

# Structuring the STEM-Prep Pathway

## Fostering independent and collaborative learning

Summer 2015

### What is the STEM-Prep pathway?

This pathway is a sequence of courses designed to prepare developmental-level mathematics students interested in STEM (science, technology, engineering, or mathematics) careers to enter—and succeed in—calculus and other technical courses that require strong algebraic skills and a mastery of functions.

The new courses under development to support the STEM-Prep pathway include *Reasoning With Functions I* and *II*.

Students begin the STEM-Prep pathway by enrolling in the Dana Center Mathematics Pathways developmental course *Foundations of Mathematical Reasoning* and its co-requisite *Frameworks for Mathematics and Collegiate Learning*.

With three semesters of coursework, students can complete this accelerated pathway to calculus or a similarly demanding college-level STEM course:

Semester 1: *Foundations and Frameworks*; Semester 2: *Reasoning With Functions I*; Semester 3: *Reasoning With Functions II*.

*The Dana Center  
Mathematics Pathways  
Curricular Materials*

<https://dcmathpathways.org/take-action/classroom-level/classroom-level-planning-implementing>

### The structure design team's work

To develop the STEM-Prep pathway, the Dana Center invited prominent leaders in mathematics education research and instruction to join one of two design teams: one focused on course *content* and the other on course *structure*.

The 14-person structure design team included instructors from Texas colleges and universities and individuals affiliated with the Mathematical Association of America and the American Mathematical Association of Two-Year Colleges (AMATYC).

The team researched programs across the country that had successfully restructured their developmental mathematics sequences while maintaining a strong emphasis on preparation for algebraically intensive coursework.

#### STEM-Prep pathway structure design team

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## Four essential structural elements

Based on the structure design team’s recommendations, four essential structural elements will shape and inform the course content for *Reasoning with Functions I* and *II*:

- (1) **Ample time:** five contact hours a week for *Reasoning with Functions I* and four contact hours a week for *Reasoning with Functions II* in a traditional semester
- (2) **Rich, scaffolded lessons:** instructor-supported, in-class active-learning lessons grounded in authentic contexts
- (3) **Instant feedback:** frequent opportunities for immediate feedback while working independently
- (4) **Independent out-of-classroom assignments:** enhanced at-home work that enables students to self-monitor their learning and to practice concepts and skills learned in class

### (1) Ample time: Contact hours

Students who would traditionally enter a beginning algebra course will enter the STEM-Prep pathway by taking concurrently the DCMF courses *Foundations of Mathematical Reasoning* and *Frameworks for Mathematics and Collegiate Learning*.

The *Frameworks* course enhances students’ study skills and prepares them to succeed in *Reasoning with Functions I* and *II*—particularly the independent learning episodes.

The *Foundations* course introduces students to elementary algebraic reasoning and mathematical modeling. In *Foundations*, students create, explore, and interpret a variety of linear models. They also practice solving simple linear equations. The *Foundations* course, however, does not cover function notation, function terminology, and more advanced algebraic skills (such as multiplying linear factors or factoring).

To prepare students for the algebraic demands of calculus and other courses needed for STEM programs of study, *Reasoning with Functions I* and *II*, then, must necessarily include a significant amount of algebraic skill building.

This need became even more obvious after the structure design team considered the content design team’s recommendations for course content. Ultimately, both design teams concluded that *Reasoning with Functions I* should be a five-credit semester-long course (since it provides most of the necessary algebraic skill building) and that *Reasoning with Functions II* should be a four-credit semester-long course (since it requires less of the algebraic skill building).

### (2) Rich, scaffolded lessons: In-class active-learning lessons

The in-class component is anchored by 25-minute active-learning lessons. These lessons are intentionally structured to be used easily as separate lessons or in sequenced clusters. This flexibility enables instructors to use the lessons in a variety of class lengths and accommodate other classroom activities (such as review sessions or exams).

The lessons are set within a variety of STEM discipline-specific contexts to provide students with immediately meaningful content. Each lesson begins with an engaging question that encourages all students to participate, stimulates rich discussions, and motivates subsequent learning.

In class, students will often work collaboratively in pairs or small groups to solve problems that range from easy (to build skills and confidence) to more challenging (to facilitate deeper learning and increase students' constructive perseverance).

Within these supportive learning environments, students will build and reinforce their conceptual understanding by communicating ideas orally with their neighbor or group. These collaborative experiences also build students' capacities to learn inside and outside of class in their subsequent STEM courses (e.g., group work in calculus and labs in the sciences).

An essential function of the in-class component of *Reasoning with Functions I* and *II* is to provide students the opportunity to experience—and process—failed attempts in an academically supportive environment. Social connections created through the in-class learning community will drive and sustain student engagement and motivation.<sup>1</sup>

All lessons will include detailed instructor notes with:

- facilitation questions for guiding class discussions or helping struggling students,
- suggestions for classroom pedagogy (e.g., individual work, small-group experiences, think-pair-share activities, class discussion, or direct instruction),
- language and literacy supports,
- some common student misconceptions, and
- explicit connections from the day's learning objectives to future coursework in a STEM discipline.

Instructor notes are intended as supports, not as directions. Some lessons also include notes suggesting alternative pathways through the content. Instructors will, of course, develop their specific approach to the lesson based on their personal preference and expertise as well as their understanding of their students' needs.

### **(3) Instant feedback: Immediate feedback and online connections**

For those times that students are working independently outside of class, *Reasoning with Functions I* and *II* will provide a variety of problems that range from entry level to more challenging. The course materials will provide students access to hints, answers, and explanations so they can experience immediate feedback on their understanding and skill mastery.

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<sup>1</sup> It is worth noting that the structure design team recognizes that some of these structural elements are also built into previously developed DCMCP course materials for *Foundations*, *Frameworks*, *Statistical Reasoning*, and *Quantitative Reasoning*. The team chose to adapt these elements to the increasingly rigorous course content that students will experience in *Reasoning with Functions I* and *II* both because early evidence shows student success in other DCMCP courses with these elements, and because we expect students will benefit from experiencing a sequence of courses using similar pedagogical scaffolding strategies.

Course materials will include homework problems in mathematical vocabulary, computations and processes, and correct use of mathematical notation.

An online learning platform will facilitate these aspects of student learning. We expect that the learning platform will offer students real-time access to their classmates and to tutors so they can continue the active learning initiated in class.

#### **(4) Independent out-of-classroom assignments**

Students will also work regularly as independent learners in an environment without instant feedback.

During this independent-learning time, students will work on problems based on recent in-class activities. This structure enables students to work on more open-ended problems, practice their written communication skills, and take time to check the reasonableness of their answers.

#### **What's next?**

The structure and the content design teams were keenly aware that promising practices from research must be balanced with flexibility in practice and implementation to accommodate the great variety of needs and contexts among the instructors and institutions implementing the STEM-Prep pathway.

As course development advances, Dana Center staff and the authors of *Reasoning with Functions* will reach out to the mathematics education community to share progress and ask for feedback to improve the lessons, activities, and assessments under development.

The STEM-Prep pathway will be discussed at state and national mathematics and mathematics education meetings over the next few years, including meetings of the Mathematical Association of America and the American Mathematical Association of Two-Year Colleges.

To receive updates on events and releases of materials through the monthly Dana Center Higher Ed In Brief, email us at [dcmathpathways@austin.utexas.edu](mailto:dcmathpathways@austin.utexas.edu).

#### **Resources**

*Reasoning with Functions I* and *Reasoning with Functions II Student Learning Outcomes* are documents developed by the content design team and Dana Center staff. The files are available here:

<https://dcmathpathways.org/resources/reasoning-functions-i-learning-outcomes>

<https://dcmathpathways.org/resources/reasoning-functions-ii-learning-outcomes>

## About this document

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### About the Dana Center

The Dana Center develops and scales math and science education innovations to support educators, administrators, and policymakers in creating seamless transitions throughout the K–14 system for all students, especially those who have historically been underserved.

We focus in particular on strategies for improving student engagement, motivation, persistence, and achievement.

The Center was founded in 1991 at The University of Texas at Austin. Our staff members have expertise in leadership, literacy, research, program evaluation, mathematics and science education, policy and systemic reform, and services to high-need populations.

### About the Texas Association of Community Colleges

In Texas, the DCMP is being developed as a statewide reform effort through a unique collaboration between the Charles A. Dana Center at The University of Texas at Austin and the Texas Association of Community Colleges. The presidents and chancellors of all 50 Texas community college systems agreed to support this initiative.

For more information about ...

- the DCMP, see <http://www.dcmathpathways.org>
- the Texas Association of Community Colleges, see <http://www.tacc.org>