%[b]
All students	63.0%[d]	52.4%[d]	

Note: Percentages with the same superscript are significantly different (p<.05).

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Gender, Semester, and Student Success

Table 3 (p. 4) shows the average ACT mathematics and COMPASS I scores of the students by gender for each of the 6 semesters. It can be seen that the scores for students in the fall populations are similar to each other, as are those of the spring populations, with the students in the fall semesters better mathematically prepared than those in the spring semesters as measured by ACT mathematics and COMPASS I scores (p<.001). Additionally, for both placement tests, the aggregate mean scores for females are lower than the corresponding mean scores for males (p<.001).

When final course grades are compared, however, the proportion of females succeeding in the course is statistically significantly larger than that of males, as can be seen in Table 4. This is found to be the case regardless of whether the comparison is performed on those students with ACT scores, on those with COMPASS scores, or on all students.

Historically, including the 1st semester of this study (Fall 2004), the students who took Intermediate Algebra in the fall semesters had a much higher success rate than those who took the course in the spring semesters. However, as can be seen in Table 5, this gap appears to be closing; that is, the success rates of the directly-placed Spring 2007 students are comparable to those of Fall 2005 and 2006 students. This increase in success rate is not a result of an increase in the percentage of students directly placed; Table 6 shows that the percentages of students directly placed into Intermediate Algebra are consistently larger for the fall semesters than for the spring semesters.

When analysis of success rates is done taking gender into consideration, females are seen to succeed at higher rates in the fall than in the spring, as shown in Table 4. The same results hold true for male students.

Initial Mathematics Course Placement and Student Success

Table 6 shows the percentages of students who placed directly into Intermediate Algebra as their first mathematics course based on COMPASS Placement Test score. In the fall semesters, a minimum of 65% of the students in Intermediate Algebra were able to place directly into the course based on their COMPASS score. However, in the spring semesters, most of the Intermediate Algebra students had COMPASS scores that required them to successfully complete a prerequisite developmental mathematics course in order to be able to enter Intermediate Algebra. Neither their COMPASS nor ACT mathematics score was in the correct range for them to place directly into Intermediate Algebra. Overall, 74% of the fall-semester students directly placed into the course, compared to 37% of the spring-semester students. This difference in proportions is significant at the 95% level.

As can be seen in Table 5, in the 6 semesters under study, the students who started in developmental mathematics succeeded in Intermediate Algebra at about a 50% rate. There have been many efforts and resources across both mathematics departments directed at increasing student success which appear to have made an impact on the increasing success rate of the students directly placed in Intermediate Algebra in the spring. An increased collaboration between the Departments of Mathematics and Developmental Programs is intended to positively impact the success rate in Intermediate Algebra of students who first take a developmental mathematics course.

We also considered the performance, as measured by final course grade, of the aggregate population in Intermediate Algebra with respect to initial mathematics course placement. Figure 1 (p. 8) shows the percentages of each of three groups of students earning each letter grade in Intermediate Algebra. Two of the groups

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Table 5

Success Rates in Intermediate Algebra Compared to Initial Mathematics Course Placement

Semester	Overall		Placed Directly into Intermediate Algebra		First Placed into Developmental Math	
	N	Success Rate	*N*	Success Rate	*N*	Success Rate
Fall 2004	292	72.6%	209	80.4%[a]	83	53.0%[a]
Fall 2005	301	59.8%	216	65.3%[b]	85	45.9%[b]
Fall 2006	404	58.4%	316	62.0%[c]	88	45.5%[c]
Spring 2005	232	49.1%	82	48.8%	150	49.3%
Spring 2006	196	52.0%	86	50.0%	110	53.6%
Spring 2007	269	55.4%	94	62.8%	175	51.4%

Note: Percentages with the same superscript are significantly different (p<.05).

Table 6

Total Enrollment Compared to Direct Placement by COMPASS I Score

Semester	Gender	Enrollment	Students placed into Intermediate Algebra by COMPASS I Score	
Fall 2004	Female	157	110	70%
	Male	135	99	73%
Fall 2005	Female	152	99	65%
	Male	149	117	79%
Fall 2006	Female	186	132	71%
	Male	218	184	84%
Fall Total		997	741	74%*
Spring 2005	Female	116	36	31%
	Male	116	46	40%
Spring 2006	Female	95	37	39%
	Male	101	49	49%
Spring 2007	Female	125	31	31%
	Male	144	38	38%
Spring Total		697	262	37%*

Note: *The difference between these percentages is 37 percentage points. The lower and upper limits of the 95% confidence interval for this difference are 32% and 41% respectively.

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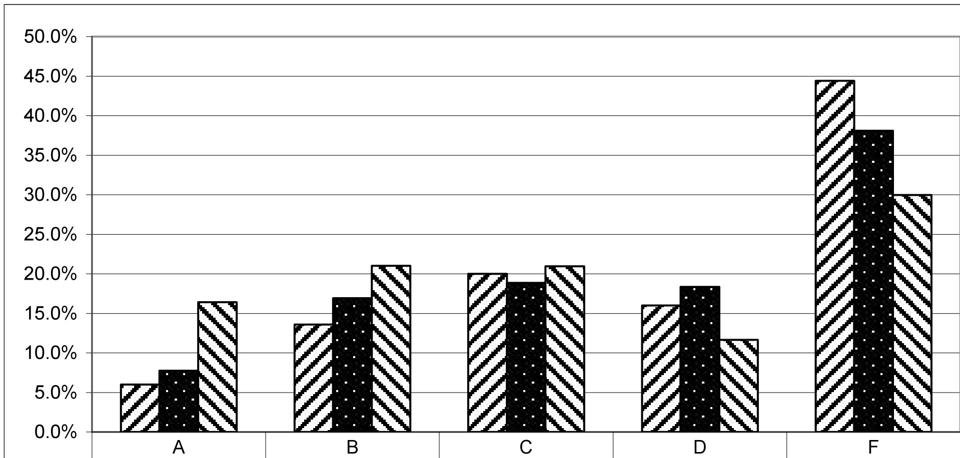
are composed of students whose COMPASS Placement Test scores placed them in one of two developmental mathematics courses, Basic Mathematics I or Basic Mathematics II, or who took no placement test and were thus enrolled in Basic Mathematics I by default. The third group consists of students whose COMPASS I score placed them directly into Intermediate Algebra. Students who initially placed in Basic Mathematics I were less likely to succeed than those placed initially in Basic Mathematics II, with those placed directly into Intermediate Algebra outperforming both groups (see Figure 1). Although seemingly obvious, this has implications, addressed following, for the university.

Final course grades for Intermediate Algebra, Fall 2004 through Spring 2007 were heavily weighted toward grades of D and F (see Figure 1). Students who earned a final grade of D or F on their initial attempt at Intermediate Algebra and successfully completed the course in a subsequent attempt were not included in our data because the study only focused on success related to initial placement of the students in their mathematics course.



	A	B	C	D	F
BM1	6.0%	13.6%	20.0%	16.0%	44.4%
BM2	7.8%	16.9%	18.9%	18.3%	38.1%
IA	16.4%	21.0%	20.9%	11.6%	30.0%

Figure 1. **Intermediate Algebra (IA) grade by starting math course (BM1 = Basic Mathematics I; BM2 = Basic Mathematics II), Fall 2004 through Spring 2007.**

Discussion

We observed fairly strong relationships between COMPASS I scores and success in Intermediate Algebra and between ACT mathematics scores and success in Intermediate Algebra. Similar strong predictive values have been shown for another developmental mathematics placement tool, ACCUPLACER (James, 2006).

When the COMPASS Placement Test was adopted as the university's placement tool, the minimum cutoff score of 30 was set to predict a 50% chance of success in Intermediate Algebra. Obviously, the university could have chosen a cutoff score that might predict a higher success rate, but that would require more students to take a developmental mathematics course and possibly to spend more on tuition. The two types of placement errors, Type I (allowing an unprepared student to take the course) and Type II (keeping a prepared student out of the course) were weighed in the placement cutoff decision.

Our findings show that no matter how analyzed, female placement test scores are statistically significantly lower than male placement test scores. Yet, when final course grades are compared, the proportion of females succeeding in the course is significantly larger than that of males, regardless of whether the comparison was performed just on students with placement scores or on all students. Similar findings of females having lower mathematics placement test scores but higher grades than males have been observed before (Bridgeman & Wendler, 1991; Kimball, 1989). There are many reasons for this discrepancy, but it does suggest that the ACT and COMPASS are better predictors of success for males than for females.

It does suggest that the ACT and COMPASS are better predictors of success for males than for females.

As expected, our findings show that the ACT and COMPASS score averages are higher for fall-semester students than for spring-semester students. Fall-semester students also had significantly higher success rates than did spring-semester students. This held true when the analysis was done by gender as well. However, as observed in the most recent spring semester in this study, the success rate of the spring-semester students directly placed into Intermediate Algebra has approached that of the fall-semester students, whereas the success rate of students who come to the course via a developmental mathematics course has not increased.

Our data have shown that students starting their university mathematics course work in developmental courses struggle in Intermediate Algebra more than those students who place directly into Intermediate Algebra. At first glance, this seems obvious. However, the purpose of the developmental courses is to bring students up to a mathematics competency level which is comparable to that indicated by the placement test score range that would place a student directly into Intermediate Algebra. This goal is being met for some students (approximately 50%) but not for all. This indicates that the process of preparing students to move from developmental mathematics courses to Intermediate Algebra needs to be more finely tuned if the success rate is to increase. Aware of this need, the Department of Mathematics and the Department of Developmental Programs are collaborating to reevaluate curriculum, examine the study and attendance patterns of students, and institute more rigorous prerequisite checks.

Limitations

A possible limitation to our study is that we were not able to obtain data on the students' high school curriculum, nor were we able to obtain data on their ethnic makeup; both factors have been shown to impact college performance and graduation rates (Adelman, 2006).

Another limitation we faced when comparing students' starting mathematics courses to their success in Intermediate Algebra is that we were unable to obtain students' final letter grades for Basic Mathematics I and II. Thus we could not study whether success in Intermediate Algebra was related to the letter grade in the developmental mathematics courses. In other instances in our study, we found statistically significant differences corresponding to grades (e.g., placement test scores and course grades, as reported previously). It is possible that grades in

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the developmental mathematics courses might also show such relationships.

At first glance, including students in the study who did not have COMPASS or ACT scores might seem like a limitation. However, when we looked at the subpopulations of students with the scores and compared findings with the findings for the entire population when possible, there was no significant difference. For instance, we found that the proportion of females succeeding in Intermediate Algebra was statistically significantly larger than that of males whether the comparison was performed on those students with ACT scores, on those with COMPASS scores, or on all students in the course.

Implications for Practice and Future Research

The findings of this study suggest several implications for practice. First of all, it is important to set placement test cutoff scores that are consistent with the mission of the institution. Although Type I and Type II placement errors, also known as false positives and false negatives respectively, can never be completely eliminated when dealing with student placement, decision makers who are aware of these error types and who appropriately select cutoff scores can minimize the number of students affected by these errors in placement.

An implication of the differences between the fall- and spring-semester students is that the mathematical needs of the spring-semester students, particularly for males, are greater than those of the fall-semester students and must be more deliberately addressed. At our university, this process is underway through ongoing collaboration between the mathematics department and developmental programs department, and involvement in courses by specially trained peer tutors who are partnered with instructors, attend all class meetings, and hold study sessions with individuals and groups of students. The mathematics department is assessing the results of a study in which students in Intermediate Algebra were required to use the Math Lab each week in order to inform future course policies. The Math Lab is under the purview of the Office of Student Academic Success and is a free service for students in introductory-level classes.

Concerning success in Intermediate Algebra and initial mathematics course placement, our findings suggest that course letter grades might not give enough information to allow students in introductory-level classes to move to subsequent courses with confidence of success. Students are placed in their initial university mathematics course either by a placement test or by default, and subsequent progress is based solely on the attainment of a letter grade of C or higher in that course, assigned by the instructor. No nationally-normed tool is used to measure mathematics competency after the initial placement. It might be valuable to consider using such a tool at the end of the semester along with aligning exit standards with skills needed to succeed in Intermediate Algebra.

An internal unpublished study (Butler, Konet, & Wheland, 2003) at our institution investigated the connection between preparedness for Intermediate Algebra as measured by COMPASS scores and success in the course. Preparedness was not measured by final letter grade in the previous developmental mathematics course. The COMPASS mathematics placement test was administered in Fall 2003 to 636 Intermediate Algebra students during the 3rd week of the course. These COMPASS scores were used to classify the students, all of whom met a prerequisite for the course, as either "prepared" or "underprepared" for the course. Among the 456 students who completed the course, 77% of those classified as "prepared" succeeded in the course, whereas only 46% of those classified as "underprepared" succeeded in the course. If these findings are replicated in future studies of students in developmental and intermediate algebra courses, this might suggest that students would benefit from being required to take an additional placement test early in the semester and being required to attend tutoring labs or other forms of learning support if they are deemed underprepared.

> *The mathematical needs of the spring-semester students, particularly for males, are greater than those of the fall-semester students.*

The increased collaboration between the Departments of Mathematics and Developmental Programs has already resulted in changes to Basic Mathematics I and II and Intermediate Algebra. The impact of these changes on success in Intermediate Algebra among students who first take a developmental mathematics course will be considered in a future study.

Conclusion

As seen in the Ohio Board of Regents report, remediation in mathematics is a continuing need. This need does not stand alone; it is accompanied by a need for accurate placement in mathematics courses and placing students in a course at too low of a level might lead to successful completion of the course, but both waste resources for the student and the state. Placing students in a course for which they are not prepared at too high of a level can negatively impact their success, also at the expense of wasted resources. The decision about what is an optimal setting of cutoff scores is an important concern at many universities. Our research shows that at our university, many of our goals were met through the determination of placement cutoff scores most appropriate to our math curriculum.

Our results also provide insight into the value of taking a comprehensive view of the entire mathematics sequence from the developmental level to the conclusion of the general education level, including issues around accurate placement, seamless transitions from one course to the next, sufficient preparation for each course in the sequence, alignment of curriculum, gender differences, and support structure for students. The findings can help similar institutions assist student success in college mathematics.

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