A Matched-Samples Comparison of Pass Rates for Students Coenrolled in Developmental Education and College-Level Math Compared to Similar Non-Coenrolled Students

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We used a matched samples design to compare outcomes of students enrolled in a traditional model of developmental mathematics education with a similar group of students coenrolled in developmental and college-level math courses. Drawn from students enrolled in a pilot program at nine community colleges in a Southeastern state, we compared 208 students in the coenrolled group with 208 exact matched students in the developmental math-only group. We found that students who are coenrolled in developmental and college-level math were three times as likely to pass the developmental education course as compared to similar students who took development math alone.
Keywords: *developmental math, coenroll, community college*

In the United States, almost two-thirds of community college students are not academically prepared for college-level coursework (Bailey, 2009; Bailey & Cho, 2010; Bailey & Jaggars, 2016; Bailey, Jenkins, & Jaggars, 2015; Jaggars & Hodara, 2011). Colleges have addressed math deficiencies with math developmental education programs to prepare students for college-level math coursework (Bailey, Jeong, & Cho, 2010; Bettinger & Long, 2005). However, fewer than half of the students who begin developmental education complete it, and even fewer go on to graduate (Bahr, 2010; Bailey et al., 2015).

Background

Developmental education is one of the greatest challenges confronting community colleges. One issue arises from how students are placed into developmental education. In the past, students were often assessed with the use of a one-shot placement exam that was not very accurate (Scott-Clayton, Crosta, & Belfield, 2014; Scott-Clayton & Rodriguez, 2012). After taking developmental education courses, students often find that the college-level curriculum is not aligned well with the developmental education curriculum, making the transition difficult (Bailey, 2009). This all assumes that students can successfully navigate the complex structure of courses you have to take before taking "real" college-level courses. The bundle of issues often results in students not succeeding in developmental education and then dropping out of college (Bailey & Jaggars, 2016; Jaggars & Hodara, 2011). To address this, some colleges have initiated new models of support that provide intense academic support with college-level courses (Bailey & Jaggars, 2016).

Underprepared students. Many underprepared students do not recognize that they are underprepared (Bol, Campbell, Perez, & Yen, 2016). There are three types of underprepared students: culturally underprepared, emotionally underprepared, and academically underprepared (Bettinger & Long, 2009). This study focuses on the academically underprepared students. Academic preparation is often assessed using a placement exam score which determines the entry point and amount of developmental education needed. However, this placement exam often does a poor job of determining the amount and type of developmental education needed. Thus, underprepared students are often referred to a sequence of three or more developmental courses that may cover content that the student does not need (Bailey & Jaggars, 2016; Bailey et al., 2010). The extra coursework is a form of barrier to access to college courses both in terms of time and money. In fact, only 11% of students enrolled in three or more developmental math courses typically complete a college-level math course (Bailey & Jaggars, 2016; Bailey, Jenkins, & Jaggars, 2015).

Accelerated curriculum structures. In recent years, there have been dozens of studies and dissertations written on developmental education and the various efforts to expand, revise, reform, or terminate it. These studies have examined developmental education from the perspective of the students who require developmental courses, the instructors who teach developmental courses and college gateway courses, and the high school teachers and leaders who were responsible for preparing students

for college-level work. Examples of some of the recent studies in these areas include:

- VanOra (2019) conducted a longitudinal study which explored community college students' perceptions on the value of development education. Utilizing semi-structured interviews, students described their perceptions of the advantages of beginning college by taking developmental courses.
- Schrynemakers, Lane, Beckford, and Kim (2019) discussed initiatives for increasing college completion rates by reducing the barriers to completion associated with developmental courses. The authors found student college readiness has declined and that faculty perceptions of the changes in remedial education have been to the detriment of students and the academy in general.
- Whiton, Rethinam, and Preuss (2018) and Williams, Tompkins, and Rogers (2018) examined issues related to high school education. Whiton, Rethinam, and Preuss explored curricular and other factors affecting the need for developmental education in college, while Williams, Tompkins, and Rogers gathered data from high school teachers on how the number of students requiring developmental work might be reduced.

Two recent studies have examined accelerated developmental education. Wikstrom (2018) conducted a comparative analysis among three subgroups: on-level students, accelerated developmental students, and students in traditional developmental courses. The purpose of his study was to better understand the effectiveness of the accelerated program. The corequisite method was designed to reduce the time community college students spend in developmental sequencing and to accelerate students who are placed into preparatory classes. Wikstrom (2018) examined completion rates and GPA for gateway and subsequent English and math courses for each subgroup. Confidence intervals and hypothesis tests were analyzed to determine if significant differences existed among the three subgroups. Results from his analysis indicated accelerated developmental students succeeded at the same rate as students in traditional developmental programs in both gateway and subsequent math courses.

Campbell and Cintron (2018) found students who attempted accelerated developmental programs successfully completed college-level math at a rate not statistically different than students who chose the traditional developmental program. For students in the Campbell and Cintron study, the corequisite approach is as successful as the previous developmental

model of requiring students to satisfy developmental requirements prior to enrolling in college-level math courses.

In California, many colleges provided corequisite courses, defined as the pairing of a transfer-level course with a support course, for students who required additional support in college-level courses. By examining early implementers of these reforms, Rodriguez, Mejia, and Johnson (2018) conducted a comprehensive examination of multiple measures placement and corequisite developmental education. Their study explored what colleges could find for both outcomes and implementation challenges. Rodriguez, Mejia, and Johnson (2018) found that English, more than math, was used in the early implementation of these reforms. Nevertheless, early implementer college reforms seem to be leading to gains in student access to transfer-level courses and declines in enrollment in developmental education. The researchers suggested increases in completion of transfer-level courses have occurred for every demographic group, but equity gaps remain.

Tennessee offers a uniquely valuable look at acceleration because it provides a chance to compare two different alternatives to traditional developmental education policies. Findings of research by Kane, Boatman, and Kozakowski (2020) and Kane, Boatman, Kozakowski, Bennett, Hitch, and Weisenfeld (2019) suggested both high school-based remediation and a corequisite model of developmental education have advantages over traditional prerequisite programs. Both approaches allow students an accelerated start which leads to completion of more college-level credits during the first and second year. Further, there are data which indicate community college corequisite developmental education may be more successful than remediation based in high school in helping students pass college-level math classes because of the elimination of the lag-time between the intervention and the attempt to complete college-level courses.

The majority of students who need developmental education courses drop out of college before completing their developmental education course sequence due to a failed course (Bailey & Jaggars, 2016; Bailey et al., 2015; Scott-Clayton & Rodriguez, 2012). To combat high attrition rates, colleges are experimenting with accelerated curriculum structures (Bailey et al., 2015). Acceleration of developmental education coursework reduces exit points and matches learning outcomes with college-level courses (Bailey & Jaggars, 2016; Bailey et al., 2015). One acceleration method is to use shorter modules that cover content students are missing. Another method is to coenroll academically underprepared students in both traditional developmental coursework and college-level courses

along with intense academic support (Bailey & Jaggars, 2016; Bailey et al., 2015; Jaggars, Hodara, Cho, & Xu, 2015; Wikstrom, 2018). Although community colleges using the coenroll model have reported increases in overall fall-to-fall retention rates of students (Bailey et al., 2015; Jaggars et al., 2015), these results are correlational and do not control for changes in the types of students enrolled each fall.

In this study we focus on developmental education, not remedial programming. There has been consistent and sometimes significant misunderstanding of the difference between remediation and developmental education (Boylan, Calderwood, & Bonham, 2017). Developmental education is the integration of courses and support services guided by the principles of adult learning (Boylan, 1990). Remediation, however, refers to stand-alone courses addressing precollege-level content. Although a number of researchers and policymakers have, mistakenly, used these terms interchangeably, we recognize the distinction between the terms, and our study is focused on developmental education.

Purpose

The traditional developmental education system is failing students (Bailey & Jaggars, 2016; Bailey et al., 2015; Jaggars & Hodara, 2011). Some students who are referred to developmental education coursework do not need it (Bailey & Jaggars, 2016; Belfield & Crosta, 2012). For those students who need developmental coursework, coenrolled developmental education with college-level coursework and integrated intense academic support may prove more successful than just developmental education (Bailey & Jaggars, 2016). According to Bailey and Jaggars (2016), "the spread of the coenrolled model is perhaps the most significant development in the remediation reform movement in the past two years" (p. 8). The purpose of this study is a rigorous examination of coenrollment of students in math developmental education and college-level math. Using a matched samples design, we examine the outcomes of two groups of similar students who either took traditional developmental education or participated in a coenroll pilot project. One group of students coenrolled in a pilot program where they took developmental and college-level math at the same time. The second group of matched students enrolled in a traditional model of developmental mathematics. Comparing students who are similar in terms of socioeconomic status (SES), first-generation and minority status, age, sex, location of college, and number of credit hours taken helps us mimic a randomized control trial. Although only a pilot program, this study isolates the effectiveness of coenrolling students

in developmental and college-level math courses as compared to the traditional developmental education design.

Methodology

We tackle the issue of whether coenrollment of developmental education with college-level math is a viable intervention that could shorten the developmental cycle, thus helping to retain students who might drift away from the community college system. We do so using a matched samples design that mimics random assignment. Although we cannot randomly assign students to coenroll or not, we can pair students from the coenrollment group with similar students in the developmental education only group on important characteristics that are known to influence pass rates (Fraenkel, Wallen & Hyun, 1993). Although randomized control experiments are considered the gold standard in causal research, matched samples attempt to replicate the ideal of randomized experiments (Stuart & Rubin, 2008) and are frequently used in medical and social science research to evaluate causal inference in observational data (Ho, Imai, King, & Stuart, 2007; King & Nielsen, 2016; Morgan & Harding, 2005). We address the following research question:

> To what extent do students enrolled in traditional developmental math differ from similar students coenrolled in developmental math and college-level math on the completion of developmental math courses?

The null hypothesis is that there will be no difference in the completion of developmental education courses in math between the two groups: those in traditional developmental education courses and students who are coenrolled in developmental and college-level math courses.

Sample, Measures, and Analysis. Nine community colleges in a Southeastern state participated in a pilot project where certain degree- and/or certificate-seeking students whose placement exams required that they take developmental math could voluntarily coenroll in developmental and college-level math courses. The nine colleges served urban, suburban, and rural populations. All the colleges volunteered to participate in the pilot project. When categorized by 2017 student population, two colleges were small (<2,000), five colleges were medium (2,000–15,000), and one college was large (>15,000). Over the course of one academic year, 208 students took advantage of the pilot coenroll option. Approximately 7,000 students from the nine community colleges took developmental math alone.

Data were obtained through an extensive data protocol process approved by and delivered by system-level office staff. All student-identifying information was removed prior to data being sent by the system-level office staff. We used seven criteria to match developmental and corenrolled students: Pell Grant received (yes/no), first-generation status (yes/no), race (white/non-white), age (≤ 25, > 25), gender (male, female), type of college (rural/urban) and number of credit hours (See Table 1 for pre-match descriptives). We used an exact matching method wherein each person on the coenroll group was matched with an identical non-coenroll counterpart on all the seven covariates which minimizes variance (King & Neilsen, 2016). The system's institutional research office provided de-identified data for the academic year 2016–2017 concerning student pass rates. We defined a passing grade as A, B, C, or D (1), whereas did not pass was a grade of F or W (0). Due to the binary nature of the dependent variable, we use binary logistic regression to determine the odds of passing the course.

The final sample contains 208 coenrolled students and 208 similar non-coenrolled students. Fifty-five percent of the sample were aged 25 or younger, 49% received Pell Grants, 52% were non-white, 80% attended an urban college, 58% were female, and 65% were first-generation college students. More importantly, only 61% of the sample as a whole passed a developmental math course.

Table 1. *Descriptive Statistics of Matching Criteria Prior to Match*

	Dev-Ed Only			Coenrolled		
	N	%	*M (sd)*	*N*	%	*M (sd)*
Received Pell	3547	52.12%		102	49.04%	
First Generation	4972	67.12%		135	64.90%	
Minority	3553	47.96%		107	51.44%	
Age ≤ 25 yrs	4652	62.80%		116	55.77%	
Female	3887	52.47%		121	58.17%	
Urban	5873	79.28%		167	80.29%	
Num Credits	7408		42.09 (26.10)	208		37.62 (24.41)

Results

Using binary logistic regression to assess differences between the matched coenrolled group and non-coenrolled group, we find that students in the coenrolled group were significantly more likely to pass the math develop-

mental education course than the matched developmental-only students (see Table 2). And the difference was quite large (exp(B) = 3.601, $p < .001$). Students who coenrolled in developmental math and college-level math were over three times as likely to pass the developmental education course as compared to students who took the developmental math course alone.

Table 2. *Logistic Regression Predicting Likelihood of Developmental Math Course Completion*

B	SE	Wald	*df*	*p*	Odds Ratio	
Coenroll	1.281	.216	35.212	1	.000	3.601
Constant	-.113	.139	.692	1	.406	.891

N = 416

To determine what covariates were contributing to the model in a significant fashion, we restricted the sample to the matched groups and ran another logistic regression with covariates in the model (see Table 3). Other than being coenrolled (exp(B) = 3.657, $p < .001$), age was the only other significant covariate (exp(B) = .603, $p = .028$). The odds of passing a developmental education course for students older than 25 years old was higher than students who were 25 years old or younger (1 = equal odds).

We posited that the null hypothesis was that there was no difference in passing rates for a developmental education course between similar students who took a developmental education course alone as compared to students who coenrolled in developmental education and college-level math. Our null hypothesis was not supported. We found that students who coenrolled in developmental education and college-level math courses were 3.6 times more likely to pass the developmental education course as those students just enrolled in developmental math.

Table 3. *Logistic Regression Predicting Likelihood of Developmental Math Course Completion with Covariates*

B	SE	Wald	*df*	*p*	Odds	Ratio	
Coenroll	1.297 .218	35.289	1	.000	3.657		
Received Pell		-.044	.231	.037…	1	.847	.957
Urban	.149	.299	.248	1	.619	1.160	
Minority	.236	.232	1.040	1	.308	1.267	
First Gen	.180	.233	.599	1	.439	1.197	
Age ≤ 25	-.506	.230	4.828	1	.028	.603	
Female	.050	.226	.049	1	.825	1.051	
Num Credits	.019	.027	.465	1	.495	1.019	
Constant	-.206	.336	.375	1	.540	.814	

N = 416

Discussion

Nearly two-thirds of community college students are not academically prepared for college-level coursework (Bailey, 2009; Bailey & Cho, 2010; Bailey & Jaggars, 2016; Bailey, Jenkins, & Jaggars, 2015; Jaggars & Hodara, 2011). The ramifications of needing to complete developmental education courses are often a barrier to student success, as students face the financial and psychological obstacles of taking courses for which they do not receive college credit. Coenrolled developmental and college-level math courses may provide a solution for students to be more successful in math than students who take developmental education math alone. In some sense, coenrollment places students closer to the college experience by being enrolled in actual college courses. It may lessen the financial or psychological burdens of students being required to wait to "enter" college. Regardless of what intangible benefits coenrollment may confer, in this study we found strong evidence that students who took coenrolled college and developmental math courses were much more likely—more than three times as likely—to pass the developmental math course than similar students who took developmental math alone. Other community colleges may use the findings to introduce the idea of the coenrolled model of math developmental education to their college.

Limitations. Please note that although we used a rigorous analytic method—matched samples—the sample was limited to students from nine colleges in one Southeastern state and did not include nondegree-seeking

students. We also were limited in matching criteria and would have liked to have matched students on an additional characteristic of prior achievement. Matching on prior achievement may have better delineated those students with more advanced math skills that felt prepared to take on college math. However, by using the established methods of determining who needed developmental math, every student in this study was deemed as needing math remediation. This was a pilot study; thus, our sample size is relatively small. Since both groups in our study had more than 200 students, we are confident in the robustness of our analyses and our ability to detect statistically significant differences.

Implications for Practice

This study offers support for expanding coenrolled developmental and college-level math courses on community college campuses. Whereas many students fail developmental math courses and drop out of degree programs due to the sequence and cost of developmental courses that precede college-course taking, the coenrolled intervention offers one mechanism that may decrease the separation rate and speed time to graduation.

As community colleges move away from placement exams, other forms of developmental education such as taking targeted math modules become less feasible. The use of multiple measures is growing nationwide. However, using multiple measures as admission and placement criteria make it harder to pinpoint exact mathematic deficiencies. Coenrollment offers an alternative to the provision of developmental support without the need for a placement exam.

Coenrollment may not be the answer for everyone. It may be that students who are the most underprepared would feel overwhelmed in both developmental education and college-level coursework. We examined math courses. In a study about English courses, we could find the results are similar, but it is equally as likely the content and sequencing of English courses make coenrollment less feasible. Finally, it may be likely that students will spend less on tuition using the coenrollment model. The loss of revenue from reduced development education courses may be hard for some systems to accept.

Conclusion

We used a rigorous research design to add to the scant body of quantitative research on the success or lack of success of the coenrolled math course model. Bailey and Jaggars (2016) support the coenrolled model

and call it "perhaps the most significant development in the remediation reform movement in the past two years" (p. 8). Additionally, Cohen, Brawer, and Kisker (2013) add that intense math support coupled with college-level math is a much better approach than separating the support from the college-level math. Our study provided strong empirical backing for these claims. We presented rigorous empirical evidence that supports researchers' claims that joining developmental math education with college-level math is more effective than keeping them separate.

References

Bahr, P. R. (2010). Revisiting the efficacy of postsecondary remediation: The moderating effects of depth/breadth of deficiency. *The Review of Higher Education, 33*(2), 177–205. doi:10.1353/rhe.0.0128

Bailey, T. (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. *New Directions for Community Colleges* (145), 11–30. doi:10.1002/cc.352

Bailey, T., & Cho, S. W. (2010). Developmental education in community colleges. *Community College Research Center*, 1–8. Retrieved from https://www2.ed.gov/PDFDocs/college-completion/07-developmental-education-in-community-colleges.pdf

Bailey, T., & Jaggars, S. S. (2016). When college students start behind. *The Century Foundation,* 1–15. Retrieved from https://tcf.org/content/report/college-students-start-behind/

Bailey, T. R., Jenkins, D., & Jaggars, S. S. (2015). *Redesigning America's community colleges.* Cambridge, MA: Harvard University Press.

Bailey, T., Jeong, D. W., & Cho, S. W. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review, 29*(2), 255–270. Retrieved from https://ccrc.tc.columbia.edu/publications/referral-enrollment-completion-developmental-education.html

Belfield, C., & Crosta, P. M. (2012). Predicting success in college: The importance of placement tests and high school manuscripts. *Community College Research Center,* (42), 1–41. Retrieved from http://ccrc.tc.columbia.edu/media/k2/attachments/predicting-success-placement-tests-transcripts.pdf

Bettinger, E. P., & Long, B. T. (2005). Remediation at the community college: Student participation and outcomes. *New Directions for Community Colleges,* (129), 17–26. doi: 10.1002/cc.182

Bol, L., Campbell, K. D. Y., Perez, T., & Yen, C. J. (2016). The effects of self-regulated learning training on community college students' metacognition and achievement in developmental math courses. *Community College Journal of Research and Practice, 40*(6), 480–495. doi: 10.1080/10668926.2015.1068718

Boylan, H. (1990, July). *Developmental education 101.* Paper presented at the Kellogg Institute for the Training and Certification of Developmental Educators, Boone, NC.

Boylan, H. R., Calderwood, B. J., & Bonham, B. S. (2017). *College completion: Focus on the finish line.* Report of the National Center for Developmental Education, Appalachian State University, Boone, NC.

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

Cohen, A. M., Brawer, F. B., & Kisker, C. B. (2013). *The American community college*. San Francisco, CA: Jossey-Bass.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (1993). *How to design and evaluate research in education* (7th edition). New York, NY: McGraw-Hill.

Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2007). Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis, 15*, 199–236.

Jaggars, S. S., & Hodara, M. (2011). The opposing forces that shape developmental education: Assessment, placement, and progression at CUNY community colleges. *Community College Journal of Research and Practice, 37*(7), 575–579. Retrieved from http://ccrc.tc.columbia.edu/media/k2/attachments/opposing-forces-shape-developmental.pdf

Jaggars, S. S., Hodara, M., Cho, S. W., & Xu, D. (2015). Three accelerated developmental education programs: Features, student outcomes, and implications. *Community College Review, 43*(1), 3–26. doi:10.1177/0091552114551752

Kane, T. J., Boatman, A., Kozakowski, W., Bennett, C., Hitch, R., & Weisenfeld, D. (2019). *College remediation goes back to high school: Evidence from a statewide program in Tennessee* (NBER Working Papers 26133). Cambridge, MA: National Bureau of Economic Research, Inc.

Kane, T. J., Boatman, A., & Kozakowski, W. (2020). Is college remediation a barrier or a boost? Evidence from Tennessee. *Education Next, 20*(2), 64–70.

King, G., & Nielsen, R. (2016). Why propensity scores should not be used for matching. *Harvard Institute for Quantitative Science, Paper 481.* Retrieved from https://gking.harvard.edu/files/gking/files/psnot.pdf

Morgan, S. L., & Harding, D. J. (2005). Matching estimators of causal effects: From stratification and weighting to practical data analysis routines. *Unpublished manuscript, Department of Sociology, Cornell University.* Retrieved from https://www.researchgate.net/profile/David_Harding6/publication/228655677_Matching_estimators_of_causal_effects_From_stratification_and_weighting_to_practical_data_analysis_routines/links/55d369d708ae0a341722676a.pdf

Rodriguez, O., Mejia, C. M., & Johnson, H. (2018). *Remedial education reforms at California's community colleges: Early evidence on placement and curricular reforms.* Public Policy Institute of California. https://www.ppic.org/wp-content/uploads/remedial-education-reforms-at-californias-community-colleges-august-2018.pdf

Schrynemakers, I., Lane, C., Beckford, I., & Kim, M. (2019). College readiness in post-remedial academia: Faculty observations from three urban community colleges. *Community College Enterprise*, *25*(1), 10–31.

Scott-Clayton, J., Crosta, P. M., & Belfield, C. R. (2014). Improving the targeting of treatment: Evidence from college remediation. *Educational Evaluation and Policy Analysis, 36*(3), 371–393. doi:10.3102/0162373713517935

Scott-Clayton, J., & Rodriguez, O. (2012). *Development, discouragement, or diversion? New evidence on the effects of college remediation* [White paper]. National Bureau of Economic Research. http://www.nber.org/papers/w18328

Stuart, E. A., & Rubin, D. B. (2008). Best practices in quasi-experimental designs. In J. W. Osborne (Ed.), *Best practices in quantitative methods* (pp. 155–176). Thousand Oaks, CA: Sage.

VanOra, J. (2019). It's like one step for me to go forward: A longitudinal study of community college students' perceptions on the value of developmental education. *Community College Enterprise, 25*(1), 59–76.

Whiton, J. C., Rethinam, V., & Preuss, M. D. (2018). High school factors predicting enrollment in developmental courses. *Journal of Developmental Education*, *42*(1), 8–32.

Wikstrom, C. S. (2018). *Access with progress: A comparative analysis on the co-requisite model of developmental acceleration* (Doctoral dissertation, Old Dominion University, Virginia). Retrieved from https://digitalcommons.odu.edu/efl_etds/55/

Williams, M. R., Tompkins, P., & Rogers, B. (2018). High school teachers' perceptions of developmental education. *Journal of Developmental Education, 41*(2), 2–10.

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