8) **De-stress.** Keep a healthy mind and body! Take time out to relieve stress. Keep in mind that students can detect when we are stressed which creates stress in them.

Definitely, the good news is that all of us are more prepared for the upcoming online semester. Our educational experiences, points of view, expertise and tools have changed and grown. Along with all of these new technological experiences, we, as educators, will continue to maintain high expectations for our students. We do need to exercise our new found superhero traits and abilities as we travel through this technological world of teaching and learning. All the tech tools in the world will not replace effective teaching and learning without our superhero mindset. More than ever, commitment and dedication to deliver outstanding online teaching and learning are essential. We should remember that this journey still is quite new to both educators and students but we are getting better each day as we navigate through it together. As they say, the proof is in the pudding! And we will continue to make and eat our superhero pudding. So, let's applaud all the virtual superheroes and help each other fly to success!

Co-Requisite Remediation: A Pilot Study on Expanding the Placement Range into Co-Requisite Courses

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Abstract

Different developmental mathematics programs are offered at various institutions across the United States. Many vary from state to state, and even college to college within states. One of the designs that has emerged as a frontrunner is the co-requisite model. This pilot study builds on previous success of the model by exploring the effect of pass rates when the placement range for co-requisite courses is expanded. The goal is for the pilot results to help indicate whether or not more students should place directly into the co-requisite model, bypassing the prerequisite stand alone. Results are promising, and continue to show success for this model. Keywords: Corequisite, mathematics, remediation, developmental

1. Introduction

Every academic year, millions of students across the United States enroll in developmental1 courses. In fact, it is estimated that about 59% of community college students and 33% of students at four-year public universities are underprepared in mathematics [15, 22]. Evidence suggests that only 33% of students placed in developmental mathematics courses ever complete the pipeline to earning a college mathematics credit within three years [4]. Research continues to suggest that students who place in developmental courses have "consistently worse" academic outcomes than those who do not [18]. This population of students is often times first generation, low income, underprepared, and minority [4, 18, 27].

There are many different types of developmental programs across the nation to address this shortfall. Many vary from state to state, and even college to college within states [7, 19, 30]. Traditionally, developmental programs consist of as a sequence of courses designed to progress students through developmental mathematics beginning with an elementary algebra or a similar course and ending with a college credit gateway2 algebra course. The structure of this traditional sequence in practice can pose barriers to student success [4, 28]. As a result, now, and especially in the most recent decade, developmental program designs have shifted to include other types of design such

1 Developmental and remediation are used interchangeably throughout the paper

2 Gateway is used to describe a required college-level credit mathematics course

as modular, self-paced, compressed, the emporium model, and so on in place of the traditional sequence [6, 28].

One in particular, the co-requisite model, has gained traction in recent years and has emerged alongside the math pathways reform movement across the nation [9, 10, 12, 28]. Co-requisite remediation can be designed in a variety of ways, but for this study, we will consider it as an opportunity for students to take their college-credit gateway course at the same time as a developmental support course, thus bypassing a standalone developmental course [11, 24].

2. Literature Review

According to several studies, co-requisite remediation is an upcoming reform strategy and has shown to improve student success in remediation [14, 15, 21, 22]. In Tennessee, under the co-requisite model, student pass rates jumped from 12% with the prerequisite model to 51% with the co-requisite model [32]. Complete College America reports that in states that have scaled the co-requisite model, the percent of students successfully completing gateway math or English courses in one academic year has doubled or tripled [12]. In addition, the California Acceleration Project advocates for student placement in college-level math pathways courses along with co-requisite supports. When controlling for demographic and academic factors, student's completion of a college-level course within two academic years increased from 12% in traditional developmental courses to 38% with the accelerated courses [17]. Co-requisites are designed to accelerate students through the sequence of developmental study, often times saving students not only time, but also money [5, 11], which can be a challenge for low-income students who are overrepresented in developmental courses [3].

The lack of success in developmental courses can discourage students from completing their college studies [26]. Scott-Clayton [30] reports that if students who are assigned to remediation courses were given the chance to begin with college-level courses, 25% to 33% of them could have earned a B or higher. According to him, community college students have been over diagnosed as underprepared. Since most content of developmental mathematics courses are similar to mathematics knowledge which students learn when they are in high school [23], a lot of students lose momentum and interest in their developmental study [1]. To compare with the students who haven't been placed into developmental mathematics courses, students who are in developmental courses are also more likely to drop or delay their degree [4].

When considering the co-requisite model in mathematics remediation, one challenging factor is how students are placed and if they are being placed appropriately [25]. Many colleges require new freshmen to take a placement test when they get to campus or to use test scores already taken for placement, such as ACT or SAT, to determine mathematics course placement. Depending on students' performance on these placement exams, they may or may not need developmental courses before enrolling in college-level work. According to data from The Center for Community College Student Engagement [8], 86% of students agree/strongly agree that they are academically prepared to succeed in college, however, 68% of community college students take at least one developmental course [20].

Expanding research on the co-requisite mathematics program design and placement is more important now than ever [10]. It is recommended to continue to contribute to the developmental mathematics reform, and to observe and explore the effect of modifications to the co-requisite model to ensure student success [2]. As noted by Scott-Clayton [30], "As long as a virtuous cycle between research, policy, and practice continues, outcomes for students will hopefully keep moving in the right direction" (p. 9). This leads to the following research question:

How does modifying student placement effect co-requisite course pass rates?

In the following sections, we will present our data collection and analysis, results, and discussion.

3. Data Collection and Analysis

This study takes place at a midsize southern four-year public institution where the co-requisite model for developmental mathematics has been in place since

summer 2016. The model consists of courses for two pathways: College Algebra (for STEM majors) and Quantitative and Mathematical Reasoning (QMR, for non-STEM majors). For the College Algebra pathway, there are three placement options: Foundations of College Algebra (pre-requisite); College Algebra with Lab (co-requisite) and College Algebra (standalone). For the QMR pathway, there are also three placement options as follows: Foundations of QMR (pre-requisite); QMR with Lab (co-requisite); and QMR (standalone).

The foundations courses are designed for students who need a full semester of mathematics remediation to prepare for college-level math. Upon passing the foundations course with an A, B, or C, then he or she enrolls in the gateway course within the aligned pathway the next semester. The co-requisite courses are designed to allow students to enroll in college-level mathematics along with a developmental support lab during the same semester. The support lab is a one-hour developmental course that takes place typically either right after or right before the college-level course. During the lab, instructors typically review pre-requisite material needed for the college-level course and/or use the time for activities and group work. The co-requisite courses have the same instructor, and students receive the same grade for each. Lastly, the standalone courses are a typical three-hour college-level credit gateway course.

At this institution, approximately 300-400 students are enrolled in developmental courses each semester, about half in the foundations courses and half in the co-requisite courses. Students place into each pathway based on their major and test scores (see Table 1).

Previously, at this University, data from summer 2016 to fall 2017 were analyzed qualitatively with respect to the co-requisite model. Analysis found that the pass rate for co-requisite courses was 75% (402 out of 539) and the pass rate for foundations courses was 59% (273 out of 463). Further analysis indicated that only 28.5% (132 out of 463) of the students who completed the foundations course, enrolled and passed the gateway course to earn college math credit. In other words, students were still getting lost in the pipeline from foundations to gateway courses [11]. As a result of these findings, in spring 2019, a small pilot study was conducted to observe what would happen with student pass rates in co-requisite courses if the following changes were made to placement:

1. All students who would normally place into Foundations of QMR were allowed to enroll in co-requisite Quantitative and Mathematical Reasoning. This included students whose ACTMath is less than or equal to 15
2. All students with ACTMath 16-17 who would normally place into Foundations of College Algebra were allowed to enroll in co-requisite College Algebra.
3. All students whose high school GPA was 3.0 or higher were allowed to enroll in co-requisite courses regardless of placement exam grade(s).

	Foundations		**Co-Requisite**		**Standalone**	
	QMR *(Non-STEM major)*	College Algebra *(STEM major)*	QMR *(Non-STEM major)*	College Algebra *(STEM major)*	QMR *(Non-STEM major)*	College Algebra *(STEM major)*
ACTMath	15 or less	17 or less	16-18	18-20	19+	21+
COMPASS	40 or less	42 or less	41-43	43-44	44+	45+
ACCUPLACER	59 or less	69 or less	60-76	70-79	77+	80+
SATMath	460 or less	489 or less	470-514	490-529	515+	530+

Table 1. *Mathematics test score placement*

In essence, the goal was to explore the effect of allowing more students into the co-requisite courses to eliminate the pipeline from foundations to co-requisite. Since this was a pilot study and students did not satisfy the current placement guidelines, central advisors sought out students who fit the criteria given in 1-3, and gave them overrides for the appropriate course(s). This results in a small sample size, however, the goal was to gain some insight on whether or not expanding the placement range ("the bubble") of co-requisite courses increases students' chances for success or not, even if this meant not having a large sample size.

Data was collected from the Office of Institutional Research and included student ACTMath sub scores and course grades for students enrolled in foundations courses, co-requisite courses, and college-level standalone courses for each pathway. For 1 and 2, pilot students were identified as not having met the ACTMath cut off requirement, and not having any pre-requisite course(s). For 3, students were identified who did not meet the co-requisite cut off, whose high school GPA was 3.0 or higher, and who were enrolled in the co-requisite courses.

SAS programming was used to organize and analyze the data with respect to test scores and pass rates for each cohort. Passing for the foundations courses includes grades of C or higher. A passing grade for the co-requisite and standalone courses is considered D or higher. For this pilot study, the ACTMath was used as the primary tool for placement. The ACTMath is the most commonly accepted placement test at this University and therefore, was more appropriate to focus on, rather than others such as SAT or Accuplacer.

4. Results

For the first part of the pilot study, all students who would normally place into Foundations of QMR were allowed to enroll in co-requisite QMR. This included students whose ACTMath is less than or equal to 15 (For standard placement scores see Table 1). In Table 2, results indicate that students whose ACTMath≤ 15 passed co-requisite QMR at 50%, while students with ACTMath 16-18, those typically placed in the course, passed co-requisite QMR at 54.5%. There were several students who were enrolled with ACTMath ≥19 possibly due to choice or scheduling reasons. Interestingly, they had the same pass rate as those with ACTMath ≤15.

	N	A	B	C	D	F	W	Pass %
***ACTMath ≤15**	**10**	**1**	**0**	**3**	**1**	**4**	**1**	**50**
ACTMath 16-18	22	5	2	5	0	6	4	54.5
ACTMath ≥19	2		1				1	50

Table 2. Co-Requisite QMR Pass Rates
* indicates pilot students

While the pass rates for spring 2019 in co-requisite QMR were not high, pilot students still performed the same as those who were typically placed in the course. In addition to comparing pass rates for ACTMath scores for the co-requisite QMR course, pass rates were also compared to the standalone QMR course (see Figure 1).

Pass rates for standalone QMR were higher the lower the ACTMath score, however, the sample size is very small, and some of these students in the standalone QMR may have been enrolled in the foundations course as a pre-requisite. For ACT ≥19, the cutoff for the course, the average pass rate was 50%, about the same as for the co-requisite courses.

The second part of the pilot study allowed students with ACTMath 16-17 who would normally enroll in Foundations of College Algebra to enroll in co-requisite College Algebra. In Table 3, results indicate that students with ACTMath 16-17 passed with an average of 82.4%. This is higher than those with ACTMath 18-20 who typically place in the course, who passed with a rate of 68.9%. There were also seven students with ACTMath≥21 who would have qualified to take standalone College Algebra, but perhaps due to choice or scheduling reasons, were enrolled in the co-requisite College Algebra. These students passed with a rate of 57.1%, surprisingly, not as high as the lower ACTMath scores.

	N	A	B	C	D	F	W	%
***ACT 16-17**	**34**	**4**	**5**	**16**	**3**	**4**	**2**	**82.4**

ACT 18- 20	29	5	8	5	2	4	5	68.9
ACT ≥21	7	2	1	1	0	1	2	57.1

Table 3. Co-Requisite College Algebra Pass Rates
*indicates pilot students

In addition, the pass rates of the co-requisite College Algebra courses were compared with the pass rates of the standalone College Algebra course with relation to the ACTMath scores (see Figure 2).

Findings indicate that those in the co-requisite courses did very well compared to those in the standalone courses. In fact, for ACTMath 16-17, the co-requisite students passed at a rate 15.4% higher. Note that for students with ACTMath lower than 21 in the standalone course, they had most likely taken Foundations of College Algebra, or an equivalent, before enrolling.

For the last part of the pilot study, any student whose high school cumulative GPA was 3.0 or higher were allowed to enroll in co-requisite courses regardless of low testing placement scores. It was very difficult to figure out which students were placed based on GPA alone, and not on other factors. A lot of the time, ACTMath or other scores determined the placement, not the high school GPA. In the cases where it looked like the high school GPA was the reason for placement, there was not enough data overall to make any conclusions.

5. Discussion

Based on the results from the first part of the pilot study, it was found that students with ACTMath ≤ 15 who would normally place into Foundations of QMR passed at about the same rate as those with ACTMath ≥ 16 who place into co-requisite or standalone QMR. Compared to our previous study which found that 47.5% of students enrolled in Foundations of QMR completed with a passing grade, at 50%, although not high, it is still better than the previous Foundations of QMR course pass rate [11]. It is also better than the pipeline completion rate (28.5%), and findings indicate it is also about the same pass rate as those already placed in the course. Based on these results, it is suggested to eliminate the course Foundations of QMR to allow all students who would normally place into this course into co-requisite QMR. This will allow all non-STEM major students to begin the QMR pathway in a college-level credit course, increasing the odds to retention and graduation, and eliminating the pipeline to nowhere [4, 15, 30]. In addition, since pass rates are not high for the QMR courses, it is suggested to look at ways to improve overall pass rates in these courses. Since it is difficult to teach students to identify

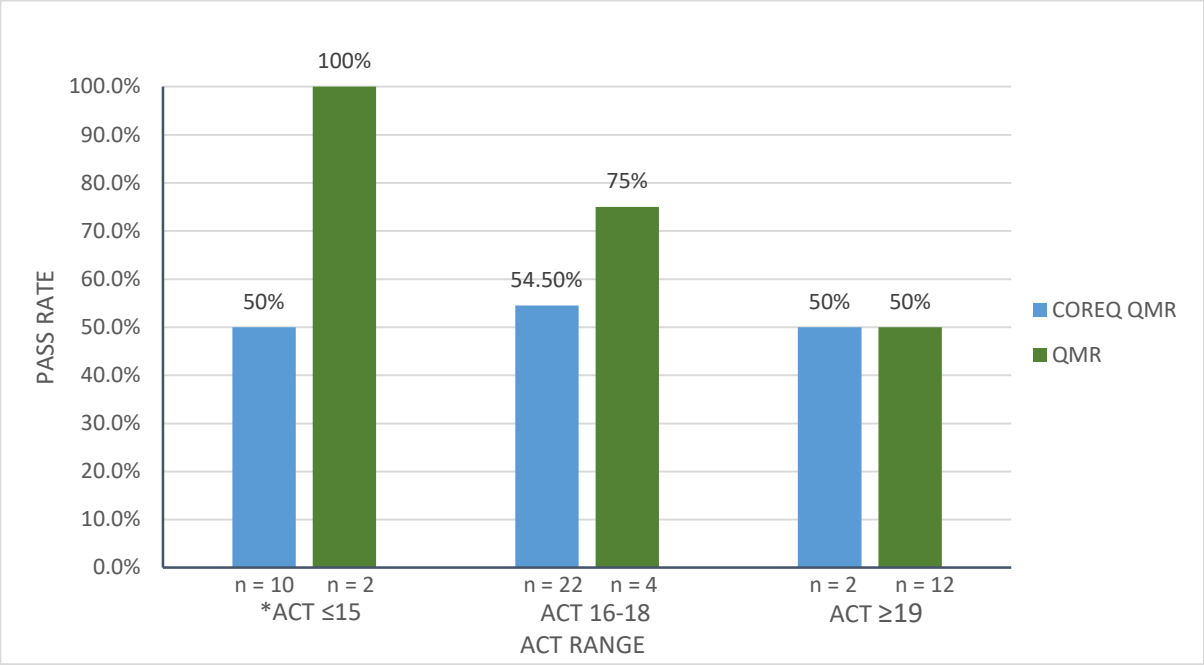

Figure 1. *QMR Pathway Pilot Results*

mathematics in context [16], it is important that faculty be given professional development support to enhance quantitative reasoning in their courses [13]. The ability to think quantitatively plays a central role in undergraduate education, and while there is no single pedagogy, problem centered or inquiry focused learning approaches may be best [13].

For the second part of the pilot study, it was found that students whose ACTMath 16–17 with no prior foundations course, did very well in the co-requisite College Algebra with a pass rate of 82.4%. In fact, although numbers are small, pilot students passed 13.4% higher than those who normally place into the courses (ACTMath 18-20). The previous study indicated that 62.2% of students enrolled in Foundations of College Algebra passed the course. In addition, these pilot students would have also entered the pipeline with a 28.5% completion rate to earn college-level math [11]. Thus, based on these results, it is suggested to expand the range of test scores for co-requisite entry to include ACTMath 16-17 and have other similar placement tests expand their range accordingly as well (i.e. SAT, Accuplacer, etc.). If students have a better chance at earning college math credit, then they should be allowed to do so, again bypassing the pipeline to nowhere [4, 15, 30]. The success in the co-requisite courses mirrors the success that others have noted [14, 15, 21, 22]. It is important to continue to contribute to literature in this area to validate the ongoing research on the co-requisite model [2].

As an overview, it appears that placement based into pre-requisite courses based on ACTMath is not indicative of potential achievement in co-requisite courses. This confirms the literature that placement tests may be mis-assigning students, with most being misplaced into remediation courses [29]. Atkins and Beggs [2] found that "students who were unable to demonstrate acceptable mathematics proficiency based on the ACT were able to demonstrate college-level mathematics mastery" with the co-requisite model. This confirms the idea that little is known about the quality of these exams, other than the validity reports published by the test-makers [30]. As a result, it may be important to examine institution placement policies, and to push for alternatives to placement, such as multiple measures, which may be more indicative of student success in developmental courses [25].

6. Conclusion

More and more states are adopting the co-requisite model for developmental education. Evidence suggests that it may help more students pass college level math, increasing student retention and eventually

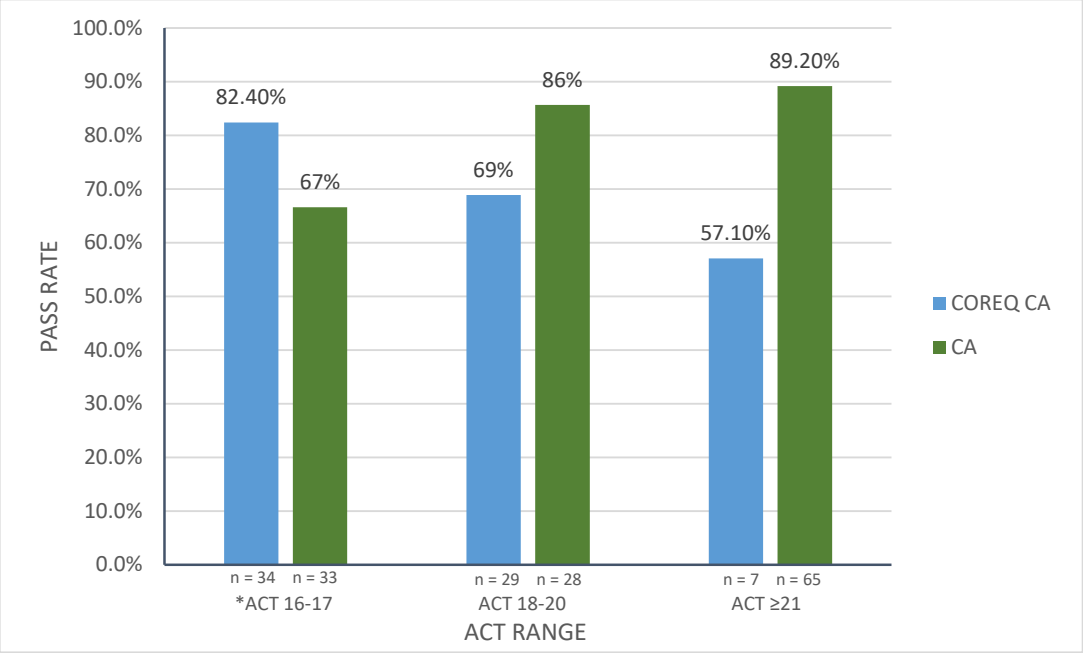

Figure 2. *College Algebra Pathway Pilot Results*

graduation rates [10, 12, 31]. This one-semester model decreases cost, a burden for many, especially low income students [2]. Many students feel they are prepared for college-level math after high school [8], and research has shown they are able to perform well despite their misplacement [29].

In the future, it may even be worthwhile to explore what happens if all students were allowed to enroll in co-requisite College Algebra, despite test scores. If numbers show that they can perform as well as those typically placed, it could give these students a better shot at ever finishing and completing a college-level math course, and long term, a college degree. In addition, more research is needed on evaluating and adjusting placement test score cut-offs. This may include incorporation of multiple measures, such as inclusion of high school GPA or prior math achievement as indicators for success.

There are some limitations to this study. First, although the sample was objective and diverse, the sample size is small. Since this is a pilot study, we relied on advisors to place students accordingly, and this in return, turned out with small numbers. In addition, the number of students who come to the University with these test scores is small to begin with, again, limiting the number for the pilot study. The results presented here, while promising, are by no means definitive. Once the suggestions are implemented, a rigorous study will need to be conducted with much more data to confirm placement success.

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