A Cost-Benefit Analysis of Corequisite English Developmental Education: Evidence from a Randomized Controlled Trial in Texas Community Colleges

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We estimate the societal costs associated with corequisite and traditional pre-requisite English developmental education and compare them to societal benefits. Our context is the randomized controlled trial conducted by Miller et al. (2022) that estimated the effects of three different approaches to English corequisites implemented in 5 Texas community colleges. The main drivers of differential costs across pathways and colleges are the number of credit and contact hours in each pathway, class sizes, and the type of faculty used to teach courses (adjunct or full-time). Corequisites are less expensive than pre-requisite pathways in two colleges, they are more expensive yet roughly similar in two other colleges, and they are much more expensive in one college. Miller et al. (2022) find that corequisites induced more students to pass the required college-level English course in all colleges, but do not find that they impacted persistence in college. Considering the enormous societal benefit of a college education, corequisites are most likely the preferred policy from a societal point of view even when they are more expensive to implement and given that they only have a small impact on the likelihood of completing college. From students' point of view, corequisites are always preferred because they require less tuition and have a higher likelihood of success.

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Abstract

We estimate the societal costs associated with corequisite and traditional pre-requisite English developmental education and compare them to societal benefits. Our context is the randomized controlled trial conducted by Miller et al. (2022) that estimated the effects of three different approaches to English corequisites implemented in 5 Texas community colleges. The main drivers of differential costs across pathways and colleges are the number of credit and contact hours in each pathway, class sizes, and the type of faculty used to teach courses (adjunct or full-time). Corequisites are less expensive than pre-requisite pathways in two colleges, they are more expensive yet roughly similar in two other colleges, and they are much more expensive in one college. Miller et al. (2022) find that corequisites induced more students to pass the required college-level English course in all colleges, but do not find that they impacted persistence in college. Considering the enormous societal benefit of a college education, corequisites are most likely the preferred policy from a societal point of view even when they are more expensive to implement and given that they only have a small impact on the likelihood of completing college. From students' point of view, corequisites are always preferred because they require less tuition and have a higher likelihood of success.

1. Introduction

Over half of U.S. high school graduates who enroll in community college are deemed to be underprepared in either reading, writing, or math.[2] Historically, these students have been required to take and pass non-credit-bearing developmental education (DE) courses in the deficient field before enrolling in college-level courses that use those skills. Unfortunately, many students do not pass required DE courses and end up dropping out of college without a degree. This process of attempting remedial education and not completing a degree incurs large costs on all parties involved: students, colleges, and, ultimately, the taxpayers who often subsidize public higher education. As new research showed a clear lack of progress for students placed in traditional DE courses, colleges began to pilot new approaches to both assessing students' skills and addressing their needs (Bailey et. al., 2010; Martorell and McFarlin, 2011; Bickerstaff and Lewy, 2022).

In this study, we estimate the costs of traditional pre-requisite developmental education and compare costs and benefits to a promising alternative: corequisite developmental education. Under a corequisite DE model, students simultaneously enroll in both a college-level course and a DE support course. For example, students requiring reading and writing remediation would take the standard (non-DE) introductory English writing course while concurrently enrolling in a structured, developmental education course designed to support learning. The corequisites model may be more effective because (by default) all students at least attempt the college-level course, while under the pre-requisite model only those who pass the pre-requisite DE course can attempt the college-level course. Even if a corequisite model leads to better college outcomes, it is vital to know how the costs compare to the traditional pre-requisite model: if corequisites lead to better outcomes *and* they cost less, the choice is clear, but if corequisites lead to better outcomes and they cost more, then policy makers must decide whether the additional costs outweigh the benefits.

A growing body of evidence demonstrates that corequisite remediation helps students progress more quickly through college-level courses. A recent, multi-site, randomized controlled trial in Texas showed that students assigned to corequisite remediation in English were 18 percentage points more likely to complete a college-level English class within two years than students assigned to traditional developmental education courses (Miller, et. al. 2022).[3] Similarly, a randomized controlled trial at the City University of New York (CUNY) demonstrated that students randomly assigned to enroll directly into a college statistics course with corequisite support—as opposed to the traditional developmental math course, followed primarily by a college algebra course—were 14 percentage points more likely to complete a college-level math course within one year and 19 percentage points more likely to complete one within three years (Logue et. al. 2016, Logue et. al. 2019).

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[2] The National Center for Education Statistics reported that in 2015, 55.5% of community college students had taken at least one DE course (https://nces.ed.gov/Datalab/TablesLibrary/TableDetails/13128?keyword=2019467&rst=true).

[3] Since the publication of Miller et. al. (2022), the research team continued to track outcomes of students assigned to treatment and control for one additional year. The results indicate that being assigned to an English corequisite increased the probability of passing a college-level English course within three years by 16 percentage points, the probability of passing English Composition II within three years by 7 percentage points. Since the results did not change the primary conclusions of Miller et. al. (2022), we base the cost-benefit estimates on the published findings. Detailed results from the analysis of three-year outcomes are available upon request.

Buttressing these findings from large randomized studies is an increasing body of evidence from quasi-experimental and descriptive research conducted in a variety of geographic settings. These studies examine a range of approaches to implementing corequisites, consistently finding that both English and mathematics corequisite remediation is associated with significant increases in the likelihood that students complete a college-level course in the subject area in which they are deemed to be underprepared (Cho et. al., 2012; Ran and Lin, 2022; Meiselman and Schudde, 2022). Similarly, recent studies of statewide mandates in California and Florida that require colleges to offer alternatives to mandatory, stand-alone remediation such as corequisites have found that the mandates led to significantly lower enrollment in developmental education courses and notable increases in rates of passing college-level courses (Ngo and Melguizo, 2022; Park et. al. 2020). Taken together, the evidence suggests that implementing corequisite remediation in both mathematics and English will improve students' chances of passing college-level courses, and states might consider mandating that colleges do so.

At the same time, evidence on long run impacts of corequisites has been mixed. The randomized study at CUNY found that assignment to corequisite remediation in math increased the probability of transferring to a four-year college or completing a credential within three years by 5 percentage points (Logue et. al. 2019). However, the Texas study found no evidence that students randomly assigned to an English corequisite were more likely than those assigned to pre-requisite developmental education to persist in any college in the state for one or two academic years (Miller et. al., 2022). Additional quasi-experimental research in Tennessee and Texas also showed no impact of corequisites in math or English on persistence and completion, although these studies do find that it increased the likelihood of taking subsequent college-level classes (Ran and Lin, 2022; Meiselman and Schudde, 2022).[4]

Based in part on this evidence, corequisite remediation has emerged as one of the most common approaches to DE reform across the country. In particular, a 2016 national survey indicates that more than one third of community colleges offered corequisites in reading and writing at that time (Rutschow, Cormier, Dukes, & Cruz Zamora, 2019),[5] and a report from the Education Commission of the States found that at least 20 states have policies in place that encourage innovative models of DE such as corequisite remediation (Whinnery & Pompelia, 2018).

While the research base on the impacts of corequisites is large and continues to grow, there is comparatively little research documenting the costs of corequisite remediation relative to standard pre-requisite

[4] Researchers have speculated about potential factors that may be behind the cross-study differences in results on the longer-term effects of corequisite remediation? In some cases, it may boil down to differences in implementation across the studies. One particular factor that has emerged as potentially important for math corequisites is the specific college-level course for which students receive corequisite remediation may be important. Logue et. al. (2016, 2019) studied a corequisite model that enrolled students in a statistics course paired with support, while the control students who were able to pass the developmental mathematics course mostly enrolled in algebra, a course with notoriously low pass rates. In the quasi-experimental study in Tennessee, the authors attribute the positive impacts of math corequisite remediation largely to efforts to align the college-level math course component with student degree plans, as opposed to enrolling students in college algebra by default. Taken together, these results have led some researchers to hypothesize that there may be particular benefits to combining corequisites with ongoing efforts to reform math pathways (Miller and Martorell, 2022).

[5] We are unaware of more recent national estimates of the extent of corequisite implementation, but this number has surely increased since the time of the survey, particularly given that states including California, Texas and Tennessee have mandated the use of corequisites in more recent years.

remediation and comparing those costs to benefits. Jenkins et al. (2010) study the corequisite Accelerated Learning Program at the Community College of Baltimore County and conclude it is preferable to the traditional pre-requisite model because it induces more students to pass the college-level English course at roughly the same cost. Similarly, Belfield, Jenkins, and Lahr (2016) study both math and English developmental education in Tennessee community colleges and conclude that the corequisite model is more cost effective than the pre-requisite model.

Our study contributes to the research base on the costs and benefits of corequisites by estimating the costs of three different corequisite approaches implemented at five community colleges in Texas as part of the multi-site randomized trial conducted by Miller et. al. (2022). Over three semesters, Miller et al. identified the set of first-time college students who scored slightly below the "college-ready" threshold on an English reading and writing test and randomly assigned them to either a corequisite or the traditional pre-requisite pathway. On the pre-requisite pathway, students were first required to take the DE course Integrated Reading and Writing (IRW); upon passing IRW, students could take the required college-level course English Comp 1. On the corequisite pathway, students were simultaneously enrolled in both English Comp 1 and a DE support course. The experimental variation allowed Miller et al. to estimate the program's main benefit: the differential impact of a corequisite model on the percentage of students passing English Comp 1. They found that corequisites increase the likelihood of passing English Comp 1 by 18 percentage points across all colleges, but corequisites did not impact persistence in any college in the state.

In this study, we estimate the costs of these pathways and compare them to program benefits. Our analysis follows the standard cost-benefit framework (also known as the ingredients method) which involves identifying the net benefits of the two alternative models for society as a whole. Decision makers, however, may also be concerned with equity across stakeholders, and so our analysis identifies to whom the costs and benefits accrue. This stakeholder analysis requires identifying transfers between parties, which in our context include tuition paid by students to colleges and funding provided to colleges by the state (i.e., taxpayers).

We find that the main drivers of differential costs across pathways and colleges are the number of credit and contact hours in each pathway, class sizes, and the type of faculty used to teach courses (adjunct or full-time). Colleges pay instructors by the contact hour per class, so more contact hours and smaller classes are more expensive, and full-time faculty are between 50% and 300% more expensive than adjunct (intermittent) faculty.

In total, corequisites are less expensive than pre-requisite pathways in two colleges, they are slightly more expensive in two other colleges, and they are much more expensive in one college. In the college with the most costly corequisite model, the DE support portion of the corequisite contained 3 contact hours and had only 6 students, which resulted in an instructional cost that was 2.5 to 6 times higher than the other schools which offered 1-contact hour courses with 10 or more students per course. These differences across colleges demonstrate the variability in intensity of corequisite approaches and that policymakers have considerable control over the costliness of corequisite programs.

Combined with the higher English Comp 1 pass rates, the case for these corequisites models is clear for the two colleges in which corequisites were less expensive than pre-requisites. However, in the other 3 colleges, corequisites were either slightly or significantly more expensive than pre-requisites. The cost per additional

student who passed English Comp 1 at these schools ranged from about $200 to $5000. Institutional leaders and policymakers must ultimately decide whether the increase in numbers of students passing first college courses in English and the additional credit accumulation is worth these costs. And additional investments may be needed to move the needle on persistence and completion given findings that these corequisites did not impact these outcomes (Miller et al., 2021).

Transfers between stakeholders do not impact net benefits to society (they are a cost to one stakeholder and an equal benefit to another), but they do impact who bears the burden of those costs and may be of interest to decision makers concerned with equity. Both pre- and corequisites involve large transfers of tuition from students to colleges and of funding from the state (i.e., taxpayers) to colleges (for some models, transfers sum to more than the cost of instruction). In these particular corequisite models, all of the students benefited because they were more likely to pass English Comp 1 and paid less in tuition since the corequisite required fewer credit hours (1 credit hour of DE support in the corequisite versus 4 for pre-requisite course).

Our analysis has highlighted the key drivers of differential costs between co- and pre-requisite developmental education. Recent research on math corequisites in Colorado and Texas suggests that two of the major cost drivers–use of full-time faculty and smaller class sizes–may not provide any benefits in terms of improved outcomes (Bahr et al., 2022; Ryu et al. 2022), so institutions should think carefully about the design of their corequisites and the importance of investing in these features. The research does suggest that more time-intensive corequisites are associated with better outcomes for students, though most of the corequisites in this study were among the least intensive (with just 1 weekly hour of support) and showed large benefits for students (Miller et al., 2022). Given the substantial tuition and instructional costs associated with more time-intensive corequisites and the crowding out of time for other credit-bearing coursework, institutions will want to make sure that the support intensity matches student needs.

The remainder of this paper is structured as follows. Section 2 describes the co- and pre-requisite models implemented at the colleges of study, the population, and the data sources. Section 3 describes the cost-benefit methodology as applied to the context of college pathways. Section 4 presents the results of the model, and Section 5 concludes.

2. The Intervention and Context

We briefly summarize the experimental intervention and the broader context of corequisite developmental education; for further details, see Miller et al. (2022).

2.1. Corequisite English developmental education models

The study included five Texas community colleges, labeled Colleges A-E to preserve anonymity. In accordance with guidelines from the State of Texas, each designed their own corequisite English DE program. These programs broadly map into three models: Accelerated Learning Program, Extended Time, and Academic Support Services. (See Daugherty et al. (2018) for a review of the various corequisite models that have been used in practice to date.)

Colleges A and B implemented Accelerated Learning Program (ALP) models in which DE students were mixed with college-ready students in a traditional English Comp 1 section and simultaneously enrolled in a stand-alone support course. The same instructor taught both courses using a common textbook. The main differences between College A's and College B's ALP models was that College A had more contact hours in their DE support course (3 compared to 1 contact hour) and College A had smaller maximum class sizes in English Comp 1 (20 compared to 25 students). Both colleges capped the number of DE students per DE support section at 10.

College C implemented an Extended Time model which acts as an extension of the English Comp 1 course. DE students were assigned to longer, stand-alone sections of English Comp 1 and the DE support portion was often indistinguishable from the regular course content. Thus, College C was the only study school in which corequisite and non-DE students were not co-enrolled in English Comp 1 sections. In addition, College C set the maximum class size for the corequisite DE support/English Comp 1 course equal to that of the traditional English Comp 1 course; at 22 students, this was by far the largest DE support class size across study colleges.

Colleges D and E implemented Academic Support Service models in which DE students were mixed with college-ready students in English Comp 1 sections but were given either extra office hours with the same instructor (College D) or were required to attend a college writing center for extra help (College E). Both colleges allowed only 10 DE students per support section, and maximum English Comp 1 class sizes were set at 30 in College D and 25 in College E.

2.2 Sample, data, and experimental results

All first-time college students enrolling between fall 2016 and fall 2017 (3 semesters in total) who scored below, yet close to, the college-ready cut-off score on the state's college readiness exam were randomized into corequisite (treatment) and pre-requisite (control) groups. Students were asked to join the study, but consent was not full, with rates ranging from 67% to 91% across colleges. Thus, Miller et al. report Intent to Treat (ITT) estimates of the program impact which reflect this imperfect compliance. In total, 1,482 students agreed to participate: 466 from College A, 181 from College B, 449 from College C, 279 from College D, and 107 from College E.

Students in pre-requisite groups were assigned to first take the developmental education course Integrated Reading and Writing and, upon passing, they became eligible to enroll in English Comp 1. Students in the corequisite groups were assigned to enroll jointly in English Comp 1 and the DE support course. corequisite students at all colleges received the same grade in both English Comp 1 and the DE support course.

Using Texas Higher Education Coordinating Board (THECB) administrative data, Miller et al. (2022) tracked these first-time students for two years and reported program impacts on taking and passing (receiving a "C" or better) English Comp 1 and persistence in any college in the state. Their main findings are (1) that corequisite DE increases the likelihood of passing English Comp 1 within two years in all colleges (and by 18 percentage points on average across colleges) and (2) there is no impact of corequisites on college persistence.

Our cost analysis uses Miller et al.'s ITT estimates along with several other data sources, including THECB administrative data, publicly available documents from the colleges, personal communications with college administrators, and national surveys of labor markets and post-secondary institutions. Unfortunately, we were only able to obtain information from the THECB for the Fall 2016 semester, so our working assumption is that faculty salaries and class sizes in the other semesters (Spring 2016 and Fall 2017) are unchanged from Fall 2016.

2.3 Main factors driving differential costs, benefits, and transfers

There are several main factors aside from the corequisite model (ALP, Extended Time, or Academic Support) that drive differential costs, benefits, and transfers between the corequisite and pre-requisite pathways adopted by study colleges.

1. Contact and credit hours per course: Students pay tuition for each credit hour they attempt, while faculty compensation and most state funding are based on the number of contact hours delivered. For English Comp 1, there was no variation across schools in the contact and credit hours, as the state of Texas requires 3 contact/credit hours in all colleges. For the DE support, courses at all schools earned and paid tuition for 1 credit hour, yet College A's course required 3 contact hours per week compared to the 1 contact hour per week required by all other Colleges. More hours of instructional support in a corequisite may provide some developmental benefits to students, with research on Texas math corequisites indicating higher pass rates for individuals enrolled in corequisites with more hours of corequisite support (Ryu et al., 2022). In all colleges the corequisites required fewer credit hours than the pre-requisite IRW course; College A's IRW course required 5 credit hours, Colleges B, C, and D IRW course required 4 credit hours, and College E's IRW course required 3 credit hours. The variation in contact and credit hours across both schools and DE modalities has important implications for all stakeholders: for students, how much they pay in tuition; for taxpayers, how much they transfer to colleges; and for colleges, both their instructional expenditures and revenue.

2. Class size: Faculty compensation does not vary with class size, but tuition and most state funds scale proportionately with the number of students enrolled. Therefore, smaller sections incur higher net costs to colleges (instructional costs net of tuition and state funding) and higher costs to taxpayers via state funding. Both maximum allowable class sizes and actual average class sizes varied substantially across colleges and courses and are therefore important drivers of differential costs. Of course, class size is also known to impact student learning, which leads to the ever-present tension between higher-cost, more-effective small class sizes and lower-cost, less-effective large class sizes (Bettinger and Long, 2018). However, recent research on Texas math corequisites indicate that students in larger corequisite courses were actually more successful (Ryu et al., 2022), while Colorado corequisite research found no relationship between class size and student outcomes in math corequisites (Bahr et al., 2022).

3. Faculty salary and the ratio of faculty type: Colleges employ either full-time or adjunct faculty to teach English Comp 1, IRW, and DE support courses. Full-time faculty are salaried and teach a fixed number of contact hours per year (30 at all study colleges) in addition to performing general service

to the school. Adjunct (or intermittent) faculty are paid by the contact hour, they do no additional service, and they earn fewer fringe benefits such as vacation time or retirement fund contributions. In general, adjuncts cost much less per contact hour than full-time faculty, which implies that the type of faculty a college employs can greatly influence instructional costs. Research from both Colorado and Texas finds that students enrolled in math corequisites taught by adjunct instructors were slightly more likely to pass the college course (Bahr et al., 2022; Ryu et al., 2022). However, there is mixed evidence overall, with some research suggesting that students with adjunct faculty may award higher grades in courses but are less likely to take and pass subsequent courses (Ran and Xu, 2018).

4. Tuition paid by students: Students pay a set tuition for every credit hour attempted, even for DE credits which do not count towards a degree. Tuition is a transfer between students and colleges and so does not constitute a cost to society, however, it is an important consideration for both parties involved. Tuition varies across schools and models in two ways: the per-credit-hour price of tuition and the number of credit hours required per course.

First, while tuition per credit hour at Colleges A, B, C, and D was roughly the same, College E's tuition was almost double that amount. Therefore, holding constant the number of required credit hours, College E received more revenue from students, and those students incurred concomitantly higher costs. Second, the variation in required credit hours between pre- and corequisite models discussed above leads to variation in tuition both received by colleges and paid by students.

5. Course pass rates: While the number of students passing English Comp 1 is the main benefit of either modality, pass rates also impact the amount of funding colleges receive from states via "success points." As with tuition, funding is not a cost to society, but is an important consideration for colleges.

Texas allocates 90% of community college funding proportional to contact hours delivered; the remaining 10% of funding is allocated based on the number of students who complete certain milestones in their college career. This "success point" funding was introduced to incentivize colleges to focus on outcomes (completing gateway courses, persistence, graduation, etc), as opposed to inputs (course attempts). The success points relevant for our study include 1 point earned for each student who passes an English DE course (either IRW or the DE support course) and 1 point earned for each student who passed English Comp 1.

3. Methodology

We estimate program costs using a simple pathways model which tracks cohorts of 100 students through corequisite and pre-requisite tracks at each college.[6] In the corequisites pathway, 100% of students jointly

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[6] We use 100-student cohorts as a notional figure; the average cohort size per semester across the five colleges was 98.1. We track cohorts, as opposed to individual students, because colleges have maximum class sizes and the size of the cohort combined with the maximum class size determine the number of sections a college must offer. We assume that there are enough IRW and English Comp 1 students (i.e., students both far below the cutoff score and those above the cutoff score) at each college that the 100 students in our hypothetical cohort do not impact the average size of these courses. However, with only 100 students in DE support courses, it is likely that the ratio of

enroll in English Comp 1 and the DE support course. In the pre-requisite pathway, 100% of students first take the DE course Integrated Reading and Writing; then, students who pass this course are eligible to enroll in English Comp 1 in the following semester.

We consider costs which accrue to all stakeholders (students, colleges, and taxpayers). These costs include faculty salaries, associated benefits paid to faculty ("fringe benefits"), a portion of the general costs of administering and operating a college ("overhead"), and course textbooks. An additional cost of instruction is the time required by students to attend class; however, we assume that students gain a benefit which is equal to their opportunity cost of time and therefore exclude students' time costs from this analysis. This assumption seems reasonable as a first-order approximation, even for the students who do not pass or do well in a course (it is unlikely those students learn nothing in the course), but students could clearly receive either more or less benefit than their time-cost of attending classes, in which case the net costs would need to be added to our analysis[7].

Next, we calculate the two main transfers: students pay tuition to colleges, and colleges receive funding from the state (i.e., taxpayers). Transfers between stakeholders do not impact total net costs (or net benefits), but they do impact who bears the burden of paying these costs.

Finally, we compare costs to the main program benefit: the number of students who pass English Comp 1. While this comparison (i.e., cost per English Comp 1 pass) yields vital information for policymakers debating which DE model to implement, it does not entail a full cost benefit analysis. Such an analysis would require identifying (and possibly monetizing) the benefits to students and society for differential rates of college persistence and graduation (and, from a practical point of view, we cannot yet estimate the program impacts on college graduation because many students are still in school). Instead, we calculate the additional costs that are required to gain the additional number of passing students, which can be used as a benchmark in determining whether the benefits outweigh the costs.

4. Results

4.1 The costs of co- and pre-requisite pathways

Cost of textbooks

All colleges use the same book in English Comp 1 and the DE support, so corequisites students only purchase one textbook. Pre-requisite students, however, must purchase two different textbooks: one for

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the cohort size to the maximum number of DE students per support section is not an integer, forcing colleges to offer DE support sections with fewer students – a significant added cost.

[7] We assume that faculty are fully compensated for their time by their salary, a reasonable assumption considering the relatively free and competitive market for post-secondary education labor (i.e., the opportunity cost of faculty time is equal to the wage).

IRW and one for English Comp 1 (if they persist to that course). Table 1 contains estimates of the price of used textbooks as available on Amazon.com (English Comp 1 at College E and IRW at College B did not require a text). Students have the option to re-sell textbooks after a course is completed. We assume the resale value is 50% of the purchase price, and so we include only the other 50% of the purchase price as the cost of instruction, which is borne by students. Table 1 shows that the ratio of textbook costs to other instructional costs is small, ranging from 0%-6% across colleges and pathways.

Cost of teaching courses

Full-time faculty are salaried, so we estimate a per-contact-hour salary cost assuming faculty are required to teach 30 contact hours a year (the standard at all colleges) and devote 20% of their time to service. Adjunct faculty are paid a college-specific per-contact-hour rate. Table 2 contains the data used in this exercise. It shows that there is significant variation in both full-time and adjunct salaries across the 5 colleges, which reflects both variation in regional labor market forces and variation in full-time faculty experience.

Fringe benefit estimates were not available from the colleges. Instead, we use estimates for full- and part-time employees in the higher education sector from the National Compensation Survey conducted by the Bureau of Labor Statistics. Fringe benefits for full-time and adjunct faculty are 50.8% and 33% of their salaries, respectively.

The overhead rate of 50.8% is estimated as an average of published statistics from colleges B, C, and D, and from National Center for Education Statistics estimates for Colleges A and E. This cost includes buildings, maintenance, cleaning, utilities, administration, and any other non-instructional cost which is required to offer college courses.

Combining these ingredients, Table 2 shows that compared to adjuncts, the cost per contact hour for full-time faculty are between 50% (College D) to 330% (College B) larger. We next calculate the percentage of sections which were taught by full-time faculty to estimate an average cost per contact hour weighted by faculty type. As with salaries, there is large variation across colleges in this ratio. These large differences will propagate through our remaining calculations.

Credit/contact hours and class sizes

Table 1 contains the credit hours, contact hours, and average class sizes for each course at each college. The instructional cost for each course is the product of the number of contact hours, the cost per contact hour (weighted by faculty type), and the number of sections required to teach students taking the courses[8].

In the pre-requisite pathway, not all of the cohort passes IRW and enrolls in English Comp 1; the attempt rate for English Comp 1 ranges from 62.6% in College E to 75.1% in College A. Compared to the

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[8] Our data do not identify which English Comp 1 courses had corequisite DE students, and so we cannot separately calculate the average English Comp 1 class size under the corequisite and pre-requisite models.

corequisites model, the fact that not all students take the second course is a significant savings in instructional cost.

Total cost

Table 1 displays the total instructional cost for each modality at each college, as well as the difference between co- and pre-requisite pathways. Several results stand out.

First, the most expensive corequisite DE support (College A) was almost 3 times more expensive than the second most expensive DE support (College D) and it was 16 times as expensive as the cheapest DE support (College E). These huge differences in costs stem mainly from differences in the number of contact hours that must be paid to faculty and differences in class sizes. Second, as in the DE support course, the costs of IRW vary across colleges in response to variations in class sizes and contact hours (albeit, the variation in the cost of IRW is less than the variation in the cost of DE support courses). Third, the cost of English Comp 1 does not vary much across colleges, mainly due to the homogenous contact hours (3) and similar class sizes. Fourth, comparing costs across modalities, we see that corequisites are more expensive than pre-requisites at three colleges (A, B, and D) and less expensive than pre-requisites at the other two colleges (C and E). Finally, the difference in instructional costs is relatively low at all colleges other than College A: it varies between $2,789 and $18,491 at Colleges B-E, while it is $80,458 in College A.

4.2 Comparing costs to benefits

We next compare societal costs to the main benefit of either pathway: the number of students who pass English Comp 1. Pass rates are reported by Miller et al. (2022) and we express those statistics in Table 1 as the number of passing students in each of our 100 student cohorts. In all colleges, more students passed English Comp 1 under the corequisite model, with the largest difference seen in College D (27.1 students) and the smallest difference seen in College B (12.2 students). On average across all colleges, 18 more students on the corequisites pathway passed English Comp 1[9]. Hypothesis tests performed in Miller et al. (2022) show that the differences in pass rates across colleges and corequisite models are not statistically significant.

In Colleges C and E, the costs of corequisites were lower *and* more students passed English Comp 1; under these models, the case for corequisites is clear. In colleges A, B, and D, however, decision makers face a tradeoff: to pass more students under the corequisite model, more resources must be expended. A useful way to gauge the magnitude of this tradeoff is to calculate the cost per additional English Comp 1 pass gained under corequisite remediation. The final row of Table 1 shows the cost per additional pass in Colleges A, C, and D are $5,399, $229, and $682, respectively.

An ultimate determination of whether these costs are worth the additional passes requires the monetization of passing English Comp 1. Passing English Comp 1 allows students to take other college level courses and ultimately get a college degree, and a college degree can improve one's labor market outcomes. While it is

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[9] Note that the relevant statistic under the pre-requisite pathway is the pass rate of both IRW and English Comp 1, not the pass rate of English Comp 1 amongst attempters, as not all of the cohort attempted English Comp 1.

too early to track students from Miller et al.'s study into the labor market, the literature has documented an enormous return to a college degree. For example, Jepsen, Troske, and Coomes (2014) estimate the yearly return to an associate's degree are between $6,000 and $10,000 per year. However, Miller et al. (2022) estimate that after two years, there is no difference between co- and pre-requisite pathways in the likelihood of persisting in college.

4.3 Transfers from students and taxpayers to colleges

Both co- and pre-requisite pathways involve two important transfers between stakeholders: students pay tuition to colleges and colleges receive funding from the state (i.e., taxpayers). Transfers are not relevant for understanding net social benefits, as they are a cost to one stakeholder and an equal and opposite benefit to another. However, examining transfers is important because they reflect who bears which costs, and decision makers may have preferences for which groups bear the costs of developmental education in addition to the social net benefits. Table 3 contains details of our analysis of transfers.

Tuition

Tuition per credit hour is roughly the same at colleges A, B, C, and E (ranging from $67.50 at College A to $59 at College E), but it is almost twice that amount at College D ($114). Total tuition paid by students is a function of this per-credit-hour-cost, the number of credit hours, and the attempt rate of English Comp 1 in the pre-requisite model. At all colleges, the pre-requisite pathway is associated with more tuition, which is a cost for students but a benefit to colleges.

State funding

The state of Texas reimburses colleges in two ways: for success points and for contact hours delivered. The per-contact-hour reimbursement rate in 2016 was $2.69. So, with a typical course running for 15 weeks a semester, a 3-contact-hour course, for example, would bring in $121 per student in contact hour funding. Colleges earned one success point for each student who passed a DE English course (either the corequisite DE support course or IRW) and one success point for each student who passed English Comp 1. In 2016, success points were worth $185 each.

Even though not all students attempt English Comp 1 under the pre-requisite pathway, those students take more total credits than in the corequisites pathway because IRW has more hours than does the DE support in all colleges. This implies that the pre-requisite model brings in more contact-hour funding than does the corequisite model. In contrast, more students pass both developmental English and English Comp 1 under the corequisites model, implying that success point funding is more valuable for colleges (and more costly for taxpayers) under the corequisite model. In all colleges, these variations in contact hour and success point funding across models balanced themselves out, resulting in roughly the same amount of funding under both co- and pre-requisites.

Total revenue to colleges and net instructional costs

Colleges may be interested in the impact of pathways on their budgets, which are affected by both the cost to deliver courses and revenue received. Perhaps surprisingly, pathways for some colleges result in net *negative* instructional costs to colleges. In particular, on both pathways at College C and on the pre-requisite pathway at Colleges B and D, schools receive more in tuition and state funding than it costs to deliver courses. (We intentionally leave out the cost of textbooks here as that is paid by students.) The fact that some net costs are negative should have no bearing on the decision making process, as the relevant statistic is still the difference in costs between pre- and corequisite pathways.

The difference in net instructional costs to colleges (corequisites minus pre-requisites) is very small at Colleges C and E ($10 and -$32 per student), slightly larger at Colleges B and E ($238 and $449 per student), and very large for College A ($1028 per student).

4.4 Robustness of results

As with any cost-benefit analysis, we must consider whether our conclusions are robust to changes in underlying assumptions. The main assumptions driving our results include: the price and resale value of textbooks, the various inputs driving the cost-per-contact-hour of instruction (the percent of time full-time faculty devote to service, fringe benefits as percentage of salary, and the overhead rate), and our use of 2016 data for all three semesters of study. We varied these parameters and re-calculated program costs and the cost-per-additional-pass, and found that by-and-large, they do not change our main qualitative conclusions because textbooks are a relatively small component of cost and the cost drivers of faculty salary impact all schools and models equally.

5. Discussion and Conclusion

In this study, we estimated the costs of several different co- and pre-requisite English developmental education pathways that were implemented in Texas community colleges by Miller et al. (2022) and compared costs to the main program benefit: the number of students passing the introductory college-level course English Comp 1.

Considering net benefits to society as a whole, the models in two colleges clearly favored corequisites as they were less expensive and led to more students passing English Comp 1. In the remaining three colleges, corequisites led to more students passing English Comp 1 but they were more expensive to implement than pre-requisites. For these schools, policy makers must decide whether the additional students passing are worth the added costs, which we estimate to range from $200 to $5000 per additional English Comp 1 pass. On one hand, these costs are far lower than the typical return to a college degree, but on the other hand, Miller et al. (2022) find that there is no observed difference in college persistence rates between co- and pre-requisites.

From the student point of view, the corequisites in this study are clearly superior: students attempting corequisites pay less tuition than under a pre-requisite pathway, more students pass English Comp 1, and

students spend less time in the classroom (albeit, students may learn less as a result of less class time). From a budgetary standpoint for colleges, the net instructional cost of corequisites (costs less tuition and state funding) are higher than for pre-requisites in 4 out of 5 colleges.

Overall, the results of this analysis should prove useful to administrators deciding between co- and pre-requisite developmental English pathways, and can also provide critical evidence to inform decisions on how to design corequisites. Our findings on the key drivers of corequisite costs and variation across models should be considered alongside other research on the implementation and outcomes of corequisites with different features. With regard to implementation, some of the features that add costs also create implementation challenges. For example, the scheduling of students into smaller-sized cohorts for support can increase the complexity of advising and enrollment (Daugherty et al., 2018). And limitations on who can teach corequisites may raise issues with faculty buy-in, and limit the capacity for institutions to scale corequisites.

While more causal research is needed to fully understand the value of different corequisite models and features, the current evidence suggests that some of the biggest cost drivers for corequisites may offer limited value. While smaller cohorts in the academic supports are viewed as essential features of some corequisite models such as the ALP, studies of corequisites in Colorado and Texas find that smaller course sizes are not associated with better student outcomes (Bahr et al., 2022; Ryu et al., 2022). Moreover, corequisites taught by adjunct instructors are less costly to implement, and are also associated with improved outcomes for students (Bahr et al., 2022; Ryu et al., 2022).

The corequisites we examined were among the least intensive of those being rolled out across Texas and other states, as many corequisites require 3 hours of weekly support alongside the college course (Daugherty et al., 2018; Park et al., 2022; Ran and Lin, 2022; Rodriguez et al., 2018; Ryu et al., 2022). So our estimates of costs may underestimate the average costs of corequisites as they are being scaled. Evidence on math corequisites in Texas suggest that those with more hours of support had higher success rates (Ryu et al., 2022). On the other hand, some students may be able to pass the college course without any support (Scott-Clayton et al., 2014), and hence may benefit most from less intensive corequisite supports (or no support). Institutions may want to consider offering a range of corequisite supports that vary in intensity, though this will add complexity in terms of advising and scheduling.

This evidence on the cost of corequisites can help to inform the decisions of states and institutions across the country as they scale corequisites as a primary approach to academic support for entering students. It will be valuable to continue building evidence on the costs and benefits of different corequisite models as these approaches are scaled. However, it is also important to acknowledge that the evidence on corequisites for completion outcomes are mixed, and institutions may need to invest in other reforms and supports to improve college completion rates. Importantly, corequisite remediation primarily supports students during their first semester in college, whereas comprehensive advising and student support programs such as the CUNY ASAP model that support students past their first year in college and proactively connect students to needed academic and nonacademic supports to address ongoing challenges have been demonstrated to significantly improve long term outcomes including persistence and completion (Mayer and Tromble, 2022; Weiss et. al., 2019). Colleges may consider implementing corequisites in a context of comprehensive advising and supports to move the needle on completion. At the same time, they face capacity and budget

constraints that require decisions and tradeoffs between different initiatives, and will need to consider the cost effectiveness of corequisites alongside and relative to these other initiatives.

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Table 1. The costs and benefits of co-requisite and pre-requisite English developmental education.

	Accelerated Learning Program		Extended Time	Academic Support Service	
	College A	College B	College C	College D	College E
# DE students eligible for treatment	100	100	100	100	100
Co-requisite DE support & English Comp 1					
Price of textbook	$42	$13	$42	$42	$0
Cost of textbooks to students	$2,100	$650	$2,100	$2,100	$0
<u>DE support</u>					
Contact hours per week	3	1	1	1	1
Credit hours per week	1	1	1	1	1
Average # DE students per class	5.9	9.3	20	4.8	10.7
Cost to deliver DE support	$150,601	$31,909	$9,055	$56,458	$27,418
<u>English Comp 1</u>					
Credit/contact hours	3	3	3	3	3
Average class size	22.6	19.7	23.2	22.2	17.1
Cost to deliver English Comp 1	$39,199	$44,175	$23,419	$36,331	$44,001
Total cost	$191,900	$76,733	$34,574	$94,889	$71,419
Number of students passing English Comp 1	71.87	67.60	66.44	76.74	52.48
IRW as a pre-requisite for English Comp 1					
<u>Integrated Reading and Writing (IRW)</u>					
Price of textbook	$69	$0	$9	$14	$72
Cost of textbooks to students	$3,450	$0	$450	$700	$3,600
Credit/contact hours per week	5	4	4	4	3
Average class size	22.3	25.4	30.9	22.1	15.1
Cost to deliver IRW	$76,964	$38,929	$29,425	$49,676	$47,983
<u>English Comp 1</u>					
Number of students attempting	75.13	78.12	67.98	67.71	62.56
Price of textbook	$42	$13	$42	$42	$0
Cost of textbooks to students	$1,578	$508	$1,428	$1,422	$0
Credit/contact hours per week	3	3	3	3	3
Average class size	22.6	19.7	23.2	22.2	17.1
Cost to deliver English Comp 1	$29,450	$34,508	$15,919	$24,600	$27,525
Total instructional cost of pre-requisite pathway	$111,442	$73,945	$47,222	$76,398	$79,108
Number of students passing English Comp 1	56.97	55.44	44.79	49.61	38.08
(Co-requisite pathway) - (Pre-requisite pathway)					
Difference in costs	$80,458	$2,789	-$12,648	$18,491	-$7,689
Difference in students passing English Comp 1	14.9	12.2	21.7	27.1	14.4
Cost per additional pass	$5,399	$229	-$584	$682	-$534

Notes: Data on class size and attempt rates come from THECB administrative databases, however, we can not identify which English Comp 1 sections enrolled DE support students and so we use the college-wide average for both co-requisites and pre-requisites models. We assume students can sell textbooks for 50% of their purchase price.

Table 2. The pre-contact-hour cost of teaching.

	By College				
	Accelerated Learning Program		Extended Time	Academic Support Service	
	College A	College B	College C	College D	College E
Costs of instruction by full-time faculty					
Average salary per contact hour	$2,117	$2,479	$1,843	$1,487	$1,518
Percentage of time devoted to service	20%	20%	20%	20%	20%
Fringe benefits as a percentage of salary	50.8%	50.8%	50.8%	50.8%	50.8%
Overhead rate	92%	92%	92%	92%	92%
Average cost per contact hour	$4,896	$5,734	$4,264	$3,439	$3,512
Costs of instruction by adjuncts					
Compenastion per contact hour	$670	$668	$668	$911	$775
Fringe benefits as a percentage of salary	33.0%	33.0%	33.0%	33.0%	33.0%
Overhead rate	92%	92%	92%	92%	92%
Cost per contact hour	$1,709	$1,704	$1,704	$2,323	$1,976
Costs of teaching English Comp 1 or DE support					
% classes taught by full time	39.0%	29.7%	4.2%	32.7%	34.6%
Cost per contact hour, weighted by faculty type	$2,953	$2,901	$1,811	$2,688	$2,508
Costs of teaching IRW					
% classes taught by full time	54.1%	19.1%	22.2%	37.8%	28.6%
Cost per contact hour, weighted by faculty type	$3,433	$2,472	$2,273	$2,745	$2,415

Notes: Average full-time faculty salary is calculated from administrative data and adjunct compensation per contact hours data are publicy availble; they are both in 2016 dollars. Fringe benefit estimates come from the National Compensation Survey conducted by the Bureau of Labor Statistics and reflect full- and part-time employees in the higher education sector. The percentage of courses taught by full-time faculty is calculated from administrative data. The overhead rate is estimated as an average of published statistics from colleges B, C, and D and from IPEDS estimates for Colleges A and E.

Table 3. Transfers and net instructional costs to colleges.

	By College				
	Accelerated Learning Program		Extended Time	Academic Support Service	
	College A	College B	College C	College D	College E
# DE students eligible for treatment	100	100	100	100	100
Tuition per credit hour paid by students	$67.50	$62	$62	$114	$59
Co-requisite DE support & English Comp 1					
Total revenue (tuition + state funding)	$77,803	$65,954	$65,524	$90,132	$59,157
Tuition paid by students	$27,000	$24,800	$24,800	$45,600	$23,600
Total state funding	$50,803	$41,154	$40,724	$44,532	$35,557
from success points	$26,593	$25,014	$24,584	$28,392	$19,417
from contact hours	$24,210	$16,140	$16,140	$16,140	$16,140
Net instructional costs to colleges (cost to deliver courses minus revenue)	$114,097	$10,780	-$30,950	$4,757	$12,262
IRW as a pre-requisite for English Comp 1					
Total revenue (tuition + state funding)	$100,149	$87,010	$79,206	$116,578	$63,601
Tuition paid by students	$48,964	$39,330	$37,444	$68,757	$28,772
Total state funding	$51,186	$47,681	$41,762	$47,820	$34,828
from success points	$21,916	$22,085	$17,394	$23,484	$15,151
from contact hours	$29,269	$25,596	$24,369	$24,336	$19,677
Net instructional costs to colleges (cost to deliver courses minus revenue)	$11,292	-$13,066	-$31,984	-$40,180	$15,507
(Co-requisite pathway) - (Pre-requisite pathway)					
Difference in net instructional costs to colleges	$102,805	$23,845	$1,034	$44,937	-$3,245
Difference in net instructional costs to colleges per student	$1,028	$238	$10	$449	-$32

Notes: Tuition per credit hour is published on college's websites. The state of Texas reimbursed $185 per success point in 2016, and colleges earned 1 point for each student who passed a DE English course (either the DE support or IRW) and 1 point for each student who passed English Comp 1. The state also reimbursed colleges $2.69 per student-contact-hour in 2016; we assume there are 15 weeks in each semester.