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Does the Method of Acceleration Matter? Exploring the Likelihood of College Coursetaking Success Across Four Developmental Education Instructional Strategies

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Abstract

Background/Context: Accelerated instructional strategies for developmental education have been promoted as a way to help underprepared students to progress more quickly through college-level coursework. Yet, what remains unknown is whether certain accelerated strategies are more effective than others and whether this initial acceleration may lead to longer term success.

Purpose/Objective/Research Question/Focus of Study: We examine whether the likelihood of success varies for completion of mathematics and English requirements over 3 years among the Florida students enrolled in courses using one of four developmental instructional strategies: compressed, corequisite, modularized, or contextualized.

Population/Participants/Subjects: Our sample includes all first-time-in-college students during the 2015–2016 year who enrolled in all 28 public state colleges and took any developmental education course during the first year.

Research Design: We use inverse probability-weighted regression adjustment (IPWRA) to compare success rates in completion of mathematics and English requirements over 3 years for Florida college students in each of these strategies.

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Findings/Results: Overall, the results demonstrate variation in the likelihood of success for completion of mathematics and English courses over 3 years among students in different developmental instructional strategies, which suggests that the method of acceleration does matter. Corequisite courses tended to lead to greater long-term gains in math and, to an extent, in reading, while contextualized tended to be most effective in writing.

Conclusions/Recommendations: Leaders can play an important role in strengthening institutional capacity to effectively implement developmental education reform by developing faculty buy-in, ensuring adequate resources to scale and sustain reform efforts, and using data to inform future decision-making.

Keywords

Community colleges, developmental education, state policy, instruction, college coursetaking

Community colleges face considerable challenges in helping academically underprepared students become ready for college-level work. Colleges have traditionally responded by assigning students who test below a certain score on a college placement exam to one or more semester-long developmental courses that review basic skills in reading, writing, and/or mathematics. Nationwide, approximately 60% of incoming students at community colleges enrolled in at least one developmental education course, and rates were even higher for Black (78%) and Hispanic (75%) students, as well as for students from the lowest income group (76%) (Chen et al., 2020). Yet, a number of rigorous studies have demonstrated that traditional developmental education courses tend to be ineffective at improving student success (Valentine et al., 2017). Students from historically disadvantaged backgrounds disproportionately bear the burden of the additional time and financial costs associated with enrollment in these ineffective courses, which has important implications for equity (Mokher et al., 2021b).

In response to these concerns, many colleges, postsecondary systems, and states have implemented reforms to modify the instructional strategies used in developmental education courses, with the intent of helping students progress to college-level coursework more quickly. While a mounting body of evidence suggests that changing the way developmental education is taught increases student success (e.g., Jaggars & Bickerstaff, 2018; Jaggars et al., 2015; Kalamkarian et al., 2015; Ran & Lin, 2019; Weisburst et al., 2017), less is known about whether specific types of instructional strategies may be more or less effective. In addition, critics have expressed concerns that initial gains in acceleration may not translate into longer term success if students have insufficient time to master the competencies needed to succeed in college-level courses (Edgecombe, 2011).

In 2014, Florida implemented a comprehensive developmental education reform among all 28 Florida College System (FCS) institutions (the community college

system), of which new instructional strategies were an important component. Students who entered a Florida public high school by 2003–2004 and graduated with a standard high school diploma, as well as active-duty military personnel, became exempt from both placement testing and developmental education and could opt to enroll directly in college-level coursework. Yet, exempt students still had the option to take developmental courses if they thought they needed additional support, and students who did not meet the exemption criteria (e.g., out-of-state students and older returning adults) still faced developmental education requirements if they scored below the college-ready cut score on the placement test. Colleges were also required to develop plans to provide enhanced advising and academic support services in order to help students make informed decisions about which courses to select, and to provide additional resources such as extra tutoring for those who struggled academically.

To help students progress through the required mathematics and English courses more quickly, all colleges were required to replace traditional semester-long courses with one or more new instructional strategies: (1) compressed courses that meet for longer class periods during a truncated time frame, (2) corequisite courses that provide developmental and college-level courses in the same subject area concurrently, (3) modularized courses that assign students to complete only modules for competencies they have not yet mastered, and (4) contextualized courses that provide content aligned to students' major program of study. Although there is a growing body of evidence that each of these instructional strategies may be more effective than traditional developmental education courses (e.g., Jaggars & Bickerstaff, 2018; Jaggars et al., 2015; Kalamkarian et al., 2015; Ran & Lin, 2019; Weisburst et al., 2017), little is known about whether some of these strategies may be more effective than others. In response, this study addresses the following research question:

> How does the likelihood of success vary in completion of Mathematics and English requirements over three years among Florida students enrolled in different developmental instructional strategies (compressed, corequisite, modularized, and contextualized)?

Prior research has demonstrated that Florida's reform has led to significant improvements in student success in first year coursetaking overall and has reduced gaps in achievement among racial/ethnic groups (Park-Gaghan et al., 2020). This has resulted in gains to cost-effectiveness for both students and institutions, with the greatest cost savings among students from underrepresented racial/ethnic backgrounds (Mokher et al., 2021b). Furthermore, while Florida students narrowly assigned to developmental mathematics tend to have a lower likelihood of taking and passing college-level courses relative to their college-ready peers, these students experienced larger gains after the reform when developmental courses were offered in accelerated formats accompanied by support services (Mokher et al., 2021a). Given the promising evidence of the effectiveness of Florida's developmental education reform, the current study will extend this line of research to explore how the likelihood of successful coursetaking outcomes differs among students enrolled in the four types of instructional strategies used in developmental education courses at FCS institutions. Given

concerns that providing students with faster access to college-level courses could be detrimental in the long term if students lack the time to sufficiently master the material, we tracked students' coursetaking trajectories over 3 years for each of courses needed to fulfill the requirements for an associate's degree in mathematics or English.

In the next section, we provide a review of the literature that explores the mechanisms through which different instructional strategies are intended to improve student outcomes, and prior studies on the effectiveness of each strategy. Then we describe our data, which consist of student-level records from the entire population of first-time-in-college (FTIC) students at FCS institutions who enrolled in a developmental education course in their first year of college. The student-level records include an indicator for the primary instructional strategy used in each of the developmental education courses among the four options available to colleges: compressed, corequisite, modularized, and contextualized. Next, we explain our analytic approach of using inverse probability-weighted regression adjustment (IPWRA) to account for differences in the types of students who may be enrolled in each instructional strategy and compare the likelihood of completing mathematics and English requirements across the four strategies. We conclude by presenting our results—which suggest that the method of acceleration *does* matter—and discussing the implications for future research and policy decisions.

Literature Review

To examine whether certain developmental education instructional strategies tend to have higher success rates than others, it is important to understand the essential elements of each strategy and the underlying mechanisms for improving student success. Compressed courses meet for longer or more frequent class sessions so that courses can be completed over a shorter period, potentially allowing students to complete two compressed courses in a single semester. One mechanism underlying this strategy is acceleration, which means that providing students with faster access to college-level courses can develop academic momentum that sets them on a successful long-term trajectory (Attewell et al., 2012; Attewell & Monaghan, 2016). Reducing the number of semesters needed to complete developmental courses also means fewer exit points where students may stop-out due to issues beyond academic ability, such as loss of financial aid (Edgecombe, 2011). In addition, compressed courses often result in pedagogical changes through greater diversification of classroom activities; class periods tend to be longer, so teachers have greater flexibility to diversify activities (Edgecombe, 2011). Compressed courses have been associated with improvements over traditional developmental courses in both short-term outcomes, such as enrollment and completion rates in gateway courses (Cho et al., 2012; Weisburst et al., 2017), and longer term outcomes, such as credit accumulation and degree attainment (Edgecombe et al., 2014; Hodara & Jaggars, 2014).

Contextualized courses provide instruction related to students' academic pathways to increase their understanding of basic skills while simultaneously developing

knowledge within a particular academic pathway, such as business or education. These courses seek to improve student motivation by making the content less abstract and more engaging through integrating real-life examples (Perin & Holschuh, 2019). Leading professional associations, such as the National Council of Teachers of Mathematics and the National Research Council Community on Behavioral and Social Sciences and Education, have promoted this disciplinary approach of using concrete examples in real-life contexts (Skuratowicz et al., 2020). Contextualized courses also provide students with exposure to the types of tasks and materials that they will encounter in their other college classes. There is some evidence that contextualized courses may improve students' attitudes toward mathematics (Skuratowicz et al., 2020), test scores of reading comprehension ability (Perin et al., 2013), and credit accumulation and degree completion (Zeidenberg et al., 2010) relative to traditional developmental education courses.

In Florida, corequisite courses allow students to enroll in a developmental course and a credit-bearing course simultaneously. These courses have similar mechanisms to compressed courses in terms of accelerating access to college-level courses and reducing the number of potential exit points. Another problem with traditional approaches to developmental education is that students tend to be assigned to developmental courses if they score below college-ready on a placement test, even though the test may be an inaccurate indicator of their true ability. Prior studies have shown that a substantial number of students tend to be underplaced, which means that they are required to take a developmental course even though they likely could have passed a for-credit course (e.g., Leeds & Mokher, 2020; Scott-Clayton et al., 2014). Under the corequisite model, students are less likely to be harmed by underplacement because they can enroll directly in college-level courses (Jaggars et al., 2015; Logue et al., 2019; Ran & Lin, 2019; Royer & Baker, 2018). Corequisite courses may also improve student motivation and reduce stigma because students are placed in a college-level course and provided opportunities to earn college credit (Edgecombe, 2011; Ran & Lin, 2019; Royer & Baker, 2018). In addition, corequisite courses often result in curricular changes that improve alignment and relevance through the pairing of developmental skills with college-level assignments (Miller et al., 2020; Ran & Lin, 2019). A growing number of studies have found that corequisite models have been associated with large gains—10 percentage points or more—in the likelihood of successfully completing gateway courses in mathematics or English in the first year relative to traditional developmental education (Cho et al., 2012; Denley, 2015; Miller et al., 2020; Ran & Lin, 2019). However, several of these studies have found smaller or null effects on longer term outcomes such as credit accumulation and degree completion (Miller et al., 2020; Ran & Lin, 2019).

The modularized strategy breaks down course material into smaller instructional units (i.e., modules) so students can focus on the specific set of skills they have not mastered. Instructors must determine how to organize and sequence the content into discrete modules, collect formative feedback to identify students' individual learning difficulties, prescribe specific modules to correct these learning difficulties, and then

assess whether students have mastered the content before moving on (Kalamkarian et al., 2015). Modularized courses are often taught using computer-mediated instruction with an instructor who provides one-on-one support on an as-needed basis. Instructors may also need to establish structured times to monitor student progress and ensure that students are maintaining an adequate pace in the course (Edgecombe, 2011). Modularized courses may promote acceleration by allowing students to progress into gateway courses more quickly than a full semester-long course. They may also be more efficient by allowing students to focus on competencies where they need additional support. However, this format can increase the number of potential exit points in the developmental sequence, and attrition may be a problem if students fail to enroll in subsequent modules (Kalamkarian et al., 2015). While some studies have found positive effects of modularized courses on the likelihood of passing developmental mathematics (Okimoto & Heck, 2015) and test score gains (Foshee et al., 2016), others have found null effects (Weiss & Headlam, 2019).

Taken together, the results from prior research indicate that reformed instructional strategies in developmental education have the potential to improve postsecondary success for academically underprepared students relative to traditional semester-long developmental courses, particularly during the first year of college. While all four strategies are designed to accelerate the pace at which students progress to college-level courses, there are differences in the specific mechanisms used to improve structure, curriculum, and pedagogy that could result in differential impacts. The current study will extend this body of research by exploring whether some of these instructional strategies tend to increase the likelihood of success as students progress through each of the mathematics or English courses needed to complete an associate's degree.

Data

Our data consist of student-level records for all 28 public institutions in the FCS from Florida's P-20 Educational Data Warehouse. We merged files that included college enrollment records, student demographic characteristics, scores on the college placement test, college transcripts, and high school transcripts. The sample includes the cohort of incoming FTIC students in the 2015–2016 academic year who enrolled in any developmental education course during the first year of college. The 2015 cohort was selected because we have longitudinal data for a full 3 years—from 2015–2016 to 2017–2018—to examine students' coursetaking trajectories over time. We excluded students who were missing scores on the placement test because this is a critical predictor of students' performance in college courses, and we wanted to ensure that students in the various instructional strategies had similar baseline achievement levels. The Florida State Board of Education has established standard scores to demonstrate readiness for college-level coursework. Most students became exempt from the requirement to take the placement test under SB 1720, although many recent high school graduates had prior test scores that were part of a statewide initiative to administer the placement test in Grade 11 as an indicator of college readiness. Students also

Table 1. Number and (Percent) of Enrollments in Each Instructional Strategy Among Students Taking Their First Developmental Education Course, by Subject Area.

Instructional Strategy	Mathematics	Reading	Writing
Compressed	6,921 (51.4%)	3,563 (67.6%)	4,719 (72.3%)
Contextualized	958 (7.1%)	246 (4.7%)	630 (9.7%)
Corequisite	1,207 (9.0%)	327 (6.2%)	45 (0.7%)
Modularized	4,388 (32.6%)	1,137 (21.6%)	1,133 (17.4%)
Total	13,474	5,273	6,527

may have been advised to take the placement test upon college entry to assist with placement decisions, even though the test was voluntary for exempt students. Placement test scores were missing for approximately 5% of students in reading, 10% of students in writing, and 12% of students in mathematics.

The college transcript file includes an indicator of whether the primary instructional strategy for each developmental education course was compressed, corequisite, modularized, or contextualized. If students enrolled in a developmental education course in both the fall and spring semesters, we included the instructional strategy for the course that was taken during the first course in the fall semester. The overall sample sizes are 13,474 students in mathematics, 5,372 in reading, and 6,527 in writing. As shown in Table 1, compressed courses were the most popular instructional strategy, comprising more than half of developmental education enrollments in all three subject areas. Contextualized and corequisite strategies were the least common, with less than 10% of developmental education enrollments in each of these instructional strategies per subject area. Notably, less than 1% of enrollments were in the corequisite format for developmental writing, so this group was omitted from the analyses in writing because the sample size was insufficient for matching.

The English courses required to fulfill an associate's degree consist of developmental courses in reading and/or writing (for nonexempt students scoring below college-ready on the placement test), a first gateway English course (English Composition 1), and a second gateway English course (beyond English Composition 1). For mathematics, there are four courses: developmental mathematics (for nonexempt students scoring below college-ready on the placement test), intermediate algebra (a required course that counts for elective credit but does not fulfill the degree requirements in mathematics), a first gateway mathematics course, and a second gateway mathematics course. Because our sample is restricted to students who enrolled in a developmental education course in the first year, the number of required courses is the same for all students. The dependent variables include a series of dichotomous outcomes for whether the student completed each course requirement in the corresponding subject area by the end of Years 1, 2, and 3 (0 = no, 1 = yes). For each year, records are coded with a value of 1 if the student completed the course in the current

year or in a prior year. If a student dropped out of college before completing a course, they are coded as noncompleters rather than missing. The results are estimated separately for reading, writing, and mathematics.

Independent variables, which serve as matching characteristics and controls in the regression adjustment, include student race/ethnicity, gender, free or reduced-price lunch [FRL] status in high school, developmental education exemption status, age in years, foreign-born status, language minority status, whether the student took any high school courses in English for speakers of other languages (ESOL), high school context (enrollment size, percent minority, percent FRL, school-level English achievement, school-level mathematics achievement, graduation rate, and college and career acceleration rate),[1] and placement test scores in the corresponding subject area. As noted earlier, students with missing placement test scores were omitted from the sample, and no data are missing for any of the other student characteristics. We also captured variables from the high school transcript records, including an indicator for type of high school diploma (standard, GED, or home education), and high school coursetaking track based on the courses that students completed in mathematics or English (basic, standard, or advanced). The high school coursetaking tracks in mathematics are focused on algebra II, which is not required for high school graduation in Florida but has been identified in the literature as an important gatekeeper course for student success among early outcomes in college (e.g., Gaertner et al., 2014; Kim et al., 2015). Students who did not complete algebra II were classified as on a "basic" track; students who completed algebra II but no classes beyond that were classified as on a "standard" track; and students who completed algebra II and at least one more advanced course were classified as on an "advanced" track. In English, the basic track consists of students who ever enrolled in a remedial English course, the standard track consists of students who completed only regular or honors English courses, and the advanced track consists of students who completed at least one English course that could result in college credit (dual enrollment, Advanced Placement, or International Baccalaureate). Approximately one third of students in our sample did not have high school transcript records, so they are missing values on these variables. We used the dummy variable adjustment method by setting the missing value to a constant value of 0 and adding an additional dummy variable in the model for whether the actual value is missing (Cohen & Cohen, 1983).

Methods

Each college had a choice as to which of the four instructional strategies to offer; some colleges provided a single strategy in each subject, and others offered multiple strategies. Site visits at FCS institutions revealed that campus stakeholders had varying levels of familiarity with the different types of instructional strategies before the reform (Mokher et al., 2020). At some institutions, decisions about which strategies to offer were made unilaterally by college leadership, while other institutions collaborated with other stakeholders such as faculty members and advisors. Rationales for the

Table 2. Number and (Percent) of Institutions Offering Each Number of Instructional Strategies, by Subject Area.

Number of instructional strategies offered	Mathematics	Reading	Writing
One strategy	7 (25.0%)	17 (60.71%)	11 (39.3%)
Two strategies	15 (53.6%)	8 (28.6%)	16 (57.1%)
Three strategies	6 (21.4%)	3 (10.7%)	1 (3.6%)
Four strategies	0 (0.0)	0 (0.0)	0 (0.0)
Total	28 (100.0)	28 (100.0)	28 (100.0)

choice of strategies included feasibility of implementation, student preferences, and perceptions of the effectiveness of each strategy among decision makers. Some institutions identified challenges with their initial selection of instructional strategies and made modifications to the types of developmental courses offered in subsequent years. For example, campus leaders reported using data on student enrollments and success in each course type to determine which strategies they should continue to offer. Table 2 includes institution-level information on the number of instructional strategies offered in each subject area during the 2015–2016 academic year, which corresponds to the first year of college enrollment for the students in our sample. In reading, the majority of institutions (60.7%) offered a single strategy, whereas the majority of institutions offered two strategies in mathematics (53.6%) and writing (57.1%). No colleges offered all four strategies in any subject area.

Colleges offering multiple strategies could develop their own plans for deciding how to place students among the different options; in most colleges, the selection was done by academic advisors (Mokher et al., 2020). Some students may have been advised to take a particular strategy (e.g., modularized courses for students scoring close to college-ready who only needed to review a few competencies), whereas other students may have been placed into certain strategies based on scheduling or course availability. To account for differences in the types of students who may have been enrolled in each strategy, we used IPWRA, which allows for multivalued treatments in which each subject could receive one of several different treatments. In our context, the most common instructional strategy, compressed, serves as the "untreated," or comparison, group ($t = 0$), with separate "treatment" groups for corequisite ($t = 1$), modularized ($t = 2$), and contextualized ($t = 3$) strategies.

IPWRA is a doubly robust approach; in the first stage, a multinomial logistic regression model was estimated for the probability of enrollment in each of the instructional strategies relative to the compressed format. We estimated the following model for each individual i:

$$P\left(T_i = t \middle| X\right) = \frac{e^{\beta_{0t} + \beta_t X}}{1 + \sum_{t=1}^{T-1} e^{\beta_{0t} + \beta_t X}},$$

where P is the probability of selecting into individual treatment (t) among (T) available treatments. β_{0t} an intercept, and X is a matrix of covariates, including the student background characteristics (race, gender, FRL status, age), exemption status, placement test scores, type of high school diploma (standard, GED, or home education), foreign-born status, language minority status, whether the student took any high school ESOL courses, high school context (enrollment size, percent minority, percent FRL, school-level English achievement, school-level mathematics achievement, graduation rate, and college and career acceleration rate), and high school academic preparation in the corresponding subject area (basic, standard, or advanced). These propensity scores were used to reweight each observation rather than matching individual observations to other observations (Reynolds & DesJardins, 2009). We defined the weights (W) as the inverse of the generalized propensity score using the following equation:

$$W_{iT=t} = \frac{1}{P\left(T_i = t \middle| X\right)}.$$

Cases were weighted to create a pseudo-population in which the covariates had a similar distribution across each type of treatment (Leite et al., 2019).

The second stage consists of regression adjustment to predict the probability of the coursetaking outcomes to examine the extent to which each instructional strategy was associated with completing college courses in mathematics or English. We estimated the model for dichotomous outcomes, such as the likelihood of completing a developmental education course in the first year, using a linear probability model as follows:

$$y_i = \gamma_0 + \gamma_t + \Gamma X, \text{with inverse probability weights } (W_{iT}) \text{ based on } P\left(t_1\right).$$

Under this specification, y_i the outcome of interest (in this case, whether individual i completed developmental education in Year 1 where yes = 1; no = 0), γ_0 presents the intercept, γ_t the effect of participation in treatment t, and X is the matrix of covariates representing the same set of student characteristics as the first stage. The outcomes of students who received a likely treatment got a weight close to 1, while outcomes of individuals who received an unlikely treatment got a weight larger than 1. Standard errors were adjusted to reflect the uncertainty associated with the predicted treatment probabilities and were clustered at the college level.

We also used diagnostic checks to ensure the plausibility of the overlap assumption and assess covariance balance after weighting. First, the overlap assumption was that each individual had a positive probability of receiving treatment. This ensured that the predicted inverse probability weights did not get too large. The assumption can be diagnosed visually by creating a histogram that plots the estimated densities of the probability of receiving each type of treatment. The overlap assumption is at risk of being violated when there are very few observations in a treatment level for some covariate patterns. This was not an issue in our data, because none of the plots

indicated high densities near 0 or 1, and the estimated densities for each instructional strategy had most of their mass in regions that overlapped with each other (see Figure A1 in the supplemental materials).[2]

Second, we assessed the covariate balance after weighting by calculating the standardized mean difference for each covariate among students in compressed courses relative to students in each of the alternative instructional strategies. We also examined the ratio of the variance of the residuals of the covariates after the propensity score adjustment. Regression adjustment is typically considered appropriate if the absolute standardized mean difference is less than 0.25 standard deviations, and the variance ratios are between 0.5 and 2.0 (e.g., Rubin, 2001; Stuart, 2010; What Works Clearinghouse, 2017). Prior to matching, there were some large differences in student characteristics by instructional strategy that exceeded the 0.25 standard deviation criteria in each of the subject areas, as well as some variance ratios less than 0.5 or greater than 2.0 (see Tables A1–A6 in the supplemental materials, see Note 2). However, after matching in mathematics and writing, all covariates were well within the recommended ranges for standardized mean differences and variance ratios. Our analytic models included a full set of covariates (X) to account for the remaining small imbalances between treatment groups after the inverse probability weighting. In reading, the corequisite strategy had two variables with standardized mean differences greater than 0.25 after matching: high school English at risk (0.26) and high school mathematics achievement (0.27). There were also two covariates with variance ratios less than 0.5 in reading. This means that the results in reading need to be interpreted with some caution, because there may still have been some imbalances in these variables after matching.

Our analyses have several limitations. First, possible unobserved differences among students in the different instructional strategies may influence the type of strategy selected and student outcomes. For example, studies have found that high school GPA is an important predictor of college grades and degree completion (Atkinson & Geiser, 2009; Brookhart et al., 2016), but we do not have this variable in our data. However, our models do include PERT placement test scores, which are closely aligned with Florida's K–12 standards and postsecondary readiness competencies, and may be more predictive than other national placement tests. Leeds and Mokher (2020) found that adding high school variables such as GPA and state standardized test scores to PERT scores did relatively little to reduce misplacement in developmental education compared with other changes, such as modifying the cut scores for placement into college-level courses at FCS institutions. This suggests that the omission of high school GPA may not be as important in our study as in other contexts. However, there may still be other unobserved differences in factors such as student motivation among institutions that offered multiple instructional strategies. It is important to consider that our results are exploratory in nature and should not be interpreted as causal impacts. Another limitation is the generalizability of the results, which are specific to Florida during the early years of the reform. The effectiveness of various instructional

strategies may change over time as instructors gain more experience with these types of courses. The results also may have limited generalizability to other contexts. Although several states have adopted policies requiring the use of accelerated instructional strategies like corequisite for developmental education, Florida is unique in that it is the only state that allows the majority of students to opt out of developmental education regardless of their level of academic preparation. In Florida, exempt students who choose to take developmental education courses tend to be lower performing than those who opt out, so the results may have differed if all students were required to take a placement test and enroll in developmental education if they scored below college-ready.

Results

For each set of results from the IPWRA, Tables A7–A9 in the supplemental materials provide predicted probabilities of completing each course for the compressed group, and the average treatment effects (ATEs) for each of the other instructional strategies. These tables also provide contrasts of the ATEs for each combination of instructional strategies. In the text, we present figures (Figures 1–3) that provide a graphical representation of the predicted probabilities of passing each type of course in a given year by instructional strategy.

In mathematics, just over half of students in developmental education enrolled in compressed courses (51%), followed by modularized (33%), corequisite (9%), and contextualized (7%). We found that the likelihood of success tended to be greater for the corequisite strategy across nearly all college-level course outcomes (Table A7 and Figure 1). For example, the probability of completing the first gateway mathematics class by the end of Year 1 was 22% for corequisite courses, compared with 9% for contextualized courses, 6% for compressed courses, and 2% for modularized courses. These positive effects attenuated slightly but continued to persist over time. For example, the predicted probability of passing a gateway mathematics course by Year 3 was 46% for corequisite courses, while the predicted probabilities for the other instructional strategies were 34% or less. There were also some smaller negative effects for modularized courses relative to compressed courses in mathematics. The predicted probability of completing a developmental mathematics course in Year 1 was 60% for modularized courses, compared with 66% or higher for other instructional strategies, and these negative associations persisted in Years 2 and 3. In addition, students in modularized courses were less likely to pass the prerequisite course (Intermediate Algebra, MAT 1033) and the first gateway course in each year. For example, by the end of Year 3, the likelihood of completing a gateway mathematics course was 28% for modularized courses, 4–18 percentage points lower than the other instructional strategies. The results for the contextualized strategy were more mixed; students in this strategy tended to have the highest probability of passing developmental mathematics in each year, but these positive associations did not persist into subsequent coursetaking outcomes.

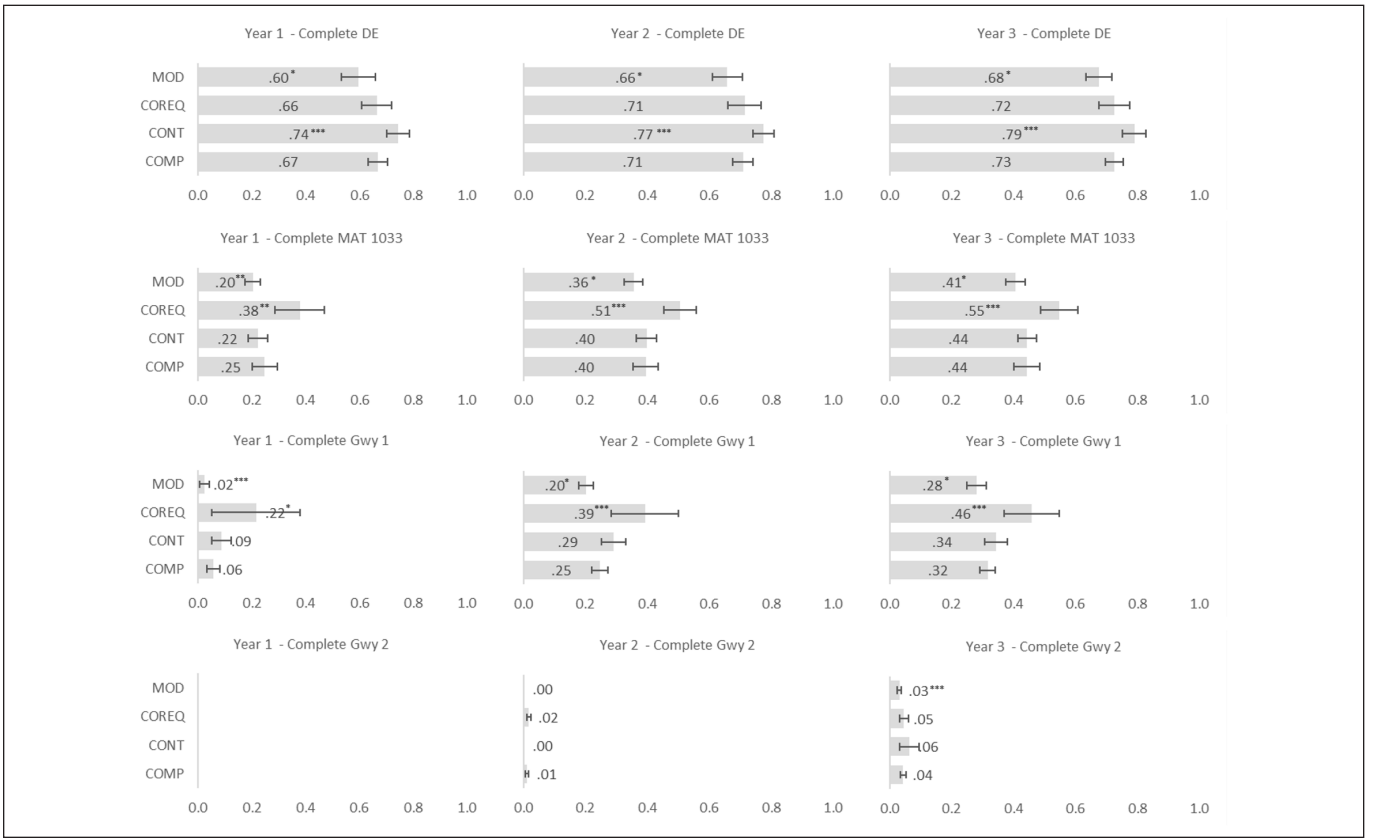

Figure 1. Predicted Probabilities of Passing Each Course by Instructional Strategies, Mathematics

Note. Results are predicted probabilities from the inverse probability-weighted regression-adjusted models in Table A7. Lines at the end of each bar indicate the 95% confidence interval. MOD = modularized; COREQ = corequisite; CONT = contextualized; COMP = compressed. Statistical significance relative to the comparison group of compressed courses is indicated as *$p < .05$. **$p < .01$. ***$p < .001$.

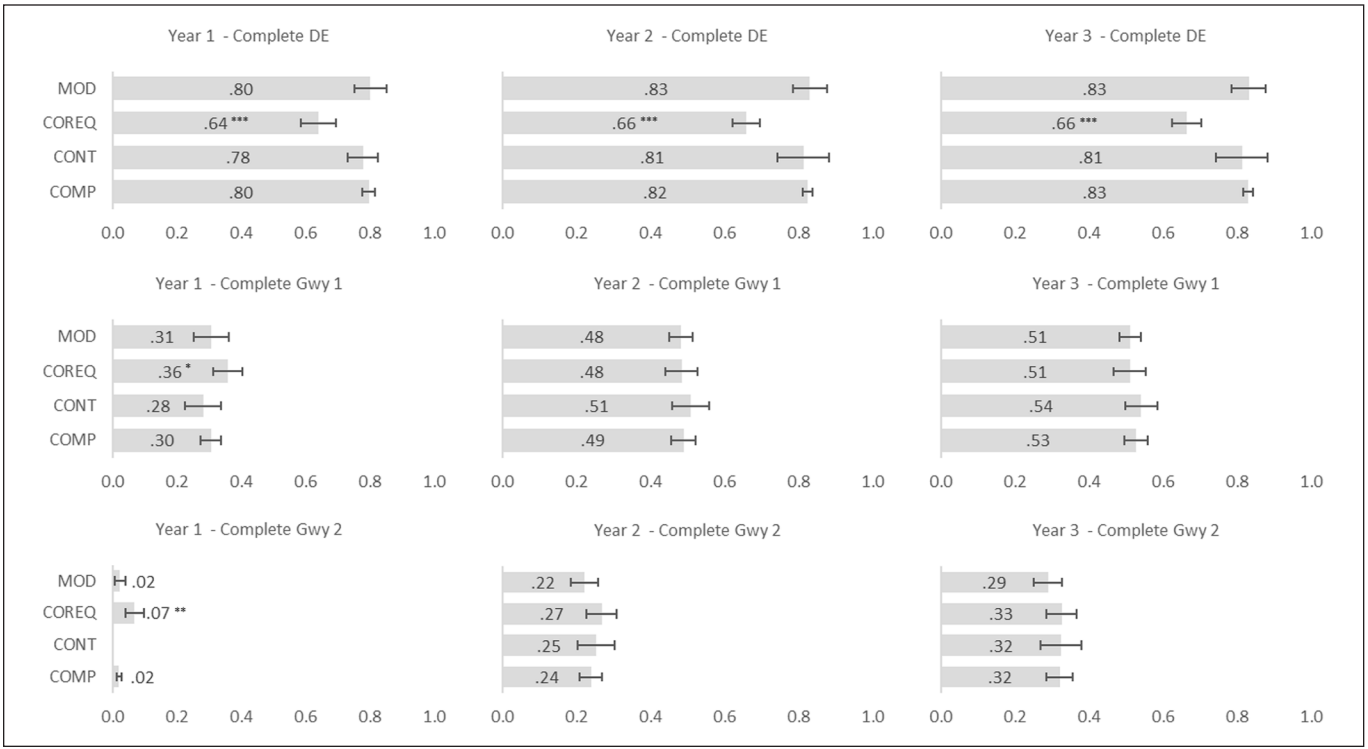

Figure 2. Predicted Probabilities of Passing Each Course by Instructional Strategies, Reading

Note. Results are predicted probabilities from the inverse probability-weighted regression-adjusted models in Table A8. Lines at the end of each bar indicate the 95% confidence interval. MOD = modularized; COREQ = corequisite; CONT = contextualized; COMP = compressed.
Statistical significance relative to the comparison group of compressed courses is indicated as *$p < .05$. **$p < .01$. ***$p < .001$.

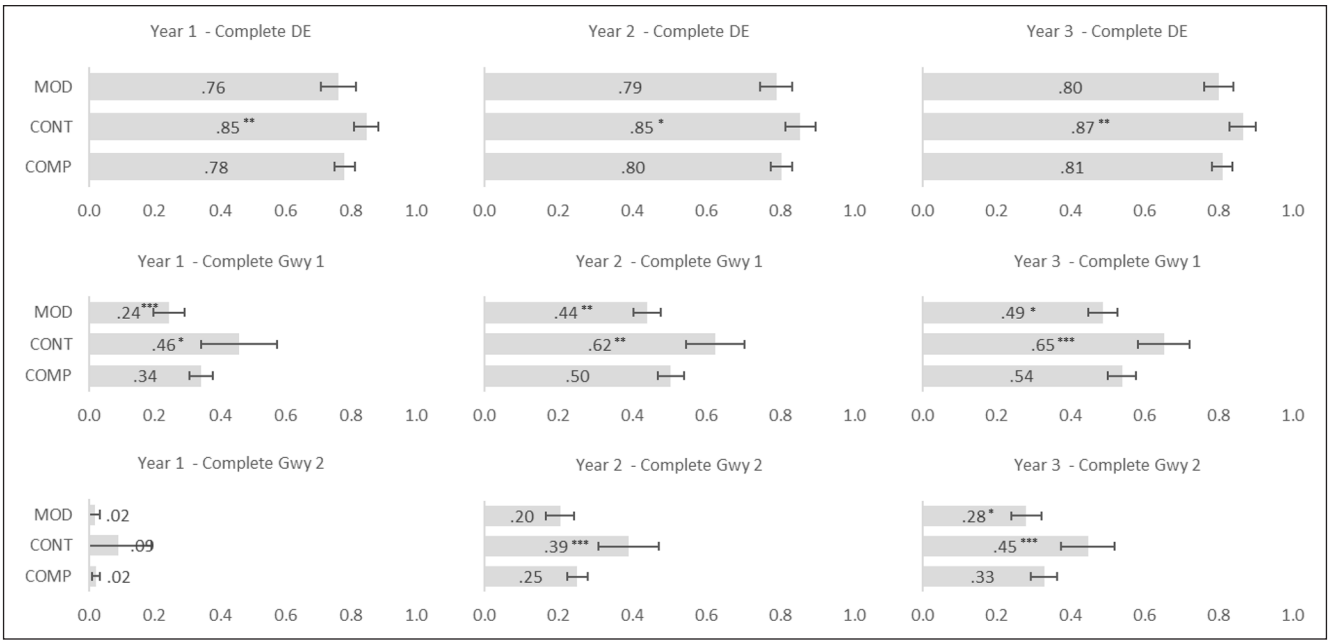

Figure 3. Predicted Probabilities of Passing Each Course by Instructional Strategies, Writing

Note. Results are predicted probabilities from the inverse probability-weighted regression-adjusted models in Table A9. Lines at the end of each bar indicate the 95% confidence interval. MOD = modularized; CONT = contextualized; COMP = compressed.

Statistical significance relative to the comparison group of compressed courses is indicated as *$p < .05$. **$p < .01$. ***$p < .001$. Corequisite is omitted because only 45 students enrolled in this instructional strategy, which is insufficient for matching.

In reading, approximately two thirds of developmental education students (67%) enrolled in compressed courses, 22% in modularized courses, 6% in corequisite courses, and 5% in contextualized courses. Students in corequisite courses had the lowest probability of passing a developmental education course in each year among all the instructional strategies (see Table A8 and Figure 2), possibly because corequisite students at many colleges are not required to pass the developmental course if they pass the concurrent college-level course. Yet, there were some small positive effects for the corequisite courses among other college-level courses in the first year. The predicted probability of passing the first gateway English course in the first year was 36% for corequisite students, which is 5–8 percentage points higher than the other instructional strategies. The likelihood of passing a second gateway course in Year 1 was 7% for corequisite students, compared with 2% or less for students in other course types. Students in other instructional strategies tended to perform similarly in all other outcomes in reading.

In writing, 73% of students enrolled in compressed courses, 18% in modularized, and 10% in contextualized. Corequisite was omitted from the writing analyses because only 45 students enrolled in this instructional strategy, and the sample size was insufficient for matching. Among the remaining three strategies, the predicted probabilities of success tended to be higher for contextualized courses relative to other strategies across multiple outcomes (Table A9 and Figure 3). In the first year, the predicted probability of completing developmental writing was 85% for contextualized students, compared with 76% for modularized students and 78% for compressed students. The increased likelihood of success for contextualized students continued into subsequent years; by Year 3, they were 11–16 percentage points more likely to pass a first gateway English course, and 12–17 percentage points more likely to pass a second gateway English course. There were also several negative effects for modularized courses compared with compressed and contextualized courses in writing. The differences were greatest in the first year, when students in modularized courses were 10–22 percentage points less likely to complete the first gateway course relative to students in other instructional strategies. In subsequent years, students in modularized courses also had the lowest probability of completing the first or second gateway English course.

Discussion

Florida's developmental education reform provided flexibility that allowed institutions and students to select from among four instructional strategies for developmental education courses, which provided a unique opportunity to explore the extent to which students' probability of success may vary by course strategy. Overall, the results demonstrated variation in the likelihood of success for completion of mathematics and English courses over 3 years among students in different developmental instructional strategies, which suggests that the method of acceleration *does* matter. Corequisite courses tend to be associated with large positive increases in the likelihood of completing college-level mathematics courses, and there were also several small positive

associations with the likelihood of success for corequisite courses in reading. Writing had an insufficient number of students in corequisite to include in the analyses; among the remaining instructional strategies were some small increases in the likelihood of success among students in contextualized courses. In addition, students in modularized courses tended to have a lower probability of success among some coursetaking outcomes relative to students in other strategies in mathematics and writing.

These findings raise an interesting question about the mechanisms through which some instructional strategies may be associated with a greater likelihood of student success than others. Corequisite courses represent the greatest structural changes by allowing students to enroll directly in college-level courses, potentially reducing stigma and improving student motivation by providing them with opportunities to earn college credit, reducing the number of potential exit points due to interference from students' environments, and developing acceleration to set students on a successful long-term trajectory. We posit that providing students with access to a college-level course in the first semester—a mechanism unique to the corequisite strategy—may be particularly important in influencing student outcomes. This is consistent with prior research by Bailey and colleagues (2010), which shows that most students failed to complete their developmental course sequence because they did not enroll in a first or subsequent course, not because they failed a developmental course. Removing the barriers associated with a lengthy sequence of developmental education courses and allowing students to enroll directly into college-level coursework may better set up students for success. In addition, providing students with twice the amount of instructional time in the same subject area during a given semester may help improve student mastery of the content. This type of "double dose" approach has been effective in secondary mathematics instruction among students with test scores below the national median (Cortes et al., 2015; Cortes & Goodman, 2014; Nomi & Allensworth, 2009).

Another interesting finding was that the contextualized strategy tended to be associated with a higher likelihood of student success compared with other strategies in writing but not for other subjects. Contextualized courses do not provide structural changes, such as faster access to college-level courses, that other accelerated instructional strategies provide. Instead, contextualized courses make curricular changes intended to make the content more engaging and meaningful to students by integrating real-world examples. Tremmel (2011) suggested that traditional approaches to teaching writing, such as five-paragraph essays on isolated topics, tend not to work well because the structure is too rigid, and the approach inhibits creativity. Students tend to become overreliant on following a formula that makes it difficult to move on toward more sophisticated writing tasks. Instead, she contended that students should be given greater control over the learning process and engage in contextualized writing instruction on meaningful topics. Another study by Golden (2018) found that engaging students in writing activities such as scenario-based learning, in which they must apply writing techniques to real-world problems, tends to result in greater development of critical thinking and analytic reading skills as compared with the use of traditional composition essays in undergraduate writing classes. The study also

found that students who participated in the scenario-based learning were more likely to successfully translate course learning objectives to other contexts, as compared with students assigned to traditional composition essays. It may be more challenging to select the context for developmental courses in mathematics because students tend to have less individual choice over the topics. Instructors may have concerns about teaching academic skills too narrowly, or students may find the material irrelevant if it is too narrow (Perin, 2011). Concerns have also been raised that contextualized mathematics courses may provide inadequate theoretical knowledge of mathematics to adequately support performance in subsequent courses or that students may have difficulty transferring the skills to other contexts (Skuratowicz et al., 2020).

The modularized instructional strategy tended to have a lower likelihood of success for coursetaking outcomes in mathematics and writing relative to other strategies. The modularized format may be more efficient by allowing students to spend more time on competencies that they have not yet mastered and providing opportunities for students to place out of some modules. However, it may increase the potential number of exit points in the developmental sequence, and attrition may be a problem if students fail to enroll in subsequent modules (Bickerstaff et al., 2016; Kalamkarian et al., 2015). Modularized courses also pose challenges with pacing and ensuring that students stay on track (Edgecombe, 2011). Students have to take greater responsibility for their own learning and know how to ask for help when they need it. In addition, instructors must figure out how to assess progress and identify when to intervene. There also may be concerns that students face greater difficultly in seeing connections across topics and retaining information by focusing on only one topic at a time (Bickerstaff et al., 2016).

Future research should further explore the mechanisms that may contribute to variation in student outcomes among instructional strategies. Given the promising evidence of the effectiveness of certain strategies such as corequisite remediation, there is now a need to extend this body of research to understand why there may be differences in student success. This will provide important context for the interpretation of the results and may inform institution-level changes to how corequisite courses are implemented. For example, classroom observations or interviews with instructors could be used to identify how course activities and content differ across courses. Additional quantitative analyses could use growth modeling to explore how different instructional strategies affect initial course performance versus subsequent growth in student success, which could help to uncover the dynamics of the effects of instructional models. Further, subsequent analyses could explore whether certain subgroups of students perform better in some types of developmental education courses than others. For example, modularized courses may be more effective for students with higher levels of academic preparation who only need a quick refresher of several competency areas, while lower performing students may need a more comprehensive review from one of the other types of developmental courses. This is consistent with prior research suggesting that a one-size-fits-all approach to developmental education may not consider the unique needs of students with different levels of preparation (e.g., Boatman & Long, 2018).

Future research should also investigate the extent to which additional support is provided to low-performing students beyond developmental education courses, and potential means for better addressing the longer term needs of these students. The predicted probability of ever completing a second gateway course is low (particularly in mathematics), regardless of developmental instructional strategy. This suggests that even if students are able to successfully complete their initial coursework, they may continue to face additional barriers as they progress through their college experiences. Belfield and colleagues (2014) cautioned that reform efforts to support first-year students may lack effectiveness in the long term if the costs of these efforts are subsidized by reductions in quality in other areas of the college experience. Therefore, it is important examine how best to provide consistent support to lower performing students from college entry through completion.

The results of this study also have practical implications for state policy makers and college administrators to consider. Compressed courses were the most common option across the state, comprising more than half of developmental enrollments in all three subject areas. Interviews with lead administrators and faculty revealed that the compressed format was perceived as the easiest one to adapt from existing courses, and it could be implemented quickly to adhere to the short timeline required by the legislation during the initial adoption of the reform (Mokher et al., 2020). Similar implementation results have been found in other contexts too: Edgecombe and colleagues (2013) conducted a scan of reforms to developmental education at 11 colleges participating in the Hewlett Foundation's Scaling Innovation project and found that the types of reforms selected tended to resemble existing approaches and required minimal changes to practice. There is also some evidence that pedagogical changes (such as those required for contextualized courses) tend to be more difficult to implement than structural changes, so institutions may be less likely to make these types of changes (Edgecombe, 2011). In Florida, the more effective strategies (including corequisite and contextualized courses) tended to have relatively small enrollments and were not offered at many institutions. Next, we offer three recommendations for leaders to consider as they seek to further scale up and encourage participation in these types of courses.

First, faculty may be resistant to reforming instructional strategies because some of the concepts about acceleration may seem counterintuitive to ensuring that students receive sufficient support, and faculty may also be concerned about the additional workload required to substantially redesign courses (Edgecombe, 2011). Kezar (2018) noted that stakeholder resistance is the most cited obstacle to organizational change, which often stems from ethical issues, such as a lack of belief in the efficacy of an idea. If leaders ignore these types of ethical and value dimensions, they miss opportunities to create buy-in and avoid resistance and cynicism. Processes that can help to reduce resistance include soliciting stakeholder participation and input, encouraging broad information sharing, and acknowledging differing values and interests. Administrators should also empower faculty with the role of leading instructional changes to attain adequate buy-in. Prior research on implementation of

Florida's developmental education reform has shown that securing buy-in from street-level bureaucrats involved in carrying out reform efforts can reduce oppositional and circumventing behaviors that can hinder successful implementation (Brower et al., 2017).

Second, institutional leaders and policy makers should ensure that adequate resources are available to scale and sustain reform efforts. The Florida legislature did not provide any additional appropriations to institutions to implement the developmental education reform, so they had to reallocate resources from other areas. In 2017, FCS institutions estimated that they spent more than $31 million on tutoring services, early alert systems, and advising to support developmental education reform (Florida College System, 2017). While some of these funds likely came from cost savings from reduced developmental education enrollments, colleges also may have had to cut services in other areas to make these changes. In the absence of statewide funding to support reform efforts, there will likely be an uneven distribution of resources devoted to these efforts across institutions, which can adversely affect student outcomes at institutions with fewer resources. Other states interested in implementing similar reform efforts may want to consider alternative funding approaches to increase the likelihood of program effectiveness, both overall and across institutions.

Third, this study demonstrates the importance of using data to inform future decisions regarding which types of reform efforts to continue and where additional changes may be needed in order to address instructional strategies that tend to be ineffective in a particular subject area. Prior research on the implementation of Florida's developmental education reform has shown that there is substantial variation across institutions in the extent to which data are shared with frontline staff, as well as perceptions regarding the effectiveness of data use among the colleges (Brower et al., 2020). Nearly half of FCS institutions exhibited characteristics of "need to know" data cultures, such as not collecting data critical to improving practice, rarely making data available to staff at all levels, or failing to systematically collect or analyze data. This is problematic because literature in organizational behavior has indicated that higher levels of data sharing may improve organizational performance (e.g., Bartol & Srivastava, 2002; Constant et al., 1994). Administrators should engage in a more distributive leadership style by increasing the accessibility of data to all staff, valuing staff's unique expertise in understanding underlying data trends, developing organizational procedures to promote data sharing, and facilitating communications across departments to inform data-driven decision making (Brower et al., 2020).

In summary, leaders can play an important role in strengthening institutional capacity to effectively implement developmental education reform by developing faculty buy-in, ensuring adequate resources to scale and sustain reform efforts, and using data to inform future decision-making. This type of support is critical for ensuring that reform efforts are designed in a way that best meets the needs of underprepared students. Given that the method of instruction does matter for student success, it is important that well-informed decisions are made about implementation as colleges across the country continue to scale up reformed developmental education courses.

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Supplemental Material

Supplemental material for this article is available online.

Notes

1. High school enrollment size is the log of the number of students enrolled in 2014–2015 from Florida's PK–12 Education Information Portal (https://edstats.fldoe.org/). The remaining high school variables are from the 2014–2015 reports of Florida's school grades, which are described in more detail at http://www.fldoe.org/core/fileparse.php/18534/urlt/SchoolGradesCalcGuide15.pdf
2. The supplemental materials (technical appendix) are available online at http://fsu.digital.flvc.org/islandora/object/fsu%3A763437.

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