

Is Corequisite Remediation Cost-Effective? Early Findings From Tennessee

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In fall 2015, with leadership from the Tennessee Board of Regents, the 13 community colleges in Tennessee implemented corequisite remediation at scale for math, writing, and reading. Under the corequisite model, academically unprepared students take entry-level college courses simultaneously with remedial academic support. The corequisite model differs from the conventional approach in which remediation is provided as a prerequisite to college-level coursework. In this brief we analyze the cost-effectiveness of the corequisite remediation model as it was implemented in Tennessee in fall 2015. Using transcript data and information on costs, we estimate the net effect of corequisite remediation on passing the initial college-level math and writing sequences. We find gains in cost-effectiveness from moving from prerequisite to corequisite remediation under almost all plausible scenarios. Based on these Tennessee data, the success rates from corequisite remediation indicate a more efficient instructional system for students who enter college academically underprepared.

Many colleges and state systems are redesigning their remedial programs with the goal of ensuring that many more academically underprepared students take and pass college-level gateway courses and enter a program of study as quickly as possible (Jaggars, Edgecombe, & Stacey, 2014). Low completion rates in remedial sequences and subsequent low retention into college-level courses suggest that remedial programs often serve as an obstacle to student progression (Scott-Clayton & Rodríguez, 2012). The result is high rates of dropout and frustration among students, and lower enrollments for colleges. Redesigns of remedial programs are intended to reduce or eliminate these problems. However, it is important that such redesigns be affordable and cost-effective. Reforms will not be successful if they cost too much to implement or indeed if they significantly reduce revenue. Colleges therefore need to evaluate both the effectiveness and the efficiency of their remedial redesigns.¹

One redesign strategy is to adopt a “corequisite” approach, in which students take entry-level college courses simultaneously with remedial academic support (Complete College

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America, 2016). Corequisite remediation can help by motivating students who would otherwise need to complete a sequence of one or more remedial courses before getting to college-level material, which can be very discouraging. It can also ensure better alignment between academic support and the requirements for success in college-level coursework. Connecting academic support directly to a college-level gateway course can help instructors to focus on areas where students are struggling and reinforce the college-level material, making it easier to learn and to retain information and skills (Jaggars, Edgcombe, & Stacey, 2014).

In fall 2015, with leadership from the Tennessee Board of Regents, the 13 community colleges in Tennessee implemented corequisite remediation at scale for math, writing, and reading, following successful pilots in fall 2014 and spring 2015. This implementation followed an earlier reform in which the community colleges in the state redesigned their prerequisite remedial program. In the earlier reform, remedial courses were divided into modules that students took based on their learning needs. Class time was spent in a computer lab, with faculty tracking student progress in class. Students who passed the prerequisite remedial modules were then eligible to enroll in the same-subject-area college-level gateway course, typically in the following semester. The new reform implemented broadly in fall 2015 is based on a corequisite model. Students who require remediation enroll jointly in a learning support course paired with a college-level gateway course. As part of the new reform, the colleges engaged faculty in aligning material for the college-level and corequisite courses.

Provisional data from a fall 2014 pilot study had shown that pass rates in the college-level gateway courses increased substantially under the corequisite model; gains were found for low-income, adult, and minority students. (It is important to note that during the pilot phase and subsequent scale-up of the corequisite model, the colleges were undertaking additional related reforms that may have influenced these gateway course outcomes, which we discuss below.) But knowing that courses are more effective does not necessarily mean they are more efficient. To deter-

mine whether the corequisite model is more efficient, it is necessary to consider the costs of such an approach. There are three possible sources of extra cost.

First, if the model is successful, more students will be retained and graduate. This is the goal of the strategy, but because students will be taking more courses, colleges will have to provide more courses, driving up their costs. Depending on the tuition and reimbursement model, these extra costs might be offset by additional revenue.

Overall, we find that corequisite remediation as implemented in Tennessee community colleges in fall 2015 is significantly more cost-effective than the prerequisite remediation model that the colleges used in academic year 2012–13. But it does cost more.

Second, the cost for each student in a corequisite remedial course might be higher than the per-student cost in a prerequisite course. For example, colleges could employ smaller sections, provide more counseling, or use more expensive faculty under the corequisite model. (And costs for college-level courses may be different as well.) These costs might persist for a long time.

Third, there will be transition costs in moving from the status quo of prerequisite remediation to the new corequisite model. The transition will require faculty and administrator time to implement the changes (e.g., to develop new courses, get those courses approved by the college, and prepare faculty to teach them). The associated transition costs need to be accounted for, but they would presumably fade away as the program is established.

Let us consider the first source of cost—the cost of additional courses under the corequisite model—assuming for the moment that the cost per student per course is the same for traditional and corequisite remediation. For corequisite remediation, the costs are higher, at least in the short term. This extra expense is straightforward. Instead of offering college-level courses only for students who

pass remediation, under the corequisite model, the college must offer college-level courses to all students who are in remediation, making it necessary to bring on additional instructors to accommodate the increased enrollment in college-level courses. This extra cost alone is substantial.

Therefore, in redesigning remedial programs, colleges face an important trade-off. Corequisite remediation may appear to be more effective, but it also requires more resources. In this brief, we examine this trade-off. First, we formalize the trade-off by developing an economic model of remediation based on the paths students take through prerequisite or corequisite remediation into college-level courses. Second, using Tennessee data, we report on the incremental gain in college-level gateway course pass rates from corequisite remediation. In this analysis, we focus on math and writing, because Tennessee's approach to corequisite instruction in reading is more complicated and more difficult to study.² Third, again using Tennessee data, we calculate the transition costs of corequisite remediation and the per-student costs of courses under the prerequisite and corequisite models. Fourth, we put the gains in pass rates together with costs to derive the cost-effectiveness of corequisite remediation. Fifth, we discuss other issues that college leaders need to consider when assessing the feasibility of switching to a corequisite remediation model. Finally, we outline questions that remain to be answered by further experimentation and innovation in remedial instruction in Tennessee and other states.

Overall, we find that corequisite remediation as implemented in Tennessee community colleges in fall 2015 is significantly more cost-effective than the prerequisite remediation model that the colleges used in academic year 2012–13. But it does cost more. With students now taking more college-level courses earlier on, corequisite remediation requires substantially more resources for the initial semester for each cohort of new students.

Economic Model of Remediation

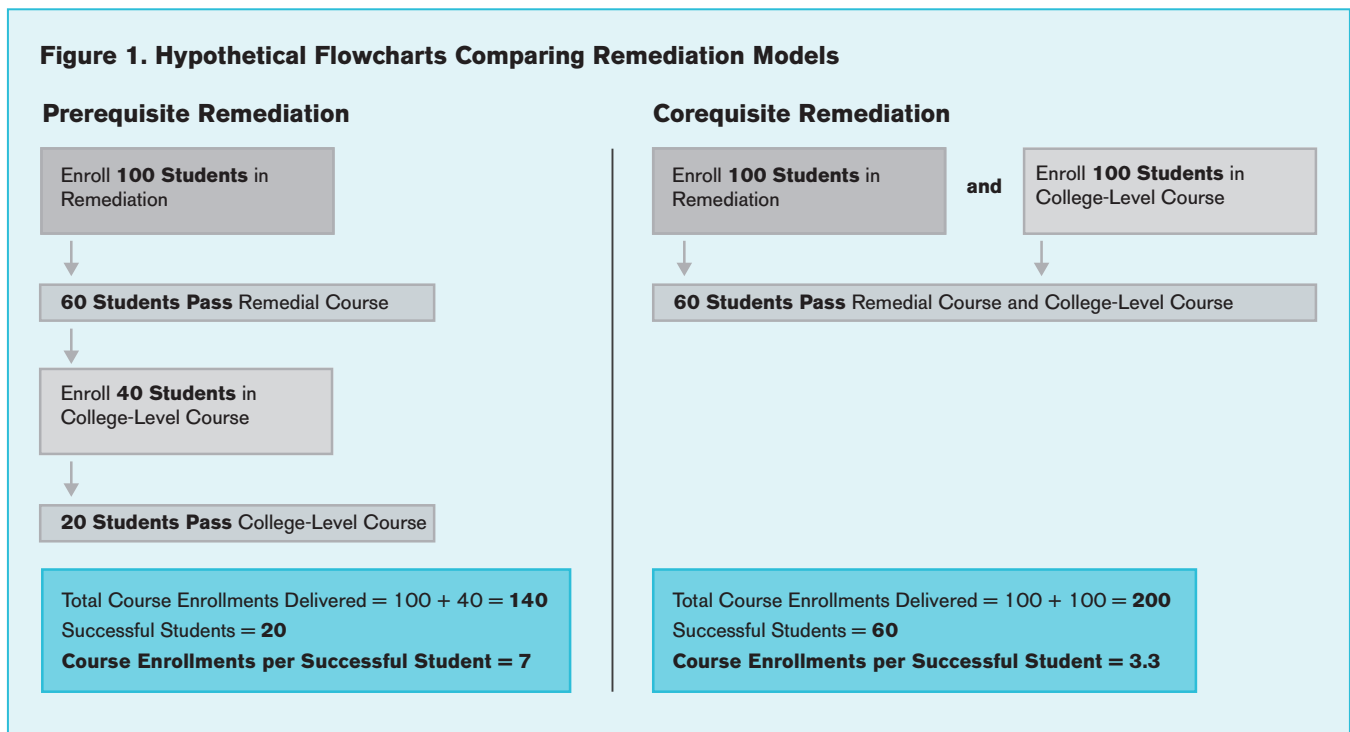
We develop a simple economic model of remediation based on the paths students follow through their first semesters in community college. This model adopts a college perspective: The college's objective is to allocate resources in a way that best enables students to pass college-level gateway courses, such as Math 101 and English 101, so that they can progress to graduation. We perform the analysis separately for math and writing.

We illustrate the model in Figure 1 using a simple hypothetical scenario. In the scenario we focus on the number of course enrollments that are delivered. We assume that the per-student costs of all the courses are the same (we relax this assumption later). We compare courses required per successful student under prerequisite and corequisite remediation.

On the left-hand side of Figure 1 is a flowchart showing progression through prerequisite remediation and the first college-level course. One hundred students enter remediation, of whom 60 pass the remedial course. Of these 60 students, only 40 subsequently enroll in the relevant college-level gateway course. Twenty of those 40 students pass the gateway course. The end result is 140 course enrollments delivered and 20 successful students. There are thus 7 course enrollments per successful student.

On the right-hand side of Figure 1 is a flowchart of corequisite remediation. One hundred students enroll in the remedial learning support course and the college-level course in the same term. Of these students, 60 pass both courses. The end result is 200 course enrollments delivered and 60 successful students. There are thus 3.3 course enrollments per successful student.³

Figure 1. Hypothetical Flowcharts Comparing Remediation Models



In this simple example, corequisite remediation is more costly because colleges must provide resources to accommodate more course enrollments. Yet the corequisite model is also more cost-effective because it requires fewer total course enrollments to be delivered to get a student successfully through the college-level course. The example illustrates the key parameters for comparing prerequisite and corequisite remediation: (1) the respective pass rates for each course, (2) the progression rates into college-level courses, and (3) the per-student costs for each remedial and college-level course. (In this hypothetical example, we assumed that each course costs the same amount. This is a reasonable assumption, as our empirical analysis below shows, but it is not necessarily the case). If we can estimate these parameters, we can calculate the cost-effectiveness of prerequisite versus corequisite remediation at community colleges. To be complete, however, we must include the costs of transitioning from one system to the next to see if it is worth changing from prerequisite to corequisite remediation. Below we make such a calculation for the math and writing remedial subject areas using Tennessee data.

Enrollments and Pass Rates

To estimate each of the parameters in the economic model for Tennessee’s community colleges, we used a range of data sources. First, we obtained student cohort enrollment numbers through direct analysis of data from the Integrated Postsecondary Education Data System (IPEDS). Across the 13 community colleges, we estimated annual first-semester enrollment in remedial math and writing at 400 and 270 students per college, respectively.

Second, we obtained data on course success rates for each Tennessee community college under the prerequisite model (fall 2012–spring 2013 data) and the corequisite model (fall 2015 data) from published and unpublished analyses by the Tennessee Board of Regents (2015). Table 1 shows the college-level gateway completion rates among these students. Under the prerequisite model, 12 percent of students assigned to math remediation ultimately passed college-level math in one academic year, and 31 percent assigned to writing remediation passed college-level writing. Under the corequisite model, the success rates were significantly higher at 51 percent and 59 percent, respectively.⁴ Note that the completion rates for the prerequisite model were measured

over a full academic year to allow students who started in a remedial course in one term opportunity to take the college-level gateway course in the next term. For the corequisite model we used data from only one semester (in which students took both remedial and college-level courses).

Table 1. Rate of College-Level Gateway Course Completion Among Remedial Students

| Subject Area | Prerequisite Model | Corequisite Model |
|--------------|--------------------|-------------------|
| Math (%) | 12 | 51 |
| Writing (%) | 31 | 59 |

Source: Tennessee Board of Regents student-level data (fall 2012 and spring 2013 semester data for the prerequisite model, and fall 2015 semester data for the corequisite model).

Note: Completion rates for the prerequisite model were measured over a full academic year; those for the corequisite model were measured over one term only.

Thus, under the corequisite model, many more students made it through their college-level math and writing courses early on, in their first term. These students had more momentum to complete their degree programs on schedule.

Transition and Per-Student Course Costs

The cost data we used are from two sources. The primary source was direct interviews of college personnel we carried out at three of the Tennessee community colleges. We conducted semi-structured interviews with department chairs and administrators with responsibility for remediation across math and writing. Respondents were asked to identify all resources needed to create, implement, and provide prerequisite and corequisite remediation as well as the resources required to transition between the two models. Using this information, we calculated the average costs per course across the three colleges. The secondary source was IPEDS data; we used the cost information from the three colleges and the IPEDS data to estimate costs across the ten other community colleges across the state (Desrochers & Hurlburt, 2016).

Transition costs are the costs of moving from one approach to another. They include the costs of personnel time to develop, pilot, and gain approval for new courses. (In some colleges in Tennessee, new remedial courses were created

to match with the college-level gateway courses; in others, new college-level gateway courses were paired with the existing remedial courses). To create these courses in Tennessee, faculty and staff time were required to design course curricula, pilot courses, consult and inform faculty and Tennessee Board of Regents personnel, and train faculty on software, course requirements, and pedagogy. In addition, institutional personnel time was required to gain approval for the courses from within each college and from the Tennessee Board of Regents, and for each college to change its registration and information systems accordingly. These costs were estimated using the ingredients method and were amortized over five years.⁵

The transition costs varied depending on how much new development was required. The amortized average transition cost per remedial subject area (math or writing) was \$10,330. Although the transition costs are significant, they are not repeated each year (beyond the five years in which they were amortized), and they are spread across each student taking a course in a subject area.

Costs per student for remedial and college-level courses were also estimated from the interviews and from IPEDS data. The per-student costs for each type of three-credit course are given in Table 2. These costs might vary depending on whether the course is remedial or college-level and depending on whether the course is part of the prerequisite or corequisite model. Relative to college-level courses, remedial courses in Tennessee have relied more on adjunct faculty for instruction, but they have often been smaller (e.g., with class sizes less than 20). The net effect is that the cost differential between college-level and remedial courses was quite small.

Table 2. Costs per Student per Three-Credit Course

| Course Type | Prerequisite Model | Corequisite Model |
|---------------------------|--------------------|-------------------|
| Remedial course (\$) | 830 | 930 |
| College-level course (\$) | 1,000 | 1,030 |

Sources: IPEDS 2013 (Desrochers & Hurlburt, 2016); interviews with Tennessee community college personnel (3 colleges).

Notes: Adjusted average for 13 Tennessee colleges. Does not include transition costs. Costs measured in 2015 dollars.

Relative to corequisite remedial courses, prerequisite remedial courses might require more computer labs for instruction and a full training and evaluation system for implementation (National Center for Academic Transformation, 2015). However, prerequisite remediation in Tennessee was designed in a particular way to save on resources. Because it was competency-based, prerequisite remediation was shorter and required less instructional time than corequisite remediation. It operated with larger class sizes (estimated at 30) and sometimes relied on instructional assistants to support students in the computer labs. Overall in Tennessee, remedial prerequisite courses were lower in cost than corequisite courses.

Relative to college-level courses operated in conjunction with corequisite remediation, college-level courses operated in conjunction with prerequisite remediation were slightly smaller, although there was a lot of variation in enrollment patterns across subjects and colleges. Thus, each college-level course cost about the same.

Overall, the costs per course were not very different under the two models. As shown in Table 2, for remedial courses, the cost was \$830 under the prerequisite model and was \$930 under the corequisite model. For college-level courses, the cost per three-credit course was \$1,000 and \$1,030, respectively. In practice, for these colleges, the cost per course did not vary much under prerequisite versus corequisite remediation.

Applying the Model: Results

Using the above data, we estimate the cost-effectiveness results for prerequisite and corequisite remediation in Tennessee. The results for both math and writing are given in Table 3 (see below) and are from the college perspective.

We start with a college with approximately 400 new students who require remediation. If these students were in the prerequisite model, only 49 (12 percent) would progress through to complete the college-level gateway math course. The total cost of educating those students in their remedial and college-level gateway courses would be \$382,100. Hence, the average cost per successful student would be \$7,720. This is the amount of resources needed to yield one successful student.

By contrast, if the 400 students were enrolled in the corequisite model, 204 (51 percent) would progress through to complete their initial college-level math course. In itself, this is a substantial increase in the number of successful students (+155). However, corequisite remediation requires 200 course enrollments to be delivered, plus resources are needed to transition from the old to the new model. The total resources allocated to those students is \$786,000. Notably, this is more than double the resources required under the prerequisite model. Nevertheless, the increase in successful gateway course completions is more than double, such that the cost per successful student is \$3,840.

| | Math | | Writing | |
|---|--------------------|-------------------|--------------------|-------------------|
| | Prerequisite Model | Corequisite Model | Prerequisite Model | Corequisite Model |
| Number of new remedial students (per year per college) | 400 | 400 | 270 | 270 |
| Number of successful students (S) | 49 | 204 | 83 | 159 |
| Total cost of remedial and college-level course enrollments (TC) ^a | \$382,100 | \$786,000 | \$310,800 | \$527,500 |
| Average cost per successful student (TC/S) | \$7,720 | \$3,840 | \$3,750 | \$3,350 |
| Efficiency gain | | +50% | | +11% |

Notes: Calculations based on Tables 1 and 2. Adjusted average for 13 Tennessee colleges. Costs measured in 2015 dollars.

^a Includes transition costs.

Overall, corequisite math remediation is significantly more cost-effective than prerequisite math remediation. The corequisite model requires 50 percent less resources than the prerequisite model does to enable an academically under-prepared student to succeed in completing the college-level gateway course.

For writing, Table 3 shows the differences in success rates, costs, and cost-effectiveness between the two models. Starting with 270 students needing remediation, under the prerequisite model 83 would be successful; the total cost for these students is \$310,800. This yields a cost per successful student of \$3,750. By contrast, with the corequisite model the number of successful students jumps to 159. This requires resources (including transition costs) of \$527,500, an increase of 70 percent over the prerequisite model. However, the cost per successful student is lower at \$3,350.

As with math, corequisite writing remediation is significantly more cost-effective than prerequisite writing remediation. There is an efficiency gain or savings of 11 percent per successful student.

These Tennessee findings are robust to sensitivity testing. Specifically, we varied the success rate, the costs per course, and the transition costs using alternative data sources in each case. We found efficiency gains from moving to corequisite math remediation under all scenarios. We found efficiency gains from moving to corequisite writing remediation in almost all plausible scenarios. Thus, we are confident that, using the Tennessee data, the success rates from corequisite remediation indicate a more efficient instructional system for students who enter college academically underprepared.

Additional Cost and Implementation Issues

The economic model presented here shows the value of corequisite remediation. Using the Tennessee data, the costs of corequisite remediation are significantly higher than those of prerequisite remediation: many more students are enrolled in college-level courses who

would not have been previously because they would not have completed their remedial sequences. However, the improvement in the college-level gateway pass rate more than compensates for these extra costs. Under corequisite remediation it costs less to get a remedial student through his or her initial college-level courses in math and writing. College efficiency has improved.

This analysis looks at college efficiency in the general sense—enabling students to make progress using the least amount of resources. However, for college leaders assessing the costs and feasibility of implementing corequisite remediation on their campuses, there are other important considerations.

To begin with, there are at least two additional considerations related to college finance. First, the change in expenditure on new entrants is significant. Including transition costs, total spending is higher in the Tennessee example by at least 70 percent. Of course, this additional spending is associated with higher course enrollments, which should translate into higher revenues both from student tuition and fees and from state funding. Nevertheless, the size of the additional expense may create financial pressure for a college if funding formulae do not immediately reflect the increased enrollments. Colleges in states (such as Tennessee) where funding formulae determine state subsidies to colleges based on their past performance would have to “pre-pay” the investment needed to implement corequisite remediation and would have to wait until they received an increased state subsidy based on improved student success at least one year hence.

Second, our estimates show that corequisite remedial and corequisite college-level courses are slightly more expensive than the prerequisite versions. This means that colleges will not be gaining “surplus” by moving to corequisite remediation. That is, each course will now require slightly more resources than before. Corequisite remediation does not reduce the amount of resources required for each new student.

In addition, colleges need to consider how best to communicate about corequisite remediation to students. From the student’s perspective, corequisite remediation appears

to be a risk worth taking. The risk is that the student now commits to the college-level course in his or her first term instead of waiting to complete the remedial sequence: this means paying more tuition and more time in class “upfront” in the first semester. (Alternatively, the student might not enroll in another course.) However, the probability of passing the college-level course is much higher. Coupled with the fact that the earnings gains from doing well in college are so high, students are likely to be much better off under a corequisite system (Belfield & Bailey, 2011; Jepsen, Troske, & Coomes, 2014). These advantages may not be evident to students, however, and so advisors and others need to agree on strategies for explaining the benefits to students.

Finally, implementing corequisite remediation involves management challenges. Implementing corequisite remediation requires substantial organizational and even cultural changes, as well as different instructional systems and procedures. For corequisite remediation to be implemented and sustained successfully at scale—as with any new instructional method or technology—college leaders need to manage broad organizational changes as well as those at the level of courses and instructional support (Klempin & Karp, 2015). Although we have included some resources required for re-organization in transition costs, there may be hidden costs in terms of faculty adjusting to the new system and confusion about how corequisite remediation operates. Course scheduling may also be harder if more constraints are put on how students can enroll in courses and if course sections are smaller. Therefore, in assessing the feasibility of implementing corequisite remediation, college leaders need to consider these and perhaps other issues beyond the cost-effectiveness of the model itself.

Unanswered Questions About Corequisite Remediation

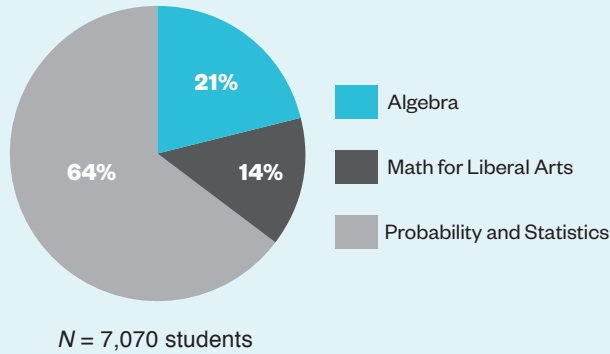
This brief is intended to help college educators and policy makers think about how to assess the costs and effectiveness of corequisite remediation. The results presented here, based on reforms in Tennessee community colleges,

though very promising, are by no means definitive. This is especially true with respect to the effectiveness of corequisite remediation, about which there are still substantial questions to be answered.

First, it is not clear to what extent the outcomes we observe, such as the much higher college-level pass rates, were due to corequisite remediation per se. The results presented here are purely descriptive. The corequisite model has not yet been subjected to rigorous evaluation. Moreover, during the period from which the data used here were drawn, Tennessee community colleges were in the process of implementing an array of very substantial reforms that may have had a bearing on student outcomes. For one, the Tennessee Promise “free community” college policy was implemented statewide beginning in fall 2015. Perhaps more consequential, for the past two years or more, both the two- and four-year institutions under the Tennessee Board of Regents have been implementing reforms aimed at creating clearer “guided pathways” to help students enter and complete programs of study faster.

As part of these reforms, the Tennessee community colleges are now advising many more students than in the past to take college statistics and quantitative reasoning (based on their desired program path) rather than algebra. Figure 2 shows the distribution of college-level courses taken by students who also enrolled in corequisite support classes in fall 2015. Only 21 percent of the college-level courses taken by corequisite students were in algebra courses; most corequisite students enrolled in Probability and Statistics or Math for Liberal Arts. According to college officials, in the past, most incoming students were referred to an algebra path rather than these others. At least some of the improvements in college math pass rates we observe could be the result of this major shift in the type of college-level math course students are taking. (Note that there may be transition costs, not accounted for in this study, of training more faculty to teach courses in statistics and quantitative reasoning as opposed to algebra.) Further research is needed on the effectiveness of corequisite remediation not only in enabling students to pass college-level math and English courses, but also on their success in other college-level courses.

Figure 2. Distribution of College-Level Math Courses Taken by Tennessee Corequisite Students, Fall 2015



Second, even to the extent that corequisite remediation is effective, it is not clear precisely what practices work best for different subject areas and students. Indeed, it appears that how the Tennessee community colleges approached corequisite remediation varied substantially across institutions and by subject area. Table 4 summarizes the approaches used by the three Tennessee colleges in which we conducted interviews. At all three colleges and in each subject area, each college-level and learning support course was worth three credits.

Table 4. Corequisite Remediation Practices at Three Tennessee Community Colleges

| Subject Area | Community College 1 | Community College 2 | Community College 3 |
|--------------|--|--|---|
| Math | <ul style="list-style-type: none"> • Three math pathways, all corequisite—Intermediate Algebra, Probability and Statistics, and Math for Liberal Arts • Learning support and college-level courses are both taught using the emporium model | <ul style="list-style-type: none"> • Two math pathways, both corequisite—Intermediate Algebra and Probability and Statistics • Use <i>7+7 approach</i> or <i>side-by-side approach</i> in both pathways; that is, corequisite students can complete learning support in 7 weeks, then complete college-level course in second 7 weeks of semester, OR, both learning support and college-level courses are 15 weeks, with same instructor for both courses | <ul style="list-style-type: none"> • Two math pathways using corequisite—Intermediate Algebra, and Probability and Statistics • Learning support and college-level courses are both taught using the emporium model |
| Writing | <ul style="list-style-type: none"> • Both courses are taught in classroom setting • In college-level course section, there is a maximum capacity of 22 students; 9 seats are reserved for corequisite students; all 9 students are enrolled in the same learning support class together with 9 more corequisite students from another college-level course section | <ul style="list-style-type: none"> • Learning support is offered online and in-person • In college-level course, 13 seats are reserved for college-ready students; 13 are reserved for corequisite students. • Same faculty member teaches learning support and college-level course | <ul style="list-style-type: none"> • Same faculty member teaches learning support and college-level course |

Third and finally, while pass rates increased substantially for college-level math and writing under the corequisite model, many students who took corequisite courses did not pass—nearly half in math. So the corequisite approach may not be effective for some students. Why this is the case and what approaches can work for these students are questions for further experimentation and research.

For systems and colleges across the country, these three issues are important. Moreover, the results from other remedial redesigns using the corequisite approach will depend on the specific values for the costs and revenue per course enrollment under each model and the relative success of the new corequisite approach. The results for Tennessee are based on the specific implementation of corequisite remediation by the state's community colleges in fall 2015.

To their credit, our colleagues at the Tennessee community colleges and the Tennessee Board of Regents, who have provided leadership for these reforms, are not declaring victory but rather are acknowledging that there are many questions to be answered about how to make corequisite remediation work best for students. The colleges and the Board have been working intensively to enhance outcomes for academically underprepared students for several years. They piloted the corequisite model in fall 2014 and spring 2015 (building on lessons from earlier reform efforts) and then as mentioned only implemented it at scale starting in fall 2015. According to the colleges and the Board, the next phase of work will be focused on trying to fine-tune corequisite remediation in the different subject areas. They acknowledge that there is probably no one right approach and that the process of improvement will be on-going and iterative. Moreover, they also recognize that there are students for whom corequisite remediation does not seem to work. How to identify those students and how best to serve them will be another key focus of their work moving forward.

Endnotes

1. On the efficiency of remediation, see studies by Bettinger, Boatman, & Long (2013) and Belfield, Crosta, & Jenkins (2014).
2. Under the corequisite model implemented by the Tennessee community colleges under the leadership of the Board of Regents in fall 2015, colleges were allowed to choose which college-level courses to pair with remedial reading as a corequisite. Identifying the particular college-level courses is difficult with the data we have available, so we confine our analyses here to math and writing. Moreover, under the prerequisite model, there was no standalone college-level reading course, so the comparison between the prerequisite and corequisite model in reading is not equivalent to that in writing and math. Further research is needed to examine the effectiveness of the corequisite approach for reading.
3. Students who fail remediation might then re-enroll in the following semester. However, that applies to both the prerequisite and corequisite models. Also, students who re-enroll might pass and so would contribute to output. Therefore, re-enrollment should not materially affect the model. The only way in which it might be influential is if there are differential re-take pass rates for students who initially fail remediation. Yet, if this occurs, it would be a bias against the corequisite model.
4. Pass rates were higher under the fall 2014 and spring 2015 pilot implementation of corequisite math and writing remediation, at 63 percent and 67 percent respectively.
5. Costs for all personnel time (faculty and institutional) were calculated based on hours of time and an hourly wage rate at that personnel level and experience level. Facilities and general overheads were estimated proportionately to hours of work time. Materials were estimated from evidence on overheads per hour.

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