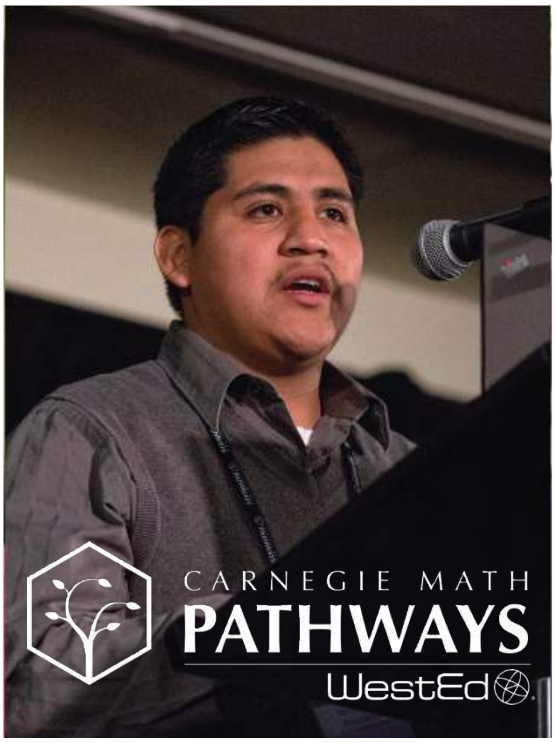

First Year Results for Quantway and Statway Corequisite Courses

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Executive Summary

Carnegie Math Pathways has responded to the changing landscape of developmental education by developing offerings specifically for the corequisite model: Quantway Corequisite and Statway Corequisite. These offerings were piloted in spring 2018 and fully available in fall 2018. In this first year, six institutions implemented these offerings, totaling 21 sections, 15 faculty, and 410 students. 65.1% of the students were successful, achieving college-level math or statistics credit in a single term.

This brief examines the implementation strategies and experiences of faculty and students across the six institutions. It explores the elements of successful implementation, such as the number of contact hours, cohort models, and faculty preparedness. It also discusses challenges of implementation, including managing class time and supporting students with varied reading levels and foundational math knowledge. Finally, it provides suggestions for improvement in the ongoing enhancement of these offerings, such as streamlining materials and building mechanisms for faculty support.

Introduction

An increasing number of states and systems are overhauling the placement methodologies used by community colleges and reconsidering the role of developmental education. The result in many cases is that students who would previously have placed into one or a series of developmental courses are now being placed directly into college-level transfer courses, often with concurrent remedial support. Such corequisite remediation combines a traditional college-level course with a developmental-level corequisite course that offers additional supports. Doing so dramatically decreases the time needed to complete the credit bearing courses and has the potential to increase students' chance of success.

The Carnegie Math Pathways program has helped spur this kind of innovation by demonstrating that with the right supports students traditionally deemed as needing remediation can be highly successful in college-level statistics and quantitative reasoning[1]. Statway and Quantway, two alternative math pathways that integrate developmental and college-level content across two terms, have proven highly successful compared to the traditional math sequence. To date, in 96 institutions throughout the country, students have achieved roughly triple the success rate in half the time compared to students in the traditional math sequence.

Building upon the successful design of these original pathways courses, Carnegie Math Pathways has developed courses specifically for the corequisite model. These new offerings include a stand-alone college-level course with a corresponding corequisite course for both statistics and quantitative reasoning.

These new Carnegie Math Pathways courses have been in use for two semesters at 6 institutions across the nation and have in some cases demonstrated even greater success rates than the original Carnegie Math Pathways. Of the 410 students who have participated in these new corequisite courses, 65.1% have been successful (with a grade 'C' or better), achieving college-level math or statistics credit in a single term.

Yet implementation models and student success rates vary by institution. This brief examines the experiences of faculty, students, and administrators implementing Statway and Quantway Corequisite courses. It summarizes outcomes from various implementation approaches, and discusses lessons learned that may help to inform educators considering corequisite implementation.

[1] Huang, M. (2018). 2016-2017 Impact Report: Six Years of Results from the Carnegie Math Pathways, Stanford, CA: Carnegie Foundation for the Advancement of Teaching, retrieved from https://carnegiemathpathways.org/reports/2016-2017-impact-report-six-years-results-carnegie-math-pathways/

Carnegie Math Pathways Corequisite Courses

The corequisite course model couples a college-level course with a developmental-level corequisite course. Students take both courses simultaneously. The corequisite course is intended to provide the additional foundational support that developmental math learners need to be successful in college-level mathematics. In building Quantway and Statway curricula specifically for the corequisite model[2], an essential requirement was adhering to the key design principles that underlie the success of the original Quantway and Statway courses. Specifically, that meant ensuring adherence to rigorous learning outcomes while enlivening the active, collaborative pedagogy centered on rich, authentic contexts and incorporating Productive Persistence interventions. Productive Persistence includes a broad array of supports intended to improve a student's mindset, sense of belonging, and other non-cognitive factors tied to success in academic learning.

The curricula were designed to be used in various implementations of the corequisite model. College-level course materials were designed for a standard 16-week 3-unit course, and the developmental-level support materials were designed to be used flexibly in corequisite courses from one to four credit hours. Each corequisite lesson is aligned to a college-level lesson in terms of context and content to provide coherence between the college and developmental course components.

The materials were developed by the Carnegie Math Pathways Curriculum Committee, a group of twelve experienced Statway/Quantway faculty from ten institutions across the country, with support and guidance from Carnegie Math Pathways staff. The Curriculum Committee surveyed each of the states and institutions in the Carnegie Math Pathways network to ensure that all of the appropriate learning outcomes were included in each course. The committee then selected and wrote lessons and problem situations that covered the required concepts while still allowing for the kinds of student discussion and discovery that make Carnegie Math Pathways unique.

Certain college-level lessons were intentionally designed with no corequisite lesson in order to allow flexibility to catch-up or review. Optional lessons were also included to address the specific course requirements of state systems and institutions. Corequisite lessons were designed to be independent of each other, so faculty can skip corequisite lessons for which they do not have time or need. Faculty have further flexibility to select the key lessons, or even pieces of lessons, that match their highest priority learning outcomes.

The materials were initially piloted in spring 2018 at two institutions. Feedback from these pilots was used to guide improvements and revisions before their broader launch in fall 2018.

[2] Sample curricula and learning outcomes that include the main concepts for each lesson are available at https://carnegiemathpathways.org/explore-the-pathways/.

Implementation

In spring 2018, 1 institution offered 6 sections of Quantway Corequisite and 1 institution offered 1 section of Statway Corequisite, enrolling a combined 155 students. In fall 2018, 2 institutions offered a total of 2 sections of Quantway Corequisite and 3 institutions offered a total of 12 sections of Statway Corequisite, enrolling a combined 255 students. Approaches to

implementation, in terms of time allocated for remediation, credit awarded, and placement[3], varied by institution. A short summary of the implementation approach taken by each of the 6 institutions is provided below. Names of institutions are omitted to preserve anonymity.

Institution A moved to a corequisite model because their faculty and administrators felt too many students were getting lost in the transition between math courses in their existing developmental sequence. They also thought that the structure and intensity of a corequisite course would give faculty a better opportunity to address students' learning needs through more frequent class sessions and smaller class sizes. Institution A offered Quantway Corequisite as a 3-contact hour college course paired with a 3-contact hour corequisite course, providing a total of 6 credits, 3 of which were college-level credits. The courses were only available to students needing developmental support.

Institution B is a 4-year institution in a state that is eliminating funding for remedial courses outside of 2-year institutions. As a result, Institution B is phasing out all remedial courses. To meet the needs of students who placed into developmental mathematics, they offered Quantway Corequisite as a 6-contact hour course, with the corequisite component administered as a lab. The combined course offering provided a total of 5 credits, 4 at the college level. The course was only available to students needing developmental support.

Institution C is a 4-year institution that does not currently offer any developmental math courses because such courses satisfy neither general education nor major requirements. They offered Quantway Corequisite as a way to provide additional support to those in their college-level courses who needed it. It was offered as a 4-contact hour course, providing 3 transfer-level credits. The course was only available to students needing developmental support.

Institution D offered Statway Corequisite in response to recent policy changes in the state that require institutions to enroll developmental students into corequisite courses. Institution D offered a 3-contact hour college course paired with a 3-contact hour corequisite course. The

[3] Each institution employed their own placement methodology to determine whether a student required remediation. The Carnegie Math Pathways courses do not stipulate specific methods to determine whether a student is required to enroll in the developmental-level corequisite course.

courses provided students a total of 6 credits, 3 at the college level. The courses were only available to students needing developmental support.

Institution E offered Statway Corequisite as a means of reducing the number of contact hours required to complete college-level math for students needing remediation, compared to the original Carnegie Math Pathways courses. The course was offered over two quarters, each with 5 contact hours. The first quarter provided 5 non-transferable units and the second provided 5 transfer-level units. The combined course offering was available only to students needing developmental support, and it was administered as a single course with no separate enrollment for the corequisite portion.

Institution F offered Statway Corequisite as a means to ensuring that all incoming students, regardless of their Math or English placements, were able to complete a college-level course within their first year. They offered a 3-unit college-level course paired with a 2-unit corequisite course. The course provided 2 pre-college credits for the corequisite and 3 college-level credits for the college course. The corequisite course was required of students who placed at the developmental level but was available to any student desiring additional support.

Results

Of the 410 students who have participated in these new corequisite courses, 65.1% have been successful (with a grade 'C' or better), achieving college-level math or statistics credit in a single term. This success rate is substantially higher than the traditional sequence of developmental courses followed by a credit bearing course. Research shows that only 31% of students who are referred to developmental math complete their developmental sequence within *three years*[4]. Additionally, only 20% of students requiring developmental math achieve college-level math credit within *three years* and only 6% achieve college-level math credit within a single year[1]. This improvement in success rates was seen for each participating institution.

Table 1 shows anonymized results by institution. The overall success rate for students in Quantway Corequisite was 79%, comprised of a success rate of 83% at Institution A, 89% at Institution B, and 39% at Institution C. There was variability within Institution A, with the success rate of sections ranging from 100% to 65%, and a standard deviation of 13%. The overall success rate for students in Statway was 54%. Institutions D, E, and F had success rates of 52%, 66%, and 50%, respectively. There was variability within Institution D, with the success rate of sections ranging from 78% to 18%, and a standard deviation of 19%. Across all 21 sections of both Corequisite offerings, 12 sections had a success rate of 65% of higher.

[4] Bailey, T. (2009). Challenge and Opportunity: Rethinking the Role and Function of Developmental Education in Community College, *New Directions for Community Colleges, 145,* accessed February 18, 2019, https://pdfs.semanticscholar.org/c1ea/a07d5e6025575ee41ed8161f780ca893a4bf.pdf.

Table 1: Results from the first year of Quantway and Statway Corequisite

	Pathway	Number of Students (# of Sections)	Total Contact Hours	Corequisite Success Rate	Standard Deviation across Sections (Range)
Institution A	Quantway	149 (6)	6	83%	13% (65% - 100%)
Institution B	Quantway	18 (1)	6	89%	N/A
Institution C	Quantway	18 (1)	4	39%	N/A
Institution D	Statway	184 (11)	6	52%	19% (18% - 78%)
Institution E	Statway	29 (1)	5	66%	N/A
Institution F	Statway	12 (1)	5	50%	N/A

Variability within institutions (standard deviations of 13% and 19%) was slightly less than the variability between institutions (standard deviation = 20%). We hypothesize that faculty preparation, previous experience with the instructional materials and pedagogical approach, and the number of contact hours for remedial support are key factors affecting the variability in student success, but additional research is needed to study this further.

Student and Faculty Experience

The benefits of the corequisite model to students are obvious in terms of reducing time and credit hours to degree, creating a meaningful impact on students' lives. One student summarized it nicely, "I love the fact that I'm learning things I needed to relearn while also learning new material. [The corequisite course] helped me knock out a class while taking a class I needed for my degree plan. I am very grateful for this program."

Additionally, the Statway/Quantway Corequisite course provides powerful learning opportunities and outcomes through its curricular design and pedagogical approach. One faculty member wrote, "Students are clearly seeing connections from [the] in-class [College course] to the Corequisite. The Corequisite often provides more practice, and sometimes bears deeper into the concepts." Another noted, "I enjoyed how the Quantway curriculum focused on topics and examples that are current and relevant to life." And yet another stated, "I liked being able to observe my students' thought process. Often, the misconception they held was not the one I would have thought if I just saw their finished work." This faculty member also noted that "the class came together as a learning community in ways I have not seen in classes taught

using a lecture model. Students were more engaged with the material and in each other's success."

Elements of Successful Implementation

The results demonstrate that the corequisite model can yield powerful outcomes for students that significantly improve their likelihood of success in college-level mathematics and accelerate their path to completion. Surveys of faculty and students participating in the courses described in this report indicate strong support for the model and an appreciation for the particular curricular and pedagogical design of the Statway/Quantway Corequisite courses. From these data, several components emerged as key for the success of the corequisite model.

Faster Completion

All successful students received college-level credit in one term, with the exception of students at Institution E where the course was implemented in two quarters. In all of the one-term models, the implementation was at least one term shorter than would have been required with other Pathway models or the traditional model. Faculty noted that this shortened time frame lowers the opportunity to lose students (e.g. between terms) and avoids potential disruptions of learning patterns and social supports caused by changing instructors, peer groups, or course schedules across terms.

Carnegie Math Pathway's Instructional Approach

The curricula are taught using a student-centered approach that engages students to actively and collaboratively problem solve within rich, authentic contexts. Faculty noted that this innovative learning approach was a new experience for many students, but once students adapted to the instructional approach, they were better able to engage and learn deeply. Faculty also felt the embedded social-emotional supports helped students' persistence and learning strategies, as well as nurtured community and belonging in the classroom.

Higher Contact Hours

There appears to be a connection between the number of contact hours assigned and course success (see Table 2). Three of the four highest institutional success rates came from the institutions with 6 total contact hours. The lowest institutional success rate was from the only institution with 4 total contact hours. Considering the high volume of content being covered, having more time for support and review may be critical to success.

Institution's Total Contact Hours	Corequisite Success Rate
4	39%
5	61%
6	67%

Cohort Model

All institutions used a cohort model, where the same faculty member taught both the college-level and corequisite portions of the course to the same group of students. Faculty noted that they felt this approach was important for student comfort, consistent social support, continuity of pedagogical approaches, and the ability to make continually needed adjustments to the course's content and timeline. The effects of the cohort strategy versus others, however, still needs further investigation since no other strategies were attempted.

Faculty Preparedness

Time for faculty to prepare and structure the materials to fit their implementation model is an important contributor to success. Time to prepare or prior experience with the curricula can build familiarity with the materials, which may allow faculty to more quickly adapt the lessons. In most cases, the faculty at institutions with higher success rates had several years of experience teaching the Pathways. While the corequisite courses are new, many of the materials and the pedagogy are drawn from the original Quantway and Statway courses. Faculty at two of the high-achieving institutions were also involved in the creation of the corequisite materials, and as such had significantly more familiarity with them and time to consider their approach to the courses. Faculty using the materials for the first time can also be successful, but may need ample preparation time or additional supports, such as a faculty mentor.

Instructor Support and Collaboration

In the two institutions with multiple sections, faculty mentioned that working collaboratively to support each other was a key to success. Faculty at both institutions held weekly meetings to learn from one another about what was and was not working. One institution also used regular class visits for this purpose. The collaborations allowed the faculty to adjust components of the course including lessons, homework, and exams and to continuously improve their strategies throughout the semester.

Student Expectations and Encouragement

Faculty also recommended that students be presented with realistic expectations early and often, including number of hours and types of work expected in class and at home. One faculty member noted that "students just need reminders that it is a big workload and they can handle it." Faculty noted that it was imperative that expectations be firmly established for students to routinely complete all at-home work. Student who did not complete at-home work were less prepared for class, which slowed down the pace of the lessons and subsequently the course overall.

The corequisite course structure may be new or daunting to students, so helping them obtain a realistic and positive mindset may increase their success. One faculty member noted that it was helpful to find meaningful ways to encourage students, such as reminding them how far they have come throughout the course.

Challenges and Suggestions for Improvement

Challenges with the corequisite model were also identified by faculty and students. Below we discuss the key challenges and suggestions for improvement.

Time

The chief challenge identified by faculty and students alike was the limited time available for learning. Describing the 4-contact hour corequisite model, a faculty member admitted "we just didn't allow ourselves enough time...it was a challenge to get [students] brushed up on their basic skills so that they could do the more challenging problems in the curriculum." Even the faculty whose courses had the highest number of contact hours reported struggling with time constraints, and time constraints led all faculty to revise how they utilized the corequisite materials. Three particular challenges and recommendations were identified, related to: 1) assessment, 2) material/content selection, and 3) pedagogy.

1) The fast pace of the course created a tension between the need to assess frequently and the lack of time available for assessment. While assessment is critical, particularly early assessment of developmental needs, faculty strongly cautioned about over-assessing and encouraged that careful attention is paid to when and how frequently assessments are administered.
2) Time constraints led all faculty to revise how they utilized the corequisite materials. For most faculty this meant focusing primarily on the college materials and using corequisite materials for support as time allowed. One instructor noted that she "felt panicked at first and gave up trying to squeeze in the corequisite but started to feel better focusing on the college level". One instructor noted that she and her colleagues cut out any developmental material that was not absolutely critical for success with the college-level learning outcomes. Multiple faculty used significant time designated for Corequisite learning to continue working on the college materials. Faculty felt that anyone teaching a corequisite course will need ample time before the course to prepare the course materials to fit the local implementation configuration and match the needs of their student population.

   Time constraints also led faculty to adjust their pedagogical approach, reducing time for collaboration, exploration, and discovery, and using more direct instruction. Faculty noted that they had to carefully select which of the rich tasks and collaborative activities in the curriculum they could allow students to fully explore. One faculty member explained that learning through productive struggle often took longer than expected, and faculty found themselves returning to lecture and guiding students' learning themselves to manage class time. One faculty member stated that he and his colleagues were teaching "a modified version where we did not go fully into the lessons. We've been picking and choosing pieces."

While there may be administrative and logistical challenges associated with doing so, it is strongly encouraged that institutions plan for at least 6 contact hours for their course. Some of

the institutions described in this report are in the process of adjusting their implementation model to allow for more contact hours because they see it as a critical factor in their students' success.

Student Reading Level and Foundational Math Knowledge

Faculty noted that the pace of the course and the rigor of the college-level material could be challenging for some students. This was particularly acute for students with weak reading skills. Weak reading skills made it difficult for students to effectively access the course materials, and it slowed the pace of instruction.

To address this challenge, several faculty suggested that the pace of the first module be slowed down. Reducing the pace in the first week or two allowed students to become comfortable with the workload and demands of the course. It also allowed students to become familiar with the new learning strategies and course design as well as provided more opportunity for faculty to recognize the areas where students were struggling and begin to address them.

Additionally, some faculty suggested that students might struggle less if they could progress through their development reading courses first, prior to enrolling in mathematics corequisite courses.

Faculty Preparation and Support

All faculty noted that they could have benefited from more time to consider which material to cover and which to reduce as well as from trainings focused on maintaining the Pathways

pedagogical design principles, particularly under time constraints. Additionally, faculty were consistent in their desire for more supports to aid them while teaching the course, such as training, user guides, and collaboration or forums with other faculty, as discussed below.

Lessons Learned

The implementation of Statway and Quantway Corequisite courses in 2018 provided important learnings that can guide future development efforts. With input from faculty, the following steps for improvement have been identified and will be implemented by the Carnegie Math Pathways and its network.

1. Streamlining Materials. Recognizing the significant time constraints of these courses, care must be taken to further streamline the curricular materials and identify essential elements. In doing so, it will still be important to preserve the pedagogical practices of active collaborative learning centered on rich, authentic contexts that are critical for student success.

2. Support For Faculty.
    a. Training. While the Carnegie Math Pathways program currently provides a comprehensive faculty preparation program that includes online training, peer to peer mentoring, and in-person workshops, we recognize that additional supports, specific to corequisite implementation, will be needed to assist faculty in navigating the challenges unique to this type of course.
    b. User Guides. Corequisite instructional user guides, which include comprehensive descriptions and examples of how others have taught these courses as well as what works and how, would be valuable. The guides should specify in detail how to tailor materials to fit into the various combinations of contact hours for each course component. The guides should discuss how to maintain the pedagogical approach given time constraints, and how to best utilize assessments and review times.
    c. Facilitating Faculty Collaboration. Faculty consistently voiced a desire for and benefit from a collaborative space for sharing strategies and resources with others teaching corequisite courses within and outside of their institution. A specific virtual space for faculty engaged in implementing corequisite courses that utilize voice and video communication functionality, is moderated to elevate consistent themes and learnings, and includes regular check-ins for discussion on particular topics is recommended.

Conclusion

This report illustrates how the Carnegie Math Pathways corequisite courses can provide an impactful alternative to traditional remediation. Results show average corequisite course success rates of roughly triple that of traditional remediation, in less than half the time. Outcomes varied across and within institutions, suggesting important areas of further study, such as an examination on the effect of faculty preparation on outcomes and the impact of course structure (e.g. number of contact hours) on outcomes.

This report also exposes student and faculty experiences with the corequisite model and the Carnegie Math Pathways courses in particular. The successes and challenges detailed indicate particular considerations for institutions contemplating implementing a corequisite model as well as suggestions for improvement to the Carnegie Math Pathways course materials and faculty support program.

The Carnegie Math Pathways Networked Improvement Community, comprised of faculty, administrators, and WestEd staff, will continue to work collectively and iteratively to improve these courses (from implementation support to instructional support) in order to maximize student success.

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