Creating and Applying a Research Reporting Framework for Corequisites

**Title:** Creating and applying a research reporting framework for corequisites

**Author:** Jacqueline Coomes, Professor of Mathematics, Eastern Washington University

**Abstract:** Philanthropic forces are shaping higher educations' efforts to improve student success in mathematics, arguing that traditional remedial mathematics education is an obstacle to student retention and graduation. Such forces have unleashed political, economic, and social justice arguments accelerate students through or around remedial mathematics. Corequisites have been held up as a shining example of this effort, but peer-reviewed research to date has not described aspects of corequisites that are beneficial, which students corequisites help, and the effects of corequisites on retention and graduation. This presentation will share a framework describing the information, data, and analyses that should be present in peer-reviewed research reports of corequisites to make them more useful to the field. We then share the results of an ongoing three-year grant funded project to design and implement two different mathematics corequisites. Finally, we share ongoing research questions and ways of exploring them. (150 words maximum)

**Summary:** Corequisites have been described as a betterment to remedial mathematics but peer-reviewed research has not yet offered much support in ways that are helpful to decision-makers. This session presents a framework for reporting research on corequisites and results of a three-year project to design and implement two different mathematics corequisites. (50 words maximum)
Questions for participants:
What information, data, and analyses would you need to see in order to believe that a particular corequisite design and implementation was successful?
What information, data, and analyses would you like to have before you begin developing your own corequisites or in order to improve your current corequisites?
Which student factors do you think affect student success in mathematics, and how can those be measured? How can those same factors be affected so that students are more likely to be successful?

Rationale for corequisites
Boylan and Trawick (2015) describe the forces that have led the impetus for changes in developmental mathematics. Well-intentioned, these political, economic, and social justice forces have been far out in front of the peer-reviewed research, convincing legislators and higher education administrators that alternate ways of completing developmental mathematics are 'best practices' and are cost-effective (Belfield, Jenkins, and Lahr, 2016; Mokher, Park-Gaghan, and Hu, 2020). But now that many institutions and states have created and offered math corequisites, what can research tell us that is useful to the field going forward? There is a dearth of peer-reviewed research, and the research that exists does not provide enough information to help administrators and math departments make informed decisions on whether and how to structure their corequisites.

The argument for corequisites goes like this: when students are required to take several courses before reaching college-level coursework, they are more likely to stop taking those courses even when they have passed the prerequisites (Bailey, Jeong, and Cho, 2010). In order to provide more students an opportunity to take a college-level class sooner, the Community College Research Center promotes the replacement of developmental prerequisites with corequisites (Bailey, Jaggars, & Scott-Clayton, 2013). However, while the lack of success in developmental mathematics is the most frequently cited reason to implement corequisites, the authors’ argument rests on research that has been challenged as insufficient and flawed (Bailey et al., 2013; Goudas & Boylan, 2012; Goudas & Boylan, 2013) and the researchers themselves admit that no corequisite model has been subjected to rigorous research (Belfield, Jenkins, and Lahr, 2016). Furthering this argument, Valentine, Konstantopoulos, and Goldrick-Rab (2017) reviewed research on placement into developmental education (reading, writing, and mathematics) and determined negative effects. Again, some assumptions in this research are problematic. The research has not shown that the placement of students into developmental tracks is the cause of their lack of retention, but rather is an indication of their status as academically at-risk.

A long sequence of developmental math is not only an economic issue, it is a social justice issue. Students who place into developmental mathematics are disproportionately from underrepresented minorities and are first-generation college students. Bonham and Boylan (2011) argue that well-designed developmental mathematics sequences have shown significant improvements in students’ success to reach college-level mathematics. However, Bailey, Jeong, and Cho (2010) showed that African American students were less likely to progress through long sequences of developmental courses than other students. Matz and Tunstall (2019) examined the issue of developmental mathematics from a social justice point of view, emphasizing the need for various corequisite models that provide more time on task and just-in-time content, but their intervention concluded with mixed results and they asserted that there is still much to be learned.
Goudas and Room (2017) provide a critical analysis of the current state of corequisites. Goudas (2018) further describes the harm that can come to a student's college trajectory. Unfortunately, as far as I can tell, there are no articles in peer-reviewed journals that summarize what we know about corequisites and that support the argument that replacing developmental mathematics sequences with corequisites increases retention and graduation. The little research that exists does not include crucial information that helps administrators and mathematics departments make informed decisions. In order to provide such a summary, the research shared from current efforts needs to contain sufficient information beyond whether their efforts were successful or not. In this research, I propose a framework describing the information, data, and analyses that need to be included in research reports on corequisites and why such information is important. Then, I use this report framework to share results of a 3-year project in which two different corequisites were developed and taught, one for science, technology, engineering, and mathematics (STEM)-intending majors, and one for quantitative literacy.

**Research reports: Definitions and categories to include**

In order to build a knowledge base for understanding the features of corequisites that support the success of students who are academically at-risk, research reports must contain certain types of information and data. For starters, Goudas and Boylan (2012) emphasize the importance of defining developmental education and success when reporting, and on understanding the larger context in which data are interpreted. Similarly, to understand the impact of corequisites, research reports must detail what they mean by corequisite, and when they can report success or partial success. In order for others to learn from the research, reports must include factors related to the content and function of the courses, contextual features, and control variables; these are important to allow readers to understand the context well enough to know whether the report can be used in a meta-analysis or in their own contexts. The presentation will further flesh out this framework for reporting.

Contextual information should include whether the corequisites were mandated or initiated from within the department, and the level and types of support from administration and advisors. Contexts should include descriptions of other initiatives affecting developmental mathematics such as math requirements for different degrees, and also how the course was developed and who was involved. The report needs to provide a clear description of the course framework and philosophy for pedagogy and content. For example, some corequisites incorporate study skills, but reports need to go beyond stating such and describe the nature of those study skills and how they were taught, citing relevant research. Reports should include thorough descriptions of content, goals, and learning outcomes. Further information should include roles of advising, non-cognitive interventions, and rationales for each of those decisions.

Rationales for decisions matter since institutions require mathematics completion to meet larger goals across campus. Contextual descriptions should include ways others on campus contributed to and responded to the corequisites. For example, other courses such as chemistry or economics may require a specific developmental course to be completed as a prerequisite, so that completing the college-level mathematics course with a corequisite may not satisfy that requirement. Were goals focused only on learning what is needed in their major or more broadly defined? Further: Who is allowed to teach the course? Is professional development included, and if so, what does it entail? And, to what extent are equitable or culturally-responsive strategies...
explicitly incorporated into the courses? What are testing and grading practices within the course? Is the course for-credit and, if so, how do the credits count?

A second category of information to include involves understanding how the course affected students. This begins with how students were placed into the course, and what researchers mean by success. Since the argument for corequisites is that more students will be retained and graduate than if they take a college-level course (CLC) earlier, then how did the corequisites affect retention and graduation? How does the CLC relate to the student learning outcomes of the institution? If the goal of the CLC is quantitative literacy that students can use in other college-level courses such as economics and science courses, but the philosophy of the corequisite was strictly to help students pass the CLC, did students do as well in their other quantitatively demanding courses? Also, if the corequisite supported the first CLC in a sequence of quantitative courses, as would be the case for STEM majors, did the research demonstrate success in those later courses?

The social justice issues briefly alluded to above highlight that some populations see less success than others. Therefore, research reports should include student factors (Childers, Hairston, and Squires, 2013) describing which students benefitted from the corequisites and which did not. This, together with the framework for content and pedagogy, can help mathematics departments design and implement more equitable corequisites, and help the field progress toward more equitable practices. The question for researchers is which factors are important and how are they measured?

The framework for reporting research on corequisites is still in progress. The presentation will provide a more complete picture while also generating ideas from the audience.

**Demonstrating effectiveness of two corequisites in one institution**

Finally, the presentation will use the framework described above to report on a grant-funded project to design and implement two different corequisites, one for quantitative reasoning and one for the STEM track. The project was funded from 2018-2021, so will have implications from issues related to the pandemic. The research report will answer most of the questions in the framework described above using statistical analyses, and descriptive and survey data. We will also discuss questions we did not answer and ways to answer them.
References


Creating and Applying a Research Reporting Framework for Corequisites

Jackie Coomes, Eastern Washington University
**Poll results**

Your opinion: To what extent does student placement into developmental mathematics cause them to leave college without a degree?

Poll created by speaker, Jacqueline Coomes

<table>
<thead>
<tr>
<th>Poll Results</th>
<th>32 Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>no effect</td>
<td>0 / 32</td>
</tr>
<tr>
<td>great effect</td>
<td>16 / 32</td>
</tr>
<tr>
<td>some effect</td>
<td>16 / 32</td>
</tr>
</tbody>
</table>

**Poll results**

Your opinion: To what extent has the current literature convinced you that corequisites will make a large difference in the retention and graduation of students?

Poll created by speaker, Jacqueline Coomes

<table>
<thead>
<tr>
<th>Poll Results</th>
<th>26 Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>not convinced</td>
<td>8 / 26</td>
</tr>
<tr>
<td>somewhat convinced</td>
<td>13 / 26</td>
</tr>
<tr>
<td>absolutely sure</td>
<td>5 / 26</td>
</tr>
</tbody>
</table>

**Poll results**

Your opinion: How much of a social justice issue is MATH?

Poll created by speaker, Jacqueline Coomes

<table>
<thead>
<tr>
<th>Poll Results</th>
<th>31 Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>it is not a social justice issue</td>
<td>13 / 31</td>
</tr>
<tr>
<td>somewhat</td>
<td>9 / 31</td>
</tr>
<tr>
<td>Math is central to social justice</td>
<td>9 / 31</td>
</tr>
</tbody>
</table>
Questions for Participants

• In what ways do your own experiences affect your perspectives on corequisites?
• What evidence do you need to be reasonably convinced that corequisites are effective and you should implement them?
• What research would help you know how to design and implement corequisites?
• What assumptions do you hold about the role of math in college?
The Problems Providing the Impetus for Corequisites

• Developmental math – “bad” for retention and graduation
Problems, continued.

• Or is it?
  – Regression discontinuity designs used to show developmental math is harmful are controversial.
  – Bonham and Boylan (2011): well-designed developmental mathematics sequences have shown significant improvements in students’ success to reach college-level mathematics.

Other Problems:
  • Social justice, including placement testing
  • Economic (Mokher, Park-Gaghan, & Hu, 2020)
  • Stigmatizing

*What other problems?*
Current Research on Corequisites

- Randomized Control Trial: Logue, Douglas, & Watanabe Rose (2019)
- Community College Research Center: Ran & Lin (2019)
- Some success:
  - Matz & Tunstall (2019),
  - Kashyap & Mathew (2017)
  - Childers, Lu, Hairston, & Squires, (2019)
- Many non-peer-reviewed sources:
  - Vandal (2014)
  - Daugherty, Gomez, Carew, Mendoza-Graf, & Miller (2018)

What other research are you aware of?
Foundations for research that builds knowledge

- Define **corequisites** and other important terms
- Articulate goals of college-level mathematics requirements
- Institutional context and related efforts matter
- Course design, teaching, and curriculum matter
- Student characteristics matter
- Define **corequisite success**
Research Framework

• Must be guided by the claims:
  – Improve retention and graduation
  – Reduce time to degree
  – Support students from groups that have been less successful in college
  – Save money

• And, must provide enough information so that readers can discern whether and how the same treatment might be effective in their context.
• A **corequisite** is a course, or a support or set of supports such as a lab or tutoring, that is paired with another course, called the **partner course**, such that the pairing has these two characteristics: (1) students in the pairing were assessed as not academically prepared to enroll in the partner course, and (2) enrolling in the corequisite concurrently is required for students to enroll in the partner course. Additionally, a main goal of the corequisite is to support students to pass the partner course.

**What concerns/questions do you have about this definition?**
Framework for research and design

<table>
<thead>
<tr>
<th>External/State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional</td>
</tr>
<tr>
<td>Department/ Course</td>
</tr>
<tr>
<td>Students</td>
</tr>
</tbody>
</table>
**Table 1: Research Areas At the System Level**

<table>
<thead>
<tr>
<th>Question</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;What is the pattern of student enrollment in developmental education... for different types of students?&quot;</td>
<td>Hu et al. (2016)</td>
</tr>
<tr>
<td>&quot;How are students' demographic characteristics, high school academic preparation, college program of study/degree intention and financial need related to the likelihood of enrolling in developmental education both before and after the implementation of [the legislation]?&quot;</td>
<td>Hu et al. (2016)</td>
</tr>
<tr>
<td>How has the policy impacted retention and graduation rates?</td>
<td>Ran and Lin (2019)</td>
</tr>
<tr>
<td>How has the policy impacted students' completion of first college-level courses?</td>
<td>Hu et al. (2016)</td>
</tr>
<tr>
<td>How has the policy impacted students from specific groups?</td>
<td></td>
</tr>
<tr>
<td>What has been the cost or savings to implement? (For students and for institutions/state)</td>
<td>Mokher, Park-Gaghan, and Hu (2020)</td>
</tr>
<tr>
<td>How have institutions sustained or changed their implementations?</td>
<td></td>
</tr>
<tr>
<td>What other retention initiatives or changes enacted around the same time could impact the success of corequisites (e.g. pathways, financial help, high school curricula)?</td>
<td>Ran and Lin (2019)</td>
</tr>
<tr>
<td>How do students and faculty respond to the reform?</td>
<td>Hu et al. (2017)</td>
</tr>
<tr>
<td>What are some unintended consequences?</td>
<td>Hu et al. (2017)</td>
</tr>
</tbody>
</table>
Institutional context and factors

- Successful reforms do not exist in isolation. Reform efforts must be comprehensive and integrated. (Kezar, 2018, and others)
- Analyze and report on the context: Other initiatives, stakeholders, partner disciplines, population of students, baseline data. What structures, support, strategies, and processes will be needed?
- Understand the current state of math expectations and services:
  - math placement process
  - alignment of current math expectations with students’ high school preparation,
  - expectations throughout the institution for students' math proficiency,
  - current structure and opportunities students have for completing their math,
  - expectations of math faculty to learn and use newer research-based pedagogies,
  - curriculum alignment among math course sequences.
<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the year-to-year retention rates of students assigned to corequisites compared to previous rates of students who took prerequisites and who would have been eligible for corequisites? (Also, broken down by demographics and other student characteristics)</td>
</tr>
<tr>
<td>Comparison of time-to-degree and graduation rates in co-requisites vs. those who took the pre-requisites? (Again, broken down by demographics and other student characteristics)</td>
</tr>
<tr>
<td>What is the retention in intended major of those who take the co-requisites vs. the pre-requisite?</td>
</tr>
<tr>
<td>For students who need additional math/quantitative classes (e.g. STEM or Business majors) how do they do in subsequent coursework?</td>
</tr>
<tr>
<td>What are the rates of success in corequisites and partner courses of different groups of students? (Demographics, GPA, HSGPA, placement score, financial need, FGCS)</td>
</tr>
<tr>
<td>Did students who took the corequisite take fewer credits overall before graduating than those who took the prerequisite?</td>
</tr>
<tr>
<td>Are students more likely to enroll in and complete their math when corequisites are an option?</td>
</tr>
<tr>
<td>What is the difference in overall cost to the institution?</td>
</tr>
<tr>
<td>What other institutional or contextual changes occurred that could have affected the outcomes, and what were those effects?</td>
</tr>
</tbody>
</table>
Department and course decisions

- Course design and structural decisions:
  - Comingled or cohorted?
  - College-credit or non-college credit?
  - Pass the Partner course but not the corequisite?
  - Content - related only to the Partner course or more broad?
  - Professional development for faculty?
  - Student characteristics and demographics?
  - Pedagogy – design principles supported by research?
  - Use of technology or other academic support such as TAs?
  - Financial support for development?
  - Texts?

Curriculum and teaching matter!
Table 3: Research areas and reporting at the course and student level

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Reporting at Course and Student Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of course framework and philosophy for pedagogy and content. In what ways does the course design support the goals of corequisites? Define success in the course: Pass the partner course, the corequisite, or both?</td>
<td>Define success in the course: Pass the partner course, the corequisite, or both?</td>
</tr>
<tr>
<td>Define and describe terms such as basic skills and study skills.</td>
<td>Define basic skills and study skills.</td>
</tr>
<tr>
<td>Who is teaching it and what are their attitudes about teaching it? To what extent do they teach the class the way it was designed?</td>
<td>Who is teaching it and what are their attitudes about teaching it?</td>
</tr>
<tr>
<td>What features of the design were the most impactful and how do you know? (e.g. To what extent does time on task seem to be a relevant factor in success?)</td>
<td>What features of the design were the most impactful and how do you know?</td>
</tr>
<tr>
<td>To what extent did the course meet its goals?</td>
<td>To what extent did the course meet its goals?</td>
</tr>
<tr>
<td>Of those groups of students that do not benefit, are there design changes that could support them better?</td>
<td>Of those groups of students that do not benefit, are there design changes that could support them better?</td>
</tr>
<tr>
<td>Surveys of student experiences in the corequisite and how they value those experiences.</td>
<td>Surveys of student experiences in the corequisite and how they value those experiences.</td>
</tr>
<tr>
<td>Examine changes in student motivation and locus of control, or other goals of the corequisite.</td>
<td>Examine changes in student motivation and locus of control, or other goals of the corequisite.</td>
</tr>
<tr>
<td>For faculty not teaching the course, what are their perceptions of student success in the partner course?</td>
<td>For faculty not teaching the course, what are their perceptions of student success in the partner course?</td>
</tr>
</tbody>
</table>
One project: 2018-current

- Grant from College Spark of Washington that gave design meeting time over two years;
- Designed and taught by faculty in collaboration
- Two different co-requisites: QR and STEM;
- Earns college credit;
- Co-mingled, blind to instructors of partner classes;
- First two pilot quarters not affected by COVID;
- ALEKs placement changed to high school transcript placement this quarter;
Data so far

• Details of context, design, curriculum, and pedagogy:
  – Combined with Pathways and recently, multiple measures placement.
  – Framework for design includes: Transparent teaching, Deep learning strategies, and Building mathematical habits of mind.

• Researching:
  – Comparing students in College-level courses (partner course) from prerequisite vs. corequisite each quarter and overall. Students in corequisites do as well as or better than those from prerequisites.
  – Success based on race/ethnicity, Pell-eligibility, major, gender, HSGPA, FGCS)
  – Surveys of student perceptions
Some results

The groups, Female, non-First Generation, non-PELL, Nursing, Multiple Races, and Unknown/Undeclared did statistically better in Core107 than in Pre107 in passing both Core130/107.

High HS_GPA and college GPA significantly help students pass both Math131/114.