DCMP Curriculum Design Standards

Dana Center Mathematics Pathways philosophy of effective and equitable curricular design

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The goal of the Dana Center Mathematics Pathways (DCMP) model is to provide all students with a quality postsecondary educational experience that aligns with their academic, professional, and personal goals. The Dana Center's higher education mathematics courses are guided by the design standards outlined in this document.

These design standards serve both inward-facing and outward-facing purposes. Internally, the standards are used by developers, authors, and reviewers to ensure that the materials are coherent and true to the DCMP vision. Externally, they communicate the DCMP vision for curriculum development to the field and are offered as a template for institutions or instructors developing their own curricular materials.

DCMP Curriculum Design Standards

Standard 1: A Student-Centered Culture of Learning

Standard 2: Supporting Students in Developing as Learners

Standard 3: Communication

Standard 4: Technology

Standard 5: Context and Interdisciplinary Connections

Standard 6: Assessment

The DCMP courses are founded on the notion that all mathematics courses can and should be rigorous, relevant, and intellectually engaging. We further believe that all students can learn relevant mathematics when given the appropriate support. These beliefs are reflected in our choice to organize our courses around big mathematical and statistical ideas and promote a balance of conceptual understanding and procedural fluency. Our course materials emphasize the value and importance of actively engaging students in constructing knowledge and in developing students' mathematical and statistical reasoning abilities. Connections between concepts and contexts are explicitly emphasized throughout the curriculum. In short, students are given the opportunity to *act as mathematicians* while engaged in *work worth doing*.

Effective and equitable instruction depends not only on quality curricular materials, but also on the implementation of appropriate and evidence-based pedagogical strategies in conjunction with those materials. To this end, we provide instructor support materials for each lesson. We also invite instructors using the DCMP courses to investigate and implement other pedagogical strategies that are supported by research, and to customize the curricular materials to best serve their unique student population and context.

The principles of equity, diversity, inclusion, and access are embedded throughout the curriculum. Ensuring that curricular materials serve the needs of diverse student populations cannot be an afterthought in the curriculum development process, but must be centered and examined throughout the authoring and reviewing process. Strategies for designing equitable curricular materials are incorporated in the six standards below.

There are many areas of overlap and commonality among the six DCMP Curriculum Design Standards. The standards refer to one another and to the principles described in this philosophy. This is intentional, reflecting the coherence necessary for effective and equitable curriculum design.

Note: The numbering of the design standards does not indicate the level of importance.

Standard 1: A Student-Centered Culture of Learning

The DCMP materials promote students' active engagement with the content. Activities are written to foster *constructive* and *interactive* cognitive engagement, as defined by the ICAP framework (Chi & Wylie, 2014).[1] Instructor support materials are provided to support the implementation of effective, research-based pedagogical strategies.

Opportunities for deep levels of cognitive engagement lead to more equitable student outcomes across gender, race, ethnicity, and socioeconomic status (Theobald et al., 2020).[2]

1. Class activities provide regular opportunities for students to engage in tasks using a variety of different instructional strategies (e.g., small groups, class discussions, interactive lectures).

2. Class activities require students to engage in inquiry, analyze data, construct hypotheses, solve nonstandard problems, reflect on their processes and their work, make explicit connections, and practice constructing viable arguments and critiquing the reasoning of others.

The DCMP curricular materials and instructor suggestions incorporate several existing frameworks and strategies that promote *constructive* and *interactive* student engagement (Laursen & Rasmussen, 2019).[3] Other strategies can be incorporated at the instructor's discretion, although the goal should be to maintain a high level of cognitive engagement by students.

Standard 2: Supporting Students in Developing as Learners

The DCMP supports students in developing problem-solving skills, a growth mindset, self-regulation, and the tenacity, persistence, and perseverance necessary for success in mathematics and statistics (Samuel & Warner, 2021; Skinner et al., 2020).[4, 5]

1. The curricular materials regularly present tasks that require students to find or develop a solution strategy or that allow for multiple strategies and solution methods. Students develop their mathematical and statistical thinking by applying previously learned concepts to solve nonroutine and unfamiliar problems.

2. The curricular materials develop students' self-efficacy by scaffolding lessons and increasing the level of challenge over time.

3. The curricular materials include instruction and information about the role of struggle in learning, and provide opportunities for students to engage in effective effort. To support effective effort, the curricular materials provide intentional opportunities to monitor, evaluate, and reflect on students' own learning process.

4. The curricular materials include instruction and information about the importance of developing a growth mindset. They provide suggestions on how instructors can engage with students to model and promote a growth mindset about learning mathematics.

Standard 3: Communication

The DCMP emphasizes the importance of communication both as a learning tool and a skill, which allows students to demonstrate understanding and evaluate arguments critically. The DCMP uses discipline-specific terminology, language constructs, and symbols to intentionally build mathematical and statistical understanding and to ensure that terminology is not an obstacle to student understanding (Cardetti & LeMay, 2019).[6]

1. The curricular materials provide students with opportunities to discuss, analyze, and think critically about mathematics and statistics in authentic texts or relevant publications (e.g., newspapers, journals, infographics) to evaluate information and make informed decisions.
2. The curricular materials require students to communicate in written, visual, and oral formats about mathematics and statistics (Finkenstaedt-Quinn et al., 2021).[7] These tasks take two general forms:
    a. Writing, explaining, or developing visual representations of mathematical concepts to deepen understanding (e.g., explaining why taking 15% off a number and then a second 15% off the result is not the same as taking 30% off the original number)
    b. Authentic, contextual tasks requiring the communication of mathematical or statistical concepts (e.g., creating an infographic that explains the meaning of the results of a statistical study, developing a presentation that explains a process used to solve a problem)
3. The curricular materials introduce new concepts to build between course content, and students' experiences and knowledge base. Informal contextual descriptions precede more formal definitions.
4. The curricular materials scaffold students' ability to use terminology accurately to communicate their thinking by including intentional instruction in the use of mathematical and statistical terminology and symbols, especially those used in different contexts or different disciplines (e.g., terminology such as *estimate*, *normal*, *random* and *function*; symbols such as parentheses and the notation for multiplication).
5. Instructor support materials provide advice and guidance on strategies and techniques that can be used with diverse student populations to support developing proficiency with terminology, language constructs, and symbols.

Standard 4: Technology

The DCMP promotes the appropriate use of the best available technology to enable students to investigate complex mathematical and statistical concepts. The use of technology allows students to focus on the deeper mathematical and statistical concepts rather than performing labor-intensive procedural processes by hand (Cullen et al., 2020).[8] Technology should support the learning objectives of the lesson and should not replace students' abilities to do simple procedural calculations by hand. In some cases, the use of technology is a learning objective in itself (i.e., learning to use a statistical package in a statistics course); at other times, the technology should support students in thinking algorithmically rather than focusing on a specific program or tool (Piercey, 2017).[9]

The DCMP assumes the following access to technology to ensure equitable engagement:

1. Students have access to appropriate technology when needed (e.g., computer software, mobile apps, calculators).
2. Instructors have access to computers with appropriate software, the internet, mobile apps, and projectors in the classroom.
3. Instructors have access to adaptive technology, as appropriate, which is accessible to all learners, including those students with special needs.

If these assumptions are not met, instructors should adapt to ensure that all students have equitable access to the necessary resources by selecting a different, but still appropriate, technological tool.

Standard 5: Context and Interdisciplinary Connections

The DCMP presents mathematics and statistics in context and connects to other disciplines to enable students to see the relevance of mathematics in their careers, as consumers, and as informed citizens (Wang et al., 2021).[10] The curriculum provides various opportunities for students to learn how to use real-world data to solve real-world problems.

1. The curriculum incorporates real data from resilient and stable contexts whenever possible; it is updated as new data or more timely contexts become available. When appropriate, technology is used to analyze real data that would not be possible using only hand calculations (e.g., large data sets).
2. The curriculum incorporates realistic applications. While problems from complex contexts may sometimes be modified to support a learning objective, the DCMP avoids using word problems that are artificially contrived (Reyes, 2019).[11]
    a. Applications reflect the varied experiences of diverse student populations. Students should encounter situations and data that are relevant to their cultures, communities, areas of study, and personal interests as well as contexts that expose them to new ideas.
    b. When real-world contexts are simplified, the data must support the same conclusions as the full real-world data to avoid teaching students incorrect lessons beyond the scope of the mathematics and statistics.
3. Applications emphasize the importance of data literacy and provide opportunities for students to analyze and communicate data in a variety of modalities.

Standard 6: Assessment

The DCMP believes that assessments are an important component of the curriculum and promotes assessment strategies that are aligned with the curricular design standards. The curriculum incorporates authentic assessment, formative assessment, and multiple opportunities for students to demonstrate understanding (Krause, 2021).[12]

1. Assessments (e.g., homework questions, exams, quizzes) are based on realistic applications, use the appropriate technological resources that students utilize in class, and provide students with opportunities to communicate their thinking.
    a. Assessments include questions that require conceptual understanding as well as those that demonstrate procedural fluency.

   b. Assessments include nonexam-based strategies such as presentations, posters, projects, and portfolios.

   c. Assessments are designed with equity in mind. For example, rather than choosing a context that might be specific to students who live in a particular region, the context is intentionally selected to not rely on a particular situational experience.

2. Formative assessments are embedded in the lessons, and instructor support materials provide additional strategies and suggested responses.

3. Assessments support the development of growth mindset, self-regulation, and persistence.

   a. Students take open-time assessments, supporting their understanding that it is not always possible to solve a problem immediately when it is presented.

   b. Students can revisit incorrect work and learn from their mistakes, emphasizing the importance of trying multiple strategies and persisting if one strategy does not work.

   c. Students reflect on their understanding of key concepts before and after activities and assessments to enable development of self-regulation.

Learn more

The Dana Center Mathematics Pathways: https://dcmathpathways.org/dcmp

DCMP courses: https://www.utdanacenter.org/our-work/higher-education/curricular-resources-higher-education

Acknowledgments

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Endnotes

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For a list of selected research informing each design standard, see DCMP Curriculum Design Standards: Annotated Bibliography.

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About Charles A. Dana Center

The Dana Center develops and scales math and science education innovations to support educators, administrators, and policy makers 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.

For more information about the Dana Center, see www.utdanacenter.org.