When Remediation Isn't Enough: Cross-Divisional Collaboration to Eliminate Institutional Barriers to Student Success at an HSI

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Abstract—More than half of the freshmen at California State University, San Bernardino are required to complete developmental coursework in mathematics. Evidence suggests that students at CSUSB who need developmental coursework have lower retention and graduation rates. As a result, CSUSB instituted a five-week summer Intensive Mathematics Program (IMP) to prepare students for general education mathematics prior to their first term. An examination of the data suggested that IMP was highly effective: over 90% of students who completed the program were ready for general education mathematics by the fall term. Based on this evidence, the campus expanded the program to further increase student success. Through a collaborative partnership between the Office of Undergraduate Studies the Office of Institutional Research, this study sought to replicate previous findings demonstrating the effectiveness of IMP, examine the longitudinal effects of the program, and determine whether or not an absence of changes in key institutional practices serve as barriers to student success.

Introduction

Today, some 75% of postsecondary institutions offer developmental courses in English and mathematics (Howell, 2011). The debate on developmental education continues to draw the attention of policymakers, educators and researchers. Though not all agree on their necessity or long-term effectiveness, "there is ample evidence to support that academic interventions can be effective in helping students overcome deficiencies in their pre-college academic preparation" (Gallard, Albritton & Morgan, 2010, p. 10). Rather than deny access to students who are deemed academically underprepared based on various criteria established by institutions and systems (ranging from standardized tests to institution-level assessments of basic skills), many colleges and universities offer developmental education courses which present these students with an opportunity to develop the requisite skills to prepare for general education (GE) coursework. When implemented using evidence-based practices, developmental education can be effective and beneficial for students.

Developmental education, as Casazza (1999) describes, is a fostering of "intellectual, social, and emotional growth and development of all learners" (as cited in Kinney, 2001, p. 10), and developmental education programs "are most effective when they include a wide variety of courses and academic support services such as tutoring, advising, laboratories, and learning assistance centers" (Boylan, Bonham & White, 1999, p. 90). Developmental education has evolved to provide not only academic remediation, but also skills training to supplement students' success in college beyond the current course.

Successful institutions use evidence-based practices to construct and tailor their program to fit their students' needs, incorporating a variety of teaching methods and study strategies to contribute to students' learning. Teachers who have a supportive attitude help reduce math anxiety and build confidence (Shields, 2007), and those who use theory-based instruction can be more effective for developmental students than those who teach in the same ways they were taught (Boylan et al., 1999). Tutoring allows students to receive one-on-one attention from peers or professional staff, providing both academic and social support. Multiple teaching styles allow instructors to reach different kinds of learners and reinforce challenging concepts. Though students may not demonstrate proficiency in reading, writing, and/or mathematics at admission, developmental education courses allow students to build skills, reach GE courses and ultimately graduate. Soliday (2002) suggests that developmental education courses provide students with resources and skills to integrate them into the campus environment (as cited in Bettinger & Long, 2009). Depending on the way courses are structured, students enrolled in developmental education courses may have access to other resources, such as study skills and social support, they may have not have been exposed to otherwise.

Upon completing developmental education, students are often faced with challenges in their college-level courses, many of which can be attributed to institutional barriers. Within this context, we have defined institutional barriers as practices or policies that inhibit student success after developmental education. Although developmental education has been deemed an effective strategy for students who are underprepared, we cannot treat it as a panacea. Institutions of higher education cannot assume that developmental education students will proceed through the remainder of their academic careers with little or no additional support. Though there is limited research regarding institutional efforts to provide on-going supports for students once they complete developmental education, we believe this gap in the research is a rich opportunity to consider how institutions of higher education can reform their developmental education programs to ensure student success beyond remediation.

To supplement a successful transition to college for students who are underprepared, continual student supports are needed, as remediation alone "is not effective in helping improve student outcomes" (Panillo, 2012, p. iii). In light of the national trend towards increasing graduation rates and decreasing time-to-degree in addition to "the dilemma of placing incoming students into the appropriate first mathematics course" (Latterell & Frauenholtz, 2007, p. 8), institutions must also grapple with the challenging task of identifying which on-going interventions are required to support students once they complete developmental education. First-year programs after remediation, including first-year seminars, learning communities, and the "integration of academic advising with first-year programs" have been identified as high-impact retention practices in public four-year institutions (Habley & McClanahan, 2004, p. 6). Learning supports such as Supplemental Instruction (SI) and tutoring programs are also among these high-impact retention practices (Engle & Tinto, 2008, p. 25; Habley & McClanahan, 2004). Many of these programs seek to contextualize and/or connect students' learning both in and outside the classroom, a key factor as students who "receive academic and social support within and outside the classrooms are more likely to persist in college" (Panillo, 2012, p. 199).

California State University, San Bernardino (CSUSB), a Hispanic Serving Institution (HSI), has a student population with 80% first-generation college students; additionally, over 70% of students who attend CSUSB are Pell-eligible. On an annual basis, 69% of first-time, full-time freshmen at CSUSB are required to participate in developmental coursework in English, mathematics or both of these critical subject areas; 55% need one or more terms of developmental work in math before they are fully prepared for baccalaureate-level work. The level of remediation for each student is determined by the student's score on the Entry Level Mathematics (ELM) test, the California State University system's placement test in mathematics. The result of the pre-matriculation assessment determines whether a student goes into a developmental course sequence that lasts either four quarters (Math 75A), three quarters (Math 75B), two quarters (Math 80), or one quarter (Math 90) before the general education mathematics coursework.

CSUSB's response to the extreme lack of preparedness in math among its first year students is the Intensive Mathematics Program (IMP). Developed by the Dean of the Office of Undergraduate Studies and the CSUSB mathematics faculty in 2002, IMP offers incoming first-time freshmen "an opportunity to

strengthen their skills in mathematics in a supportive learning environment, which allows them to begin their first quarter fully prepared for the required college-level mathematics course" (IMP mission statement). During this five-week program, students receive three hours of classroom instruction in the morning and three hours of tutoring in the afternoon four days per week. IMP presents an opportunity for students who would normally complete Math 80 or 90 over the course of one or two quarters to complete all of their developmental coursework before their first term during the academic year, an intentional design as course acceleration has demonstrated promise in several studies (Brancard, Baker & Jensen, 2006; Edgecomb, Jaggers, Baker & Bailey, 2013; Jaggers, Hodara, Cho & Xu, 2015; Rutschow & Schneider, 2011; Zachry & Schneider, 2008) and is touted as a promising reform in DE (Brock, 2010).

In addition to its intensive, accelerated pace, other aspects of IMP are fully grounded in evidence-based practices. Successful developmental mathematics programs, specifically, use various teaching and learning strategies; these teaching and learning strategies may include demonstrating multiple ways to solve a problem, encouraging participation and active learning apart from traditional lecturing, and engaging peer mentors or tutors (Bonham & Boylan, 2011). Meyers and Jones (1993) state that active learning "involves opportunities for students to meaningfully talk, listen, write, read, and reflect on the content, ideas, issues and concerns of an academic subject" (as cited by Kinney, 2001). During the program, participants attend morning instruction sessions which take place in large lecture halls with 100-125 students and at least five peer tutors per section. While the instructors present the concepts and assist students with tackling the problems of the day, peer tutors interact with students and provide support with solving problems in the classroom. The use of peer tutors creates a comfortable environment that encourages students to work collaboratively to interact and actively engage with the content and promotes mastery of the concepts taught in class. After an hour lunch break, students go into three-hour peer-led group tutoring sessions (ratios 1:15) in a smaller classroom setting. Successful completion of this five-week summer program gives students credit by examination and allows them to enroll in a GE mathematics course. Since its inception, over 1,600 students have chosen to participate in IMP.

Past analyses have shown significantly different results (average grades in GE math, % of students receiving No Credit (NC) in GE math, retention rates) for IMP students as compared to non-IMP students who initially require the same level of remediation but who complete their requirement in the traditional way (beginning in the fall). Each year, the institution has increased the number of students who were "ready" for general education mathematics in their first term of the academic year, but the number of sections of mathematics offered and the level of available academic support for those courses have not grown. This study seeks to replicate previous findings demonstrating the effectiveness of IMP and examine whether or not an absence of changes in key institutional practices serve as barriers to student success.

Results

Evidence of Program Effectiveness

Four success indicators were examined for evidence of program effectiveness: the percentage of IMP students who successfully completed the summer program and were ready for GE math; the proportion of first-time freshmen requiring developmental math; the pass rate in GE math across student groups; and the GPA in GE math across student groups.

Archival data from CSUSB were extracted for 11,434 students who enrolled as first-time freshmen (FTF) in the fall quarters of 2010 through 2014. Students were identified as GE math ready at entry, students made GE math ready through the Intensive Mathematics Program (IMP), and students made GE math ready through traditional developmental education pathways. For IMP and traditional DE students, only those placing into a one- or two-quarter remediation course sequence were included.

For the first success indicator, data were analyzed for IMP participants in summer 2014 (n = 480). To address the second indicator, GE readiness was examined by year for all FTF (n = 11,434) based on their status at admission and then at fall census after participation in summer math.

On the last two indicators, IMP students from 2010 to 2014 (n = 1,331) were compared against GE-ready students (n = 2,924) and DE students (n = 2,499). Z-tests of proportions were conducted to compare the pass rate across groups, and independent samples t-tests were conducted to compare the mean GPA across groups. In both instances, the Bonferroni correction was utilized to correct the inflated familywise error rates in multiple comparison analysis.

Summer Program Completion

Results from the most recent administration of the program in summer 2014 suggested that IMP was highly effective. Nearly 90% of students (429 of 480) who participated in IMP successfully completed the program – eliminating the need for one/two quarters of developmental math.

Developmental Math Requirements for FTF

Over the past five years, CSUSB's various summer programs have successfully reduced the proportion of students requiring developmental mathematics coursework. Consequently, a larger share of students have matriculated in the fall ready for GE math. Figure 1 shows the proportion of FTF requiring developmental math at admission to CSUSB and the proportion after summer program participation. Since 2010, the percentage of students requiring developmental math after summer program participation has dropped by 18 percentage points, from 46% to 28%.

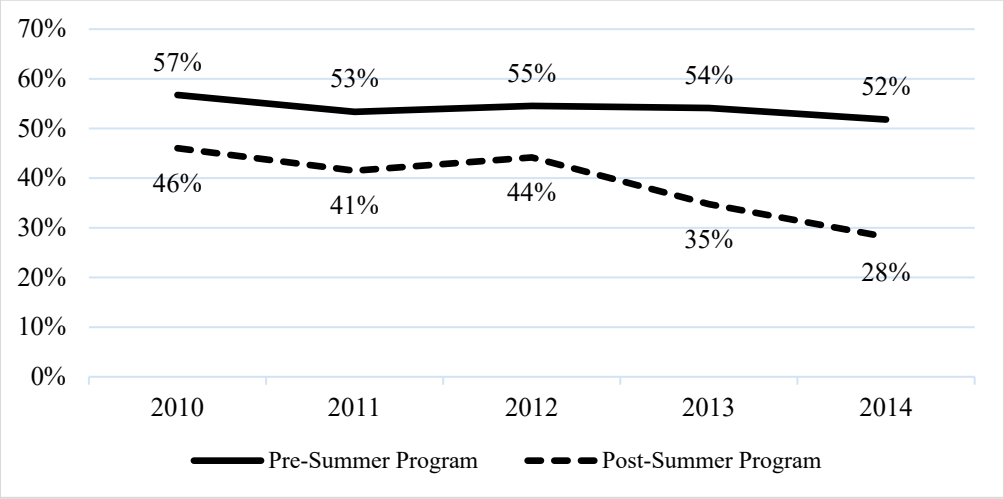

Figure 1: Fall 2010-2014 Cohorts: Developmental Math Requirements Pre- and Post-Summer Program Participation

Group Comparisons on GE Math by Pass Rate

The three student groups differed significantly in the proportion of students passing Math 110 in their first attempt. The 85.2% pass rate for GE-ready students was significantly higher than the 80.0% pass rate for IMP students (z = 4.19, p < .05). In addition, the pass rate for IMP students was higher than that the 71.2% rate for DE students (z = 5.95, p < .05). While the IMP students did not pass at a similar rate to GE-students, their pass rate was higher than DE students, suggesting that IMP was successful in narrowing the achievement gap between students prepared and unprepared for college-level math.

Group Comparisons on GE Math by GPA

Of the students who passed Math 110 and earned a letter grade, the three student groups differed significantly in their mean GPA. The average passing grade for GE-ready students (N = 2,490, M = 3.20, SD = .754) was significantly higher than the GPA for IMP students (N = 1,065, M = 3.09, SD = .769), t(3,553) = 3.79, p < .05). The difference in GPA between IMP students and DE students (N = 1,779, M = 2.95, SD = .759) was also statistically significant, t(2,842) = 4.650, p < .05). Similar to the comparisons by pass rate, IMP brings students who are not prepared for college-level math closer in academic

performance to students who are prepared. Based on our findings, we have evidence to support the effectiveness of our summer programs for reducing students' need for remedial coursework. However, additional efforts need to be made to provide students the opportunity to be successful beyond remediation.

Evidence of Institutional Barriers to Student Success

Five criteria were examined as evidence of institutional barriers to student success: the availability of course offerings needed to complete the GE math requirement; the enrollment patterns for GE math courses during the freshman year; the accessibility of academic support for students enrolled in GE mathematics; the impact of delayed enrollment on GE math success; and the impact of delayed enrollment in GE math on time-to-degree.

For these indicators, archival data were extracted for fall 2007-2014 FTF cohorts. Student-level information obtained included GE math status, specific detail on Math 110 performance (grade and term of attempt), and time-to-degree. In addition, enrollment capacity and enrollment demand data were analyzed from historical enrollment files.

Availability of Course Offerings

As demonstrated in Figure 1, CSUSB has been successful in reducing the proportion of FTF requiring developmental math and, thereby, increasing the proportion ready for GE math. Unfortunately, an analysis of the count of GE math seats and GE eligible freshmen indicates that the campus is unable to accommodate all of these freshmen. Figure 2 below shows the enrollment capacity in Math 110 and the number of GE-ready FTF. In fall 2010, the seats in Math 110 were available for nearly all of the eligible FTF who wanted to enroll. However, in the past five years, the enrollment capacity has remained stagnant while the number of eligible students has doubled. In fall 2014, 1,957 of the FTF were eligible for Math 110, but the enrollment limit was 949 students. Since enrollment in Math 110 is not limited to FTF, the difference in enrollment and eligible students is underreported.

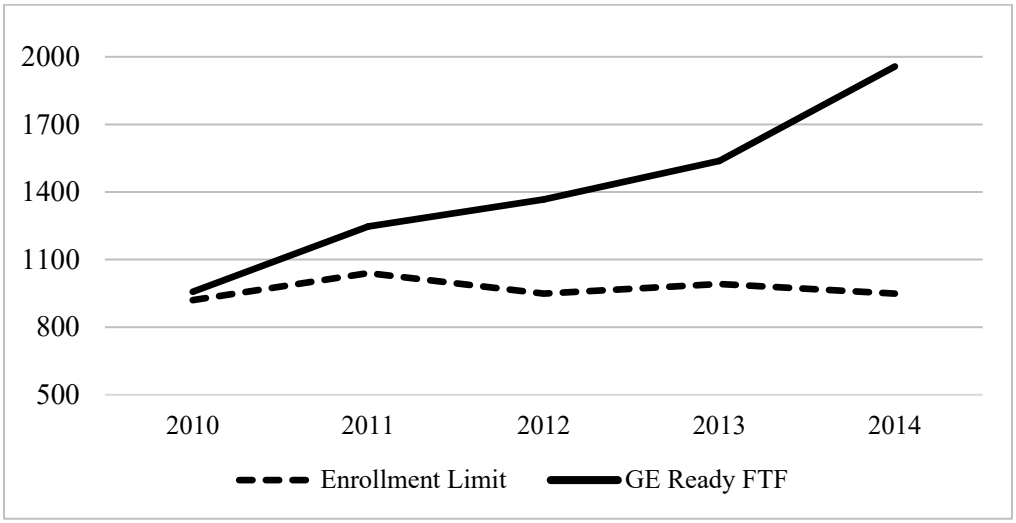

Figure 2: Fall 2010-2014 General Education (GE) Math Ready First-time Freshmen and Math 110 Enrollment Limits

GE Math Registration Patterns

While the gap between seats and students provides some evidence of the misalignment between institutional supply and student demand, it does not show the actual demand of students. That is, how many FTF wanted to enroll in GE math but could not. Enrollment demand data were captured through unsuccessful course registration attempts due to capacity limitations (i.e., the course was full). Of the 2,710 fall 2014 FTF who were required to complete GE math, 620 (23%) did not take a GE math course

in the first year. Of these 620, 191 (31%) attempted to register for Math 110 but were denied because the course was full. Figure 3 provides the breakdown. This number is most likely underreporting the unmet student demand because it does not include students who don't attempt to register when they see the course as full in the online Schedule of Classes.

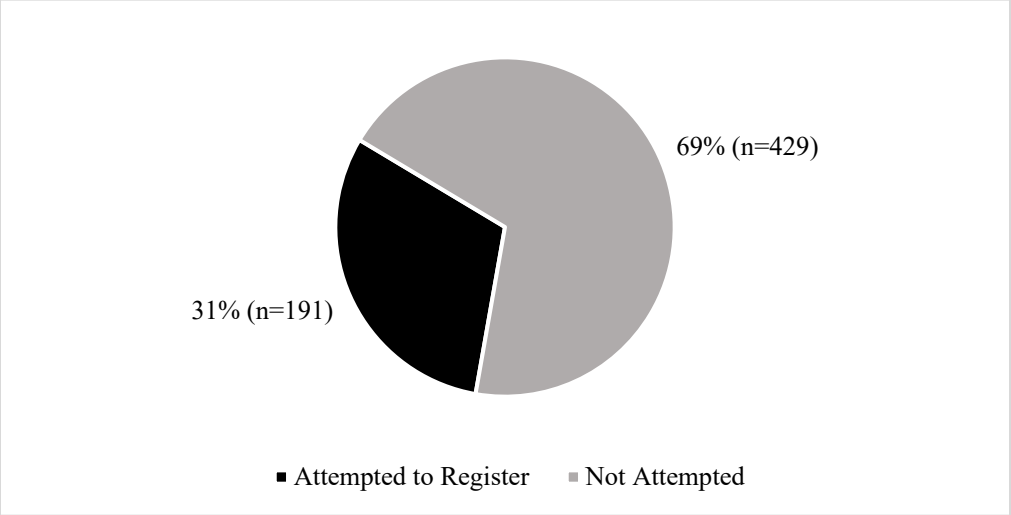

Figure 3: Fall 2014 First-time Freshmen not Attempting a 1st year GE Math Course by Math 110 Registration Attempt

Availability of Academic Support

When students participated in IMP, they received three-hours of mandatory group tutoring each day to support their learning and help reinforce concepts that were introduced by the professor. Tutor to student ratios in IMP peer tutoring sessions were 1:15. However, during the academic year, students were not required to participate in tutoring or other forms of evidence-based academic support. While the institution offered SI for two sections of GE math in fall 2014, with the capacity to serve fifty-two students, the potential demand for SI far exceeds the offerings of support for students who were made GE math ready through summer mathematics interventions (n=644). Additionally, at CSUSB, SI participants must enroll in a two-unit course that is undecipherable in the course schedule and typically offered immediately following the content course. This limits SI participants in a given quarter to those who are registered in the specific section and who do not have a course scheduled immediately afterwards. This can be extremely problematic for students who work and attend school full-time, as many students prefer to enroll in back-to-back courses to create significant spaces in their schedule on alternate days for employment. Consequently, in spite of the need, many sections of SI remain unfilled (see Figure 4).

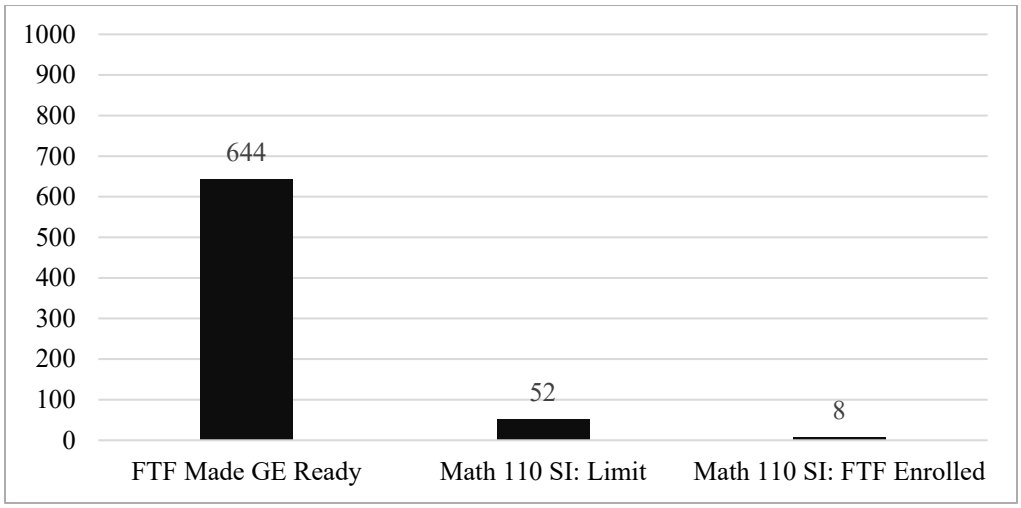

Figure 4: Fall 2014 "FTF Made GE Ready" versus Supplemental Instruction Limit and FTF Enrollment

Effects of Delayed Enrollment on GE Math Performance

To further explore the effect of course availability, the relationship between delayed enrollment and GE math performance outcomes was examined. Specifically, the pass rates and GPAs for all students from 2010 to 2014 who attempted Math 110 (regardless of GE math group status) were compared based on the term of first attempt. Four groups were analyzed: students who attempted Math 110 in their first quarter (n = 3,663); second quarter (n = 1,174); third quarter (n = 1,007); or fourth term or later (n = 1,073). The results are displayed in Figure 4. The trend is clear: delayed enrollment in Math 110, regardless of their GE math readiness at entry, is associated with a reduction in Math 110 success.

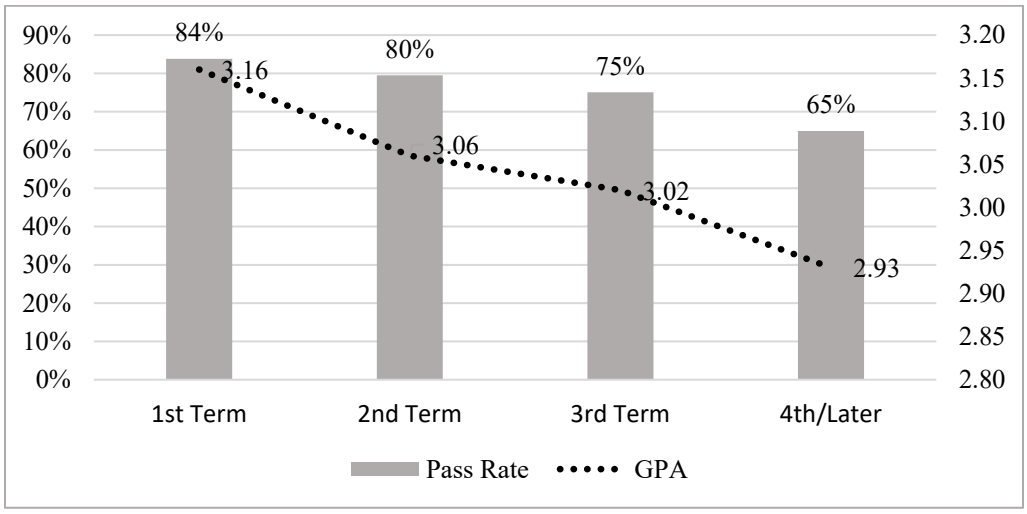

Figure 5: Fall 2010-2014 First-time Freshmen Math 110 pass rates and GPA by term of first attempt

Effects of Delayed Enrollment on Time-to-Degree

The final piece of evidence to examine institutional barriers to student success is the relationship between time-to-degree based on the year of first Math 110 attempt. Figure 6 shows the results for fall 2007-2011 FTF cohorts. Of students who graduate from CSUSB, those who attempt Math 110 in the first year differed significantly in years to degree from those who delay enrollment. Students who attempt Math 110 in their first year graduate faster (N = 1,589, M = 4.96, SD = .834) than those who delay Math

110 until their second ($N = 353$, $M = 5.21$, $SD = .784$) or third year ($N = 83$, $M = 5.52$, $SD = .861$) of enrollment. Granted, this relationship may not be a causal link. However, this provides additional evidence to support the access to GE-level math to FTF as early as possible in their academic careers.

Figure 6: Average Years to Degree by Year of First Math 110 Attempt

Discussion

Our findings suggest that targeted developmental math interventions to address specific barriers to student success and retention can have a measurable impact on student success. Students who participated in IMP showed better outcomes than their peers who participated in other developmental math courses/programs. Through IMP, the institution reduced the need for developmental math and closed the performance gap in GE math between students who were prepared and unprepared for GE math at admission. However, this successful intervention unintentionally created other barriers to student success. For example, results indicated that more students were GE ready in their first term. Even though more students were GE ready, the institution did not have the number of faculty required to teach the necessary courses. In response to this issue, the mathematics department is actively investigating strategies to increase the number of available instructors to teach the needed courses and meet the demand from students.

Another institutional barrier created by the success of IMP was an increased demand for academic support for the high-risk lower-division GE math course (Math 110) taken by most first-time freshmen. Through strategic and on-going collaboration between student support staff, program designers, administrators, and institutional researchers, the appropriate data was analyzed and then used to inform conversations focused on addressing these specific barriers. As a result of the collaboration, in fall 2015, all students who enroll in GE mathematics will have access to Supplemental Instruction for their course through the use of a more cost effective, traditional model of SI. Additionally, these sections will follow a more traditional model of SI which includes sessions led by undergraduate students and tracked through the institution's new electronic student support system. The implementation of this new, more traditional SI model will eliminate barriers associated with course enrollments and unit overloads students encountered with CSUSB's previous SI model.

Given the correlation between a delay of enrollment in Math 110 and variables such as time-to-degree and academic performance, all first-time freshmen in fall 2015 will be advised to complete their lower division general education requirements in their first two years with an emphasis on completion of general education mathematics courses (this includes Math 110 and other equivalent courses) by the end of their first academic year. Students who have not enrolled or passed their lower division math course

by the spring quarter in their first year will be contacted and encouraged to complete the lower division math requirement during the summer session to ensure that it does not serve as a barrier to credit accumulation and impact time-to-degree. These actions and plans demonstrate the beginning of a data driven strategy to support students who are required to participate in developmental math. We seek to reduce institutional barriers to student success; thus, our long-term strategy will include development of blocked scheduling courses for cohorts of students in their first term (at a minimum) and intrusive academic support throughout their entire experience at the institution.

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