

RiLADE

Research in Learning Assistance and Developmental Education

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**Corequisite Developmental Mathematics:
An Annotated Bibliography of Recent
Research
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Corequisite mathematics instruction is a trend in developmental education. This model specifies underprepared student placement into college-level courses with a concurrent engagement in integrated academic support. The corequisite model of instruction has been pitched by some as the best solution for all underskilled college students as opposed to placement in sequences of prerequisite developmental education courses (Complete College America, 2012). As a result, it has received considerable attention on the research.

This article is a follow up to the previous issue of RiLADE with the objective of offering a list of references and annotations of the research on corequisite developmental mathematics. As noted in the

prior issue, the Accelerated Learning Program (ALP, 2022) was likely the catalyst for the corequisite trend. However, bear in mind that ALP was designed and proven efficacious with a particular subgroup of underprepared students in the subject of English not mathematics.

This compilation represents an attempt to collect and annotate all relevant research on corequisite mathematics since 2009.

The search process involved collecting articles cited in *Resources on Corequisites* (Community College Data, 2020), Sam Houston State University's Engine Orange, and the websites of research and advocacy groups engaged in corequisite reform. The keywords applied were "corequisite developmental education," "corequisite mathematics," "corequisite model," "developmental mathematics," "remedial reform," and "developmental education reform." All relevant articles were retrieved in full text. Particular items of interest included in the annotations are study

methods, corequisite model dimensions, characteristics of instruction, academic support, measures of efficacy, and study results. This compilation may be helpful to those who are researching, designing, and/or delivering corequisite mathematics courses.

It should be noted that in this bibliography, there is some overlap of annotations from the last issue of RiLADE on English corequisite research. Several research articles covered both mathematics and English and were therefore included in both RiLADE issues. In these cases, the annotations here focus where possible on data provided specifically for mathematics. In a few cases, no subject area was specified, but the articles were deemed relevant due to more general contributions to understanding the corequisite instructional model.

Corequisite Developmental Education Mathematics Annotations

Anderson, P., Pribesh, S., & Williams, M. R. (2020). A matched-samples comparison of pass rates for students coenrolled in developmental education and college-level math compared to similar non-coenrolled students. *Community College Enterprise*, 26(2), 24–36.

Researchers examined the coenrollment of students in developmental mathematics and college-level mathematics to determine the extent to which completion rates differed among coenrolled students and students in a traditional developmental mathematics course. Students at nine community colleges in a Southeastern state were matched and compared based on socioeconomic status, first-generation status, race and ethnicity, age, sex, college location, and number of credit hours enrolled. Data for the 208 coenrolled students were

analyzed to select exact matches from approximately 7,000 traditionally enrolled developmental students to minimize variance. In this study, passing was defined as a D or higher. A binary logistic regression was used to determine differences between the two groups. The researchers found that coenrolled students were 3.6 times more likely to pass the developmental mathematics course if they were coenrolled in developmental mathematics and college-level mathematics.

Beamer, Z. (2020). Mathematics corequisite remediation and direct enrollment: Addressing misconceptions and concerns. *Inquiry: The Journal of the Virginia Community Colleges*, 23(1), 1-13.

With the purpose of building support for the Virginia Community College System's Direct Enrollment Pilot, the author addressed multiple concerns regarding placement, outcomes, content, and results from corequisite mathematics initiatives. The author emphasized that current research focused on students with placement scores near corequisite placement threshold (or slightly underprepared). Beamer noted that the intent of corequisite mathematics reform should not be to eliminate developmental mathematics, but rather to limit the prerequisite coursework to those students that most need it.

Buckles, E. L., Haydel, N. W., Thompson-Sanchez, J., & Page, Y. W. (2019). Implementing a corequisite algebra gateway course. *Peer Review*, 42-45.

Researchers studied the impact of a corequisite College Algebra curriculum revision at Dillard University. Students who had an ACT or SAT score just below the

College Algebra placement score were enrolled in the corequisite course. The course was four credits with students attending for 75 minutes three days per week. In addition, this course applied a commercial online math instructional platform for assignments and students were required to attend a mathematics tutoring lab. All 25 students in the summer 2018 pilot study passed the corequisite course with a C or better. Of those students, 10 enrolled in PreCalculus the following semester, of which eight students passed. The redesigned course was fully implemented in fall 2018. Of the 140 students in five sections in the corequisite course, 78% completed the course and 80% of the completers passed with a C or better. These results indicated that corequisite College Algebra courses have the potential to lower the time and cost of developmental mathematics course sequences.

Campbell, E., & Cintron, R. (2018).
Accelerating remedial education in Louisiana. *New Directions for Community Colleges*, 2018(182), 49-57.

The Louisiana Board of Regents conducted pilot studies at eight community colleges from 2012 through 2015. The intent was to identify best practices in accelerating developmental education. Outcomes were reported from five community colleges involved in the mathematics pilots. The model applied corequisite support based on the Community College of Baltimore County's accelerated learning program (ALP) model. Student variables examined included gender, race, Pell eligibility, and full- or part-time attendance status. Students were eligible for the pilot if they had an ACT Math score of 17 or 18. Successful completion was defined as a course grade of C or better. Students in the pilot sample (group one) were compared to those eligible

for the pilot but chose the traditional developmental math sequence (group two). Comparisons were also reported among groups one and two with students who were in a traditional developmental mathematics sequence (group three). These students were not eligible for the pilot due to an ACT Math score less than 17. There was no statistically significant difference in college-level math completion rates between the three groups. Success rates were 67.7% in group one, 68.3% in group two, and 66% in group three. However, students in the corequisite pilot did have a statistically significant lower noncompletion rate (10.2%) than the other two groups (22.2% and 20.4%, respectively). A follow-up survey was conducted to examine challenges and program improvement. Results showed the need to address student buy-in for the corequisite model, curricular and course instruction alignment, attendance and advising needs, balancing technology and instructor presence, and scaling up the accelerated model. The researchers' recommendations included having the same instructor teach both the corequisite and gateway course, requiring attendance in both courses, mandating advisement, and requiring an orientation on the corequisite program.

The Charles A. Dana Center at University of Texas at Austin. (2018). *Scaling co-requisite supports at the University of Central Arkansas: Perspective from a four-year higher education institution (Notes from the Field: Number 4).*
https://dcmathpathways.org/sites/default/files/resources/2018-05/1_Notes%20from%20the%20field_number%204_FINAL%5B1%5D.pdf

In collaboration with the Charles A. Dana Center at University of Texas at

Austin (2018), the University of Central Arkansas piloted a pair of corequisite quantitative literacy courses in 2014 which resulted in a 100% pass rate in the credit-bearing course. Both sections were taught by the same instructor. The initiative was expanded to include corequisite college algebra in 2015. This resulted in an 82% pass rate in the credit-bearing course. In this model, the (developmental education) Foundations of College Algebra course was paired with credit-bearing College Algebra. College-ready and underprepared students were co-mingled in the College Algebra sections. One of the four sections had the same instructor as the developmental course. Similar pass rates, regardless of student ACT score, for both Quantitative Literacy and College Algebra have been observed up through 2017. Student and faculty feedback indicated a preference for placing all underprepared students in corequisite courses which had the same instructor for both the college-level and support courses.

Complete College America. (2012).
Remediation: Higher education's bridge to nowhere. Bill & Melinda Gates Foundation and Complete College America.
<https://files.eric.ed.gov/fulltext/ED536825.pdf>

This publication by Complete College America ([CCA], 2012) described remedial education as a “bridge to nowhere” (p. 2) due to the number of students needing remediation, the low completion rates of remedial course sequences, the low completion rates for subsequent gateway courses, and the graduation rates for students who started in remediation. Data from 33 states regarding enrollment, completion, ethnicity, age, and Pell grant status were presented in support of the claim. However, no research methods nor specific data sources were described. CCA

proposed four strategies to “close the remediation exit ramps” (p. 12). They included strengthening high school preparation, starting students in college courses with support rather than in prerequisite courses, embedding supports in gateway courses, and requiring students to choose a disciplinary pathway upon college entry. There was no research support offered for the efficacy of these solutions.

Complete College America. (2021). *No room for doubt: Moving corequisite support from idea to imperative.*
completecollege.org/noroomfordoubt

This report offered data from to college systems showing that corequisite course models increased success rates in college gateway courses. This was in comparison to traditional developmental education course sequences. They reported substantial gains for course completion. Particular to math, the gain was 46%. Overall gains in graduation rates were projected at 50% in the CUNY system. However, no research methodology or concurrent interventions were reported or described. A case was made that these successes generated substantial tuition revenues. Due to these outcomes, it was declared that the adoption of the corequisite course model for underprepared students is imperative. This research showed slow adoption (60%) of the corequisite model. The authors also pointed out that ethnic minority groups, who are typically overrepresented in developmental education, would benefit from more widespread scaling of corequisite courses.

Complete College America. (2021).
Corequisite works: Student success models at the University System of Georgia.

<https://completecollege.org/article/corequisite-works>

This report detailed corequisite support for underprepared students attending colleges in the University System of Georgia. Though no research methods were described, corequisite course completion for math was 66% relative to a 20% rate for prerequisite developmental education. Substantial gains were also reported for ethnic minority and other nontraditional student groups. Course design principles and assessment measures that the co-requisite system applied were also described. Specific characteristics for corequisite math reported to be of more benefit included assigning the same instructor for both the corequisite support and the content courses, and requiring at least two contact hours weekly for the support course.

Denley, T. (2017). *Co-requisite remediation full implementation 2015-16* (Tennessee Board of Regents Technical Brief No. 3). Tennessee Board of Regents. <https://www.tbr.edu/sites/tbr.edu/files/media/2016/12/TBR%20CoRequisite%20Study%20-%20Full%20Implementation%202015-2016.pdf>

This was the first brief on Tennessee's full-scale implementation of the corequisite model. In the traditional prerequisite model, only 12.3% of students assigned to developmental mathematics completed the gateway mathematics course. This led Tennessee to reassess developmental education and mandate corequisite models. When the corequisite support model was implemented in community colleges during the 2015 academic year, 55% of students passed gateway mathematics courses. Fifty-two percent passed during their first semester. During the 2016 academic year,

universities implemented a corequisite model that involved a supplemental lab experience. At universities, 75% of students passed gateway mathematics courses with 67% passing during the first semester. Equally substantial gains were observed for students at every ACT level. It was noted that the majority of students in corequisite models required elementary statistics or quantitative reasoning as the gateway mathematics course. Achievement gaps by minority status, age, and income status were also examined. Seventy-three percent of minority students and 72% of low-income students at the university level passed the mathematics corequisite gateway courses. At community colleges, student pass rates in mathematics rose from 11% to 57.6% following the corequisite implementation. Minority student pass rates in corequisite courses were 47.3%. Overall gains for racial minorities, returning adults, and low-income students were strong.

Emblom-Callahan, M., Burgess-Palm, N., Davis, S., Decker, A., Diritto, H., Dix, S., ... Styles, E. (2019). *Accelerating student success: The case for corequisite instruction. Inquiry, 22*(1). <https://eric.ed.gov/?id=EJ1224767>

This literature review was conducted to promote applying corequisite instruction in conjunction with modularized mathematics and English courses in the Virginia Community College System (VCCS). The goal was to identify opportunities, challenges, and recommendations for integration. The opportunities described regarding corequisite courses included increased pass rates and cost-effectiveness. The challenges described were logistics, scope of impact, and buy-in. They recommended intentional student placement into course options and

the application of multiple remediation approaches and models.

Fair, K. E. (2017). *Effectiveness of a corequisite delivery model for developmental mathematics* (Doctoral dissertation). <https://search.proquest.com/docview/1973617882>

This describes a quantitative quasi-experimental study of the effectiveness of one type of corequisite delivery model at a public, regional southern university. In fall of 2016, 89 students in a standard college-level liberal arts mathematics class were compared to 68 students in a corequisite liberal arts mathematics class containing remedial algebra content. Students enrolled in the standard section either by placement score or prior completion of a remedial math course. Students who had a math ACT subscore of 18 or less were placed in the corequisite section. There were four sections each of the standard course and the corequisite course. The corequisite course included three additional contact hours per week that focused on algebraic content. Four instructors taught one section of each format. The study compared course success scores while controlling for six demographic variables. Those variables were gender, race, income, first-generation status, high school GPA, and math ACT subscore. Overall, there was no significant difference in the adjusted mean course scores among the standard and the corequisite sections. A one-way analysis of covariance indicated a statistically significant correlation between both high school GPA and math ACT subscores when compared with overall course scores. There were no other correlations between overall course scores and the other demographic variables. The sample included two times as many females as males. Over 75% of the participants were white, 55% were low income, and

approximately one-third were first generation.

George, M., & Milman, Y. (2019). *Quantitative literacy: Alternative pathway for college developmental mathematics students. Journal of Mathematics Education at Teachers College, 10(2), 29–35.*

This study compared the course pass rates and subsequent course enrollment and pass rates between students in a developmental quantitative literacy course and students in a developmental elementary algebra course at the Borough of Manhattan Community College. The developmental quantitative literacy course applied Quantway resources and included faculty development. The elementary algebra course used a common textbook accompanied by an online homework platform. Propensity score matching was applied in order to more appropriately compare 418 students enrolled in each type of course in spring 2013. No significant differences regarding demographics or prior math performance were identified between the two sample groups. The pass rate for the quantitative literacy course was 53% compared to 29% for the elementary algebra course. By the end of fall 2013, 110 of the 159 quantitative literacy students who enrolled in the next sequential math course passed compared to 44 of the 87 elementary algebra students.

In fall 2017, the developmental quantitative literacy course was combined with the college level quantitative reasoning course to create a 6-hour per week, 3-credit corequisite course. Of 120 students who enrolled over three semesters, 59% passed the course. Students in the corequisite course were provided a workbook and access to an online homework platform. It was asserted that a quantitative pathway should be offered for students in non-STEM programs. The corequisite model was only

developed for the quantitative literacy pathway; there was not a comparable algebra-based model for students in STEM programs.

Goudas, A. M. (2017, March). *The corequisite reform movement: An education bait and switch. Community College Data.* <http://communitycollegedata.com/articles/the-corequisite-reform-movement/>

This article reported observations and concerns regarding the research on corequisite reforms. It focused on four studies. Two were on the Accelerated Learning Program (ALP) at the Community College of Baltimore County (Cho et al., 2012; Jenkins et al., 2010) and conducted by the Community College Research Center (CCRC). One study was on the state-wide corequisite initiative in Tennessee (Belfield, Jenkins, & Lahr, 2016) by the CCRC and another was on corequisite math reform at the Community College of New York (CUNY) (Logue, Watanabe-Rose, & Douglas, 2016). The author identified a number of discrepancies between the results of these studies and the narrative surrounding the reforms. Those discrepancies included the true cost of the ALP model versus the cost-saving label, the shifting goal of graduation versus pass rates for gateway courses, the comparison of algebra and statistics, and the unreported results of an increase in college-level fail rates.

Jaggars, S. S., Hodara, M., & Cho, S. W. (2015). Three accelerated developmental education programs. *Community College Review*, 43(1), 3–26.

In an effort to understand both the positive and negative implications of

accelerated developmental education initiatives, researchers studied three initiatives at three institutions: FastStart Math at the Community College of Denver, Reading and Writing Acceleration at Chabot College, and Accelerated Learning Program (ALP) at the Community College of Baltimore County. The researchers used 24 regression models to compare four outcomes (gatekeeper completion, gatekeeper enrollment, gatekeeper pass rates, and college level credit accrual) at each of the three sites over a 1- and 3-year period. Given that participants self-selected the accelerated format, propensity score matching was utilized to estimate the impact of acceleration on the type of student who is likely to choose acceleration.

Particular to math acceleration, the FastStart program examined course transcript data for 133 program students and 1,222 comparison students participating between 2006 and 2008. Participants in acceleration initiatives (math and English) were more likely to enroll in and complete gatekeeper courses over a 1- and 3-year period than the comparison group. It was concluded that gains in completion were a result of higher enrollment in gatekeeper courses by accelerated program participants. The authors speculated that all initiatives increased the probability of students enrolling in and completing college-level math and English because they are initiatives that included academic rigor, faculty development, and student academic and noncognitive support.

Kashyap, U., & Mathew, S. (2017). Corequisite model: An effective strategy for remediation in freshmen level quantitative reasoning course. *Journal of STEM Education*, 18(2), 23–29. <https://eric.ed.gov/?id=EJ1149407>

In an attempt to compare the effectiveness of three different models for a quantitative reasoning course, researchers conducted a mixed-methods study comparing student performance and student satisfaction. During the 2014-2015 school year, multiple measures including ACCUPLACER, SAT, GPA, and secondary math courses were used to place 155 first-year students at Regis College into one of three course sequence models. Seventy students qualified for the quantitative reasoning course without embedded supports. The remaining 85 students were randomly placed in either the prerequisite model or the corequisite model. The 46 students enrolled in the prerequisite model took a 1-credit remedial course in the first semester and then the 3-credit quantitative reasoning course in the subsequent semester. The 39 students enrolled in the corequisite model took a 1-credit integrated remedial course at the same time as the 3-credit quantitative reasoning course. All six sections of the quantitative reasoning course used a common syllabus, grading criteria, tests, quizzes, homework assignments, and instructional methods. The 1-credit remedial course met one time per week for 90 minutes. Based on a chi-square test and an ANOVA, it was concluded that students in the corequisite model had a significantly higher average course grade than students in the prerequisite model. Eighty percent of students earned a C- or higher in the corequisite model compared to 50% in the prerequisite model. There was no statistically significant difference between the corequisite model and the quantitative reasoning course alone model. The supplemental instruction support component in the corequisite model is explained at length. Flexibility and customization options available with a corequisite model were described, and it was recommended that both courses are taught by the same

instructor. Limited information was shared regarding the prerequisite model structure. However, an end-of-course student survey indicated that the prerequisite model did not improve motivation, confidence, or satisfaction.

Logue, A. W., Douglas, D., & Watanabe-Rose, M. (2019). Corequisite mathematics remediation: Results over time and in different contexts. *Educational Evaluation & Policy Analysis, 41(3)*, 294-315.

Seeking to evaluate the long-term impact of corequisite remediation, these researchers examined the three-year effects on students in a randomized control trial that had earlier compared the success of developmental elementary algebra students (EA) to the success of college-level statistics students (Stat-WS). City University of New York (CUNY) databases and the National Student Clearinghouse were used to obtain course enrollments and grades for participants from fall 2013 until fall 2016. By fall 2016, 17.2% of the 297 EA students had earned an associate degree compared to 25.3% of the Stat-WS students. Results of logistic regression indicated that Group Stat-WS had an 8.1% higher probability of graduating in that time period than Group EA. Group Stat-WS also had a 4.7% to 4.8% higher probability of graduating or transferring to a bachelor's degree program. It was concluded that a demonstrated knowledge of remedial course material was not beneficial to students' subsequent college success. They also asserted that there is no evidence that assigning students to statistics instead of elementary algebra reduces the probability of success in advanced math courses. A quasi-experimental analysis was also conducted to compare pass rates of students in college-level quantitative reasoning or statistics courses to pass rates of matched students

enrolled in remedial elementary algebra. Data were collected from four CUNY community colleges for all corequisite mathematics courses from fall 2013 to fall 2015 and for propensity score matched students in elementary algebra during 2013. Multiple analyses, including propensity score matching and logistic regressions, showed that corequisite groups had a pass rate advantage that ranged from 22% to 53%. It was concluded that “corequisite mathematics is effective at increasing students’ success over time and in different contexts” (p. 307) for students that do not need college algebra for their major.

Logue, A. W., Watanabe-Rose, M., & Douglas, D. (2016). Should students assessed as needing remedial mathematics take college-level quantitative courses instead? A randomized controlled trial. *Educational Evaluation and Policy Analysis*, 38(3), 578–598.

In this study examining approaches for overcoming blocks to college progress, a randomized control trial was applied to compare pass rates in developmental elementary algebra courses with credit-bearing statistics courses. The study randomly placed and tracked 717 students at three CUNY community colleges. In fall 2013, 244 students were placed in traditional, developmental elementary algebra (EA), 227 students were placed in the elementary algebra course with weekly workshops (EA-WS), and 246 students were placed in college-level statistics with weekly workshops (Stat-WS). All participants were first-time freshmen intending to major in programs that did not require College Algebra. The pass rate was 39.3% for Group EA, 44.9% for Group EA-WS, and 55.7% for Group Stat-WS. The authors determined that if the pass rate calculations for Stat-WS only included participants just below the

college-level placement threshold, their pass rates are similar to those who placed directly into college-level statistics (67.6% and 69%, respectively). The mean total credit accumulation advantage for Stat-WS participants increased from 2.38 to 4.00 credits for EA participants during the study. It was concluded that corequisite models have the potential to increase student success.

Mangan, K. (2019, February 18). The end of the remedial course. *The Chronicle of Higher Education*. <https://www.chronicle.com/interactives/Trend19-Remediation-Main>

An overview was given of the challenges and opportunities surrounding the push to replace prerequisite remediation with corequisite remediation. Mangan summarized statewide movements and shared the perspectives of multiple professionals in the field. Five takeaways were given that included demographic challenges in the student population, the impact of corequisite remediation, the impact of the potential elimination of freestanding remedial courses, the perceived pressure of faculty to lower academic standards, and the impact of nonacademic stressors on students.

Mangan, K. (2019, December 6). Remedial reforms are removing barriers for students. Here are 4 key challenges to scaling the changes up. *The Chronicle of Higher Education*, 66(14).

The author identified four key challenges for scaling up developmental education reforms. The first challenge described is that wraparound supports are difficult for part-time faculty to provide and for part-time students to receive. The second

challenge is that faculty members are skeptical of one-size-fits-all approaches and therefore buy-in from this group cannot be assumed. The third challenge is to maintain momentum for successful initiatives once funding is no longer available. The fourth challenge is that although there are studies supporting the effectiveness of corequisite remediation, there is limited evidence that it works for all students, particularly the least prepared.

Matz, R. L., & Tunstall, S. L. (2019).
Embedded remediation is not necessarily a pathway for equitable access to quantitative literacy and college algebra: Results from a pilot study.
Numeracy: Advancing Education in Quantitative Literacy, 12(2), 1–28.

In an effort to analyze the impact of embedded remediation in gateway mathematics courses, researchers examined course pass rates, DFW grade rates, and demographic data for students in three gateway math courses at Michigan State University. In fall 2017 and spring 2018, 268 students in Quantitative Literacy 1 (QL1), 151 students in Quantitative Literacy 2 (QL2), and 587 students in College Algebra (CA) were divided into four categories based on placement score, developmental math requirement, and the type of course section. This was not a randomized, controlled trial. The non-enhanced QL sections met two times per week for 80 minutes. The first meeting each week was a lecture with the instructor and the second meeting was a recitation with a teaching assistant. The enhanced QL sections included an additional 50-minute meeting between the lecture and the recitation that was led by a teaching assistant. The non-enhanced CA sections met for two 50-minute lectures and one 50-minute recitation each week. The enhanced

CA section included two additional 50-minute meetings per week.

Following an analysis of descriptive data and listwise regressions, it was determined that final grades and DFW rates were lower for students with developmental math preparation than for those who waived developmental math to directly enroll in the gateway course. Students in enhanced sections performed worse than students in non-enhanced sections. The researchers found that course section type was not a significant predictor of success. However, prior math GPA, race, ACT math subscore, and financial need were statistical predictors of success in gateway math courses. The researchers emphasized the importance of design and implementation when considering corequisite options.

Moening, B. A. (2016). *The co-requisite model: A regression discontinuity* (Doctoral dissertation, Ball State University). ProQuest Dissertations & Theses Global.

The researcher-analyzed the relationship between a corequisite delivery model and student success as determined by course pass rates in a statewide community college system. Archival data were collected between fall 2011 and fall 2015 for 69,264 students who enrolled in stand alone gateway mathematics. Data were also collected for 9,296 students between fall 2013 and fall 2015 who enrolled in corequisite liberal arts mathematics. In fall 2013, 60% of stand alone college level math students passed the course compared to 52% of corequisite students. In fall 2015, 65% of stand alone college level math students passed compared to 71% of corequisite students. Demographic variables including age, gender, ethnicity, Pell grant status, and placement score were compared through a logistic regression. Nontraditional students by age, females, White/Asian students, and

non-Pell grant recipients all demonstrated the highest pass rates in each subgroup. A regression discontinuity showed that students who scored within five points below the placement cutoff score passed the corequisite course at higher rates than students in the gateway course that scored within five points above the cutoff score.

Park, T., Woods, C. S., Hu, S., Bertrand Jones, T., & Tandberg, D. (2018). What happens to underprepared first-time-in-college students when developmental education is optional? The case of developmental math and intermediate algebra in the first semester. *Journal of Higher Education*, 89(3), 318–340.

In seeking to consider the impact of Senate Bill 1720 in Florida, researchers examined the choices first time in college (FTIC) students made regarding math courses and the success of those students that chose to take Intermediate Algebra in their first semester. Data from the Florida Education Data Warehouse were analyzed for 20,591 FTIC students who entered the Florida College System in fall 2014. The sample only included students who were exempt from developmental education based on SB 1720. Students were divided into four groups based on their enrollment choice: (1) no math course, (2) developmental math, (3) Intermediate Algebra (the gateway course), and (4) both developmental math and Intermediate Algebra in the same semester in either a corequisite or a compressed format. Descriptive tables and multivariate regression analyses were used to convey a number of results regarding levels of preparation, enrollment patterns, and course success. High school academic preparation was the primary indicator of preparedness. Only 3.4% of the participants in the sample chose to take both developmental math and

Intermediate Algebra in the same semester. The most severely underprepared FTIC students were the least likely to choose this pathway. However, underprepared students who used corequisite or compressed developmental education supports had higher predicted probabilities for passing Intermediate Algebra than underprepared students that only enrolled in Intermediate Algebra. The predicted probabilities for passing were 48.2% (corequisite), 53% (compressed), and 40.8% (non-developmental). There was no evidence to support that either the corequisite or compressed modality was better than the other. Although the researchers found the corequisite and compressed modalities were beneficial, only a small percentage of students selected these modalities when given a choice.

Parker, S., Traver, A. E., & Cornick, J. (2018). Contextualizing developmental math content into introduction to sociology in community colleges. *Teaching Sociology*, 46(1), 25–33.

This study examined the impact of learning aligned outcomes when contextualizing elementary algebra content into Introduction to Sociology. The study included 88 students enrolled in four experimental sections and 97 students enrolled in five control sections at two CUNY community colleges during the spring 2016 term. Elementary Algebra was not a prerequisite for Introduction to Sociology, therefore, participants had a wide range of math skills. Through three modules in Introduction to Sociology, students learned about proportions and percentages through social deviance, linear equations through social inequality, and linear inequalities through social change. A five multiple choice question pre- and post-test were used to determine the average change

in elementary algebra skills throughout the course. No statistically significant difference was determined between the experimental and the control group on average pretest scores. However, the average score on the post-test increased for the experimental group and decreased for the control group. Given the small sample size and the limited number of test questions, the results indicate that contextualization may be beneficial for developing elementary algebra skills. It was noted that few elementary algebra concepts were necessary for Introduction for Sociology and that a statistics-based course would potentially be more valuable for non-STEM students.

Procknow, H., Deithoff, L., & Herd, V. (2018). Corequisite courses for developmental students at a large research university. *Journal of College Academic Support Programs, 1*(2), 9–16.

This work described the corequisite approach at the University of Texas at Austin. The program in its current form was developed in 2017 in response to state legislation. The university served students in need of developmental education through the Texas Success Initiative (TSI) program. Approximately 90% of the students in need of developmental education are non-white. Originally the corequisite sections were reserved for students at the upper echelon of the placement testing range. However, the scores have gradually been lowered each year.

The mathematics corequisite courses included a developmental support section and either math for liberal arts or one of two versions of introductory statistics. The developmental course had a maximum of 15 students that meet for 90 minutes one time per week; however, the credit-bearing courses had between 100–200 students per section. Therefore, all developmental

students were placed in the same section of the credit bearing course. There was a different developmental course for each type of credit bearing course. The developmental sections were taught by a TSI instructor that works in collaboration with the credit bearing instructors. Students are exposed to upcoming topics during the developmental sections, often through application-based experiences. The data for 2016-17 and 2017-18 indicated that all 42 students passed the college level course and 38 students earned a C- or better. The authors noted that a three-credit developmental model is being developed for students that need additional support. They also indicated that it would be advantageous to reconsider the pass/fail grading method for the developmental course.

Ran, F. X., & Lin, Y. (2019). *The effects of corequisite remediation: Evidence from a statewide reform in Tennessee* (CCRC Working Paper No. 115). Columbia University, Teachers College, Community College Research Center. <https://ccrc.tc.columbia.edu/media/k2/attachments/effects-corequisite-remediation-tennessee.pdf>

Researchers studied the impact of Tennessee's system-wide mathematics and English corequisite reform. With regard to the mathematics component of the study, they analyzed data from the state's 13 community colleges with the intent of providing estimates on the effects of corequisite models compared to the traditional prerequisite model and direct placement into the college-level gateway course. They focused on first-time students on the margins of college readiness who enrolled in gateway and developmental math from 2010 to 2016. Using regression discontinuity and difference-in-regression

discontinuity methods, they analyzed ACT scores, grade point average, credits attempted and earned, degree completion and transfer data collected from the Tennessee's Board of Regents and the National Student Clearinghouse. Outcomes were tracked through Spring, 2018. The sample of 35,707 students excluded those with low ACT scores, limiting the scores to two points above and below the ACT math score of 19 that is required for direct placement into college-level mathematics. The researchers noted a difference in racial makeup, with the sample being less diverse than the full sample of 99,776 students used for comparison. The average age of participants for both samples was 18, and 75% of the students were within one year of earning their high school diploma. The findings showed that students who completed the corequisite math support were 15% more likely to pass the gateway math course within one year of enrollment and 8% more likely to pass a subsequent college-level math course compared to the students enrolled in the prerequisite model. It was concluded that corequisite models are a scalable approach even though no significant effects were found on enrollment persistence, transfer to baccalaureate institutions, or degree completion up to three years following initial enrollment.

The researchers noted that the corequisite model dimensions varied by college and that one-third of the models included an online component. However, the effects of specific models were not considered in this study. Another consideration was that during the same period, Tennessee implemented the Seamless Alignment and Integrated Learning Support (SAILS) program that allowed math remediation to be completed in high school. The researchers disclosed that due to this pathways initiative in conjunction with the corequisite initiative,

the number of students in the Algebra-calculus track decreased from 50% in 2016 to only 20% on 2019.

Royer, D. W., & Baker, R. D. (2018). Student success in developmental math education: Connecting the content at Ivy Tech Community College. *New Directions for Community Colleges*, 2018(182), 31–38.

Ivy Tech Community College created three mathematics pathways including technical math, quantitative reasoning, and STEM to address low completion rates in gateway mathematics courses. The quantitative reasoning pathway included a corequisite remediation component. This work examined the completion rates over a five-semester period from spring 2014 to spring 2016. Of the 9,029 students that enrolled in the course, approximately 59% completed the course through the corequisite model. Prior to the redesign, the completion rate for students was 29%. However, this data point included all students enrolled in remedial math courses. It was not disaggregated by academic pathway. This study had limited data and the model dimensions were not discussed.

Rutschow, E. Z. (2018). *Making it through: Interim findings on developmental students' progress to college math with the Dana Center Mathematics Pathways (CAPR Research Brief)*. MDRC. <https://www.mdrc.org/sites/default/files/DCMP-InterimFindings.pdf>

To determine the impact of the Dana Center Mathematics Pathways (DCMP) initiative, the Center for Analysis of Postsecondary Readiness and the Dana

Center conducted a randomized controlled trial at four colleges in Texas (Rutschow, 2018). Those colleges were Brookhaven College, Eastfield College, El Paso Community College, and Trinity Valley Community College. Eligible and interested students were randomly assigned to the program group, which participated in the quantitative and statistics pathways, or the standard group, which participated in the traditional developmental to college-level course sequence. Of the 594 students that enrolled in the first two cohorts in fall 2015 and spring 2016, the developmental math course pass rates in the first semester for students in the pathways program group were almost 11 percentage points higher than for students in the standard group. However, the percentage rate declined to eight percentage points after two semesters. In comparing college-level math class pass rates, 24.9% of students in the program group passed compared to 17% of students in the standard group. It was noted that these results did not indicate that DCMP courses impacted persistence as only 50% of participants were still enrolled in college after three semesters.

Sapp, S. B. (2018). *Corequisite remediation in higher education mathematics: A community college perspective and experience (Doctoral dissertation)*. <https://search.proquest.com/docview/2171851966>

A causal-comparative quantitative study was conducted to determine student factors associated with performance and retention in corequisite College Algebra compared to non-corequisite College Algebra at a public 2-year college in the Midwest. Ex post facto data including gender, age, high school GPA, ACT composite score, ACT math subscore, attendance, pathway to placement, and course performance was analyzed for 532

students over a period of five semesters between fall 2015 and spring 2017. The participants in the study, 270 students were in the corequisite sections and 261 students were enrolled in non-corequisite sections. The 26 corequisite sections were taught by nine instructors. There was a common textbook, content, and grading scale across all sections. However, there were nine different grade weighting structures, instructor-created assessments, and varying supports such as tutoring across locations. Each corequisite section enrolled 12 students. Students passed the corequisite component if they met six of eight competencies.

Based on a correlational analysis, attendance in College Algebra and ACT composite score were predictors of success for both the corequisite and the non-corequisite students. There was no significant difference in student performance or student retention between the corequisite and the non-corequisite students. There were five pathways to placement in corequisite College Algebra including prior developmental math course completion, prior developmental math course failure, ACT math subscore, and Accuplacer or Compass placement exam scores. It was concluded that course performance was similar regardless of pathway.

Smith, A. D. (2019). Relationship between required corequisite learning and success in college algebra. *Georgia Journal of College Student Affairs*, 35(1), 23-44.

A study was conducted at a public institution in the University System of Georgia to determine if a relationship existed between required corequisite supports and success in gateway College Algebra. The researcher compared 158 first-time, full-time degree seeking College Algebra students from fall 2017 with 55

similar students in fall 2018 that had a corequisite support course along with a College Algebra course. Neither group included students with prior math credit, a high school GPA greater than 3.4, an ACT Math score greater than 19, or an Accuplacer elementary algebra score greater than 78. In comparing the two groups, the 2017 group had a higher percentage of females and white students, as well as higher average high school GPA and ACT composite scores. The 2018 group had a higher percentage of males, black, and Hispanic students. A chi-square test for independence determined a statistically significant relationship between corequisite support and course success in gateway College Algebra. Of students in the corequisite course, 72.7% passed College Algebra with an A, B, or C. This was compared to 56.3% in the College Algebra course without corequisite support.

Strother, S., & Klipple, K. (2019). *Corequisite remediation in mathematics: A review of first-year implementation and outcomes of Quantway and Statway.* WestEd.

This work offers the results from the first year of the Carnegie Math Pathways Quantway with Corequisite, and the Statway with Corequisite implementations. Results and feedback were collected from six institutions that included 15 faculty, 21 sections, and 410 students. Overall, 65.1% of the students earned a C or better in the corequisite courses. The mean pass rate for the Quantway College with corequisite course was 79% and the mean pass rate for the Statway College with corequisite course was 54%. Primary course components such as contact hours, credit hours, and placement criteria varied by institution. However, all institutions used a cohort model where the same faculty member taught both components of the course to the same group

of students. Feedback from faculty and students was collected. The ability to complete the college course more quickly, the contextualized instructional approach, and faculty preparation, support, and collaboration were noted as strengths of the model. Faculty expressed that time allotted for teaching content and course pacing were challenges with the model.

Vandal, B. (2014). *Promoting gateway course success: Scaling corequisite academic support.* *Complete College America.*
<https://eric.ed.gov/?id=ED558791>

In an attempt to persuade policymakers that corequisite remediation is superior to prerequisite remediation, the author defined corequisite remediation, described several different models, and proposed a policy that defines corequisite support. Corequisite remediation was defined as “delivery of academic support to underprepared students while they are learning gateway course content in the same subject” (p. 3). One semester corequisite models provide academic support for the gateway course. Extra time, mandatory tutoring, and compressed courses are examples. Front Range Community College, Miami Dade College, ALP, the University of Maryland, and the Austin Peay Structured Assistance Program were mentioned for having one-semester corequisite options. A second model is a one-year corequisite that assists students in completing the gateway course over two semesters. It was asserted that this model is different from the traditional prerequisite model because the content of the remedial course is more aligned to the gateway course and includes embedded supports. The Tennessee Colleges of Applied Technology offer competency-based basic skills labs in place of remedial courses. The author provided pass rates from various studies in support of corequisite

remediation. Five tenets for a policy that defines corequisite support were suggested. These include multiple models, an emphasis on college level course completion within one year, statewide implementation strategies, and performance metrics data collection.

Vandal, B. (2015). Core principles for transforming remediation. Complete College America. <https://ccrcenter.org/sites/default/files/August-15-Bruce-Vandal.pdf>

In this presentation, seven principles were offered for transforming policy and practice regarding remediation. The principles included completing gateway math and English courses within one year, aligning gateway course content with the program of study, increasing placement in gateway courses, integrating academic support at the gateway course level with an emphasis on corequisites over prerequisites, creating accelerated pathways for significantly underprepared students, using multiple measures for course placement, and implementing a practice of declaring meta-majors at the outset of college so students begin their program of study immediately. The author mentioned several institutions and initiatives that exhibit these principles including Austin Peay Structured Assistance, ALP, Carnegie Statway/Quantway, Dana Center New Mathways, Tennessee Technical College, the California Acceleration Project, and Colorado's Soft Landing.

Wilson, Y. S. (2018). *Impact of math study skills co-requisite courses on student success in pre-calculus at an urban community college* (Doctoral dissertation, North Carolina State University). ProQuest Dissertations & Theses Global.

This study compared the math course success rates and credential completion between students in a college-level Pre-Calculus class with no academic supports and students in a college-level Pre-Calculus course with a corequisite study skills course. Demographics and academic characteristics from 2013-16 including grade point average, credits earned, credentials earned, rate of transfer, and retention were analyzed for 946 students at a large, urban, multi-campus community college in North Carolina. The 222 students in the corequisite study skills course had a high school GPA between 2.6 and 2.99. The one-credit study skills course met for two contact hours per week. The college-level course content was reviewed through mini-lectures and cooperative group activities. The logistic regression following propensity score matching indicated the students in the study skills course were more likely to be white, male, and first time in college. A chi-square test was used to analyze six college-level outcomes, including credits attempted, credits completed, math credits attempted, math credits completed, and math grades of A-C. There was no significant difference between the two groups in college-level course success or retention.

Discussion and Conclusion

These annotations and references are provided in order to assist researchers and practitioners in the study and delivery of corequisite mathematics. The research cited here offers perspective on the successes and shortcomings of the corequisite mathematics instructional intervention. The work points out where those interested may find corequisite programs and course descriptions. It may also help in identifying assessment measures and benchmarks that are being employed in the field, all of which may aid in studying and delivering co-requisite developmental education.

Reviewing this literature may help interested parties develop a critical lens for efficacy research and best practices in corequisite mathematics. It will also reveal limitations of the research and show gaps in assessment and research practices. More broadly, key players in the discipline of developmental education are identified in this work, as well as some of the best practices, positions, and constituents they represent.

A conclusion that should be noted is that it seems corequisite mathematics instruction has been advocated as the solution to the problem of underperformance in remedial courses (Complete College America, 2021) without having any particular characteristics of a proven effective corequisite mathematics instructional model specified. As noted, the corequisite reform movement was likely advocated due to the success of ALP (ALP, 2022). However, ALP was designed for, and proven effective only for a particular subgroup of underprepared students in the subject of English. Whereas ALP serves as the predominant model for the English community, there does not appear to be a comparable distinguished model for the mathematics community.

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