

### Selected supporting research

### An annotated bibliography, Summer 2014

#### Overview

Dana Center staff<sup>1</sup> developed these annotated citations as a resource for practitioners and other professionals interested in learning more about the research underpinning the Dana Center Mathematics Pathways model. This document is one of three related bibliographies that explore the research literature that informs the following DCMP core ideas:

- **The DCMP's four fundamental principles**<sup>2</sup>
- The DCMP's eight curriculum design standards<sup>3</sup>
- The DCMP's *Frameworks for Mathematics and Collegiate Learning* course's four pillars (or themes).<sup>4</sup>

#### About this bibliography

The Dana Center Mathematics Pathways model is a systemic approach to improving student success and completion rates through implementation of processes, strategies, and structures built around three accelerated mathematics pathways and a supporting student success course, connected to modern programs of study. The DCMP is based on four fundamental principles:

- I. Multiple pathways with relevant and challenging mathematics content aligned to specific fields of study
- II. Acceleration that allows students to complete a college-level math course more quickly than in the traditional developmental math sequence
- III. Intentional use of strategies to help students develop skills as learners
- IV. Curriculum design and pedagogy based on proven practice

Note that these citations are not alphabetically ordered; instead, they are sequenced for importance and relevance—to illuminate, for example, the historical development of a concept, or to illustrate the connections among research findings on a given concept.

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<sup>1</sup> See the last page of this document for acknowledgments.

<sup>2</sup> The DCMP's four fundamental principles are described here: <https://dcmathpathways.org/dcmp/dcmp-model>.

<sup>3</sup> The DCMP's eight curriculum design standards are described here: <https://dcmathpathways.org/resources/curriculum-design-standards-selected-supporting-research-annotated-bibliography>.

<sup>4</sup> The DCMP's *Frameworks for Mathematics and Collegiate Learning* course's four pillars (or themes) are described here: <https://dcmathpathways.org/resources/dcmp-frameworks-mathematics-and-collegiate-learning-selected-supporting-research>.

# The Dana Center Mathematics Pathways Guiding Principles

## *An annotated bibliography, Summer 2014*

### PRINCIPLE I:

#### **Multiple pathways with relevant and challenging mathematics content aligned to specific fields of study**

The Dana Center Mathematics Pathways model offers multiple mathematics pathways aligned to various fields of study. The move towards multiple pathways in higher education mathematics coursework is influenced by trends in K–12 education and by the needs of the workforce.

For example, led by the National Council of Teachers of Mathematics (NCTM) in 2000, K–12 mathematics education expanded coursework beyond algebra to broaden the math curriculum. In addition, workforce data show that for many jobs, quantitative literacy and statistics are more useful than algebra.

The Dana Center Mathematics Pathways model offers students the choice of college-level courses in Statistical Reasoning, Quantitative Reasoning, and/or STEM-Prep. These course pathways are designed to help students build the mathematics skills most relevant to their degree requirements and fields of study.

We believe that the content of these three courses meets the math needs for a majority of fields of study. The following studies highlight the need for relevant mathematics pathways aligned with the requirements of specific fields.

**Barker, W. D., Bressoud, D., Epp, S., Ganter, S., Haver, W., & Pollatsek, H. (2004).** *Undergraduate programs and courses in the mathematical sciences: CUPM curriculum guide 2004*. Washington, DC: The Mathematical Association of America. Retrieved from <http://www.maa.org/sites/default/files/pdf/CUPM/cupm2004.pdf>

This report by the Mathematical Association of America’s Committee on the Undergraduate Program in Mathematics (CUPM) offers recommendations—based on four years of work with mathematicians and members of partner disciplines—to help college mathematics programs improve mathematics courses for undergraduates.

The CUPM recommends that all students meeting introductory or general education requirements should be in courses designed to “engage students in a meaningful and positive intellectual experience; increase quantitative and logical reasoning abilities needed for informed citizenship and in the workplace; strengthen quantitative and mathematical abilities that will be useful to students in other disciplines; improve every student’s ability to communicate quantitative ideas orally and in writing; [and] encourage students to take at least one additional course in mathematical sciences” (p. 28).

These recommendations specifically state that mathematics departments should consider students’ diverse career paths and colleges’ unique field-of-study agreements.

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This report is relevant to several aspects of this principle—particularly that mathematics content should be relevant and aligned to specific fields of study. In addition, it speaks to the principle that mathematics should be challenging, with a focus on building quantitative reasoning skills.

**Ganter, S. L., & Haver, W. E. (Eds.) (2011). *Partner discipline recommendations for introductory college mathematics and the implications for college algebra*. Washington, DC: The Mathematical Association of America. Retrieved from <http://www.maa.org/sites/default/files/pdf/CUPM/crafty/introreport.pdf>**

This report was developed by Curriculum Renewal Across the First Two Years (CRAFTY), a subcommittee of the MAA's Committee on the Undergraduate Program in Mathematics (CUPM). The report's goal is to provide recommendations for revitalizing college algebra, to make recommendations for alternative mathematics pathways to other disciplines, and to encourage mathematics departments to review their general education and introductory course offerings to make them more relevant and challenging.

The report offers recommendations for introductory mathematics requirements for five disciplines. Each recommendation was designed in collaboration with the partner discipline and outlines the specific quantitative skills necessary in the discipline. For example, the social science plan includes recommendations to use real-world social science data in mathematics courses, build greater conceptual understanding of mathematics, and require introductory statistics.

These discipline-specific introductory mathematics recommendations align with the DCMP principle of offering multiple mathematics pathways aligned to specific fields of study.

The report also evaluates the current state of college algebra. Over a million students enroll in college algebra each year, and about half fail the course with a grade of D or lower. College algebra is designed to prepare students for calculus; however, less than 10 percent of students who pass college algebra actually enroll in calculus.

The report argues that mathematics departments should respond to the changing needs of students by allowing them to take the most relevant math—which may not be algebra—for their field. It also suggests that departments redesign college algebra courses to better equip students with the mathematical skills needed outside academia—such as problem solving, quantitative literacy, and statistics. This recommendation speaks to the DCMP principle that mathematics coursework should be aligned to fields of study and that students should be provided with relevant and challenging coursework.

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**Blair, R. M. (Ed.). (2006). *Beyond crossroads: Implementing mathematics standards in the first two years of college*. Memphis, TN: American Mathematical Association of Two-Year Colleges. Retrieved from <http://beyondcrossroads.matyc.org/doc/PDFs/BCAll.pdf>**

This report from the American Mathematical Association of Two-Year Colleges (AMATYC) suggests that mathematics departments need to develop, implement, assess, and revise courses, course sequences, and programs to help students attain a higher level of quantitative literacy and achieve their academic and career goals.

Blair, the report's editor, integrates recommendations from AMATYC, the National Council of Teachers of Mathematics (NCTM), and the Mathematical Association of America (MAA), asserting that mathematics courses need to evolve to better prepare students with the quantitative literacy skills necessary to meet the demands of today's world.

Better preparation requires targeted curriculum revision designed to address the needs of students in many diverse academic paths and disciplines. Blair suggests integrating "quantitative literacy outcomes into all mathematics courses and into coursework across all disciplines" (p. 49). These recommendations are in line with the DCMP principles of creating relevant and challenging content to serve diverse students.

**Burdman, P. (2013). *Changing equations: How community colleges are re-thinking college readiness in math*. Oakland, CA: Learning Works. Retrieved from [http://www.learningworksca.org/wp-content/uploads/2013/10/LWBrief\\_ChangingEquations\\_WEB.pdf](http://www.learningworksca.org/wp-content/uploads/2013/10/LWBrief_ChangingEquations_WEB.pdf)**

Commissioned by Learning Works, this report by Pamela Burdman acknowledges the need for reform in developmental mathematics education and explores the reasons that some colleges are changing their approaches to developmental math, how they are doing it, and implications for the future.

One strategy for reform is the implementation of multiple mathematics pathways. Early data from pathway initiatives across the country suggest that pathway programs have been successful thus far. Some of the programs offering multiple mathematics pathways have seen "double to triple the success rates in less time than the traditional sequences" for students in developmental mathematics (p. 17). These findings are relevant to the DCMP principle of offering multiple mathematics pathways so that individual students can select the pathway which best suits their needs.

**Strother, S., Van Campen, J., & Grunow, A. (2013). *Community college pathways: 2011–2012 descriptive report*. Stanford, CA: Carnegie Foundation for the Advancement of Teaching. Retrieved from**

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[http://www.carnegiefoundation.org/sites/default/files/CCP\\_Descriptive\\_Report\\_Year\\_1.pdf](http://www.carnegiefoundation.org/sites/default/files/CCP_Descriptive_Report_Year_1.pdf)

The Carnegie Foundation for the Advancement of Teaching partnered with multiple organizations to identify student needs and design solutions to better equip students with the appropriate quantitative skills. More than 14 million students enter community colleges every year. The report (page 1) notes

Between 60 to 70 percent of incoming community college students typically must take at least one developmental mathematics course before they can enroll in college-credit courses (Achieving the Dream, 2006; Bailey, Jeong, and Cho 2010). However, 80 percent of the students who place into developmental mathematics do not successfully complete any college-level course within three years (Bailey, Jeong, & Cho, 2010).

This report recommends using mathematics pathway options to allow students to apply mathematical skills in a variety of real-world contexts and to develop a conceptual understanding of mathematics principles not limited to college algebra. The report authors argue that to support students in completing mathematics requirements and building valuable skills, mathematics courses should have greater alignment to fields of study and professional skills. This recommendation is in line with the DCMP principle of offering students multiple pathways and providing relevant and challenging coursework.

**Boylan, H. R. (2002). *What works: Research-based best practices in developmental education*. Boone, NC: Continuous Quality Improvement Network/National Center for Developmental Education.**

This book is the result of a collaborative project between the Continuous Quality Improvement Network (CQIN) and the National Center for Developmental Education (NCDE) to address the quality of developmental education.

The study includes 36 institutions and identifies best practices for improving developmental education. One of the study's key recommendations is to link developmental course content to college-level requirements to make the developmental coursework relevant to academic tracks and to better prepare students for success in college-level courses.

Many developmental education programs fail to link the requirements of developmental education to entry requirements for college-level courses. This connection is crucial to student success beyond the developmental level.

This recommendation is in line with the DCMP principle of designing relevant and challenging curriculum to ensure greater success in developmental coursework and beyond. The DCMP *Foundations of Mathematical Reasoning* course, for example, is built on outcomes directly related to the skills necessary for success in college-level courses and addresses this crucial link between developmental and college-level

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education.

### **PRINCIPLE II:**

**Acceleration that allows students to complete a college-level math course more quickly than in the traditional developmental math sequence**

The Dana Center Mathematics Pathways model is built upon the principle of acceleration with appropriate supports. The DCMP *Foundations of Mathematical Reasoning* course is designed to replace two to three levels of developmental mathematics coursework in one semester.

To make this acceleration successful, the *Foundations* course includes appropriate content, proven pedagogy for developmental learners, and integration of student success strategies—both within the mathematics course and as a part of the co-requisite *Frameworks for Mathematics and Collegiate Learning* course. These supports create the opportunity for successful acceleration. The following studies highlight the need for accelerated course options to move students through developmental math coursework and on to college-level coursework.

**Wlodkowski, R. J. (2003). Accelerated learning in colleges and universities. *New directions for adult and continuing education*, 97, 5–16.**

The author, a former Director of the Center for the Study of Accelerated Learning at Regis University, begins by noting that at the time, 225 colleges and universities had accelerated programs of instruction. This literature review describes research conducted around accelerated learning programs and concludes that student attitudes toward accelerated courses are positive and that students in accelerated courses are succeeding in their courses at rates comparable to those of students in conventional courses. Research findings are especially promising for adult learners who often want to progress through course sequences as quickly as possible.

The author also cites research findings that suggest that student success rates in their coursework and positive attitudes toward accelerated courses have resulted in an accelerated graduation time for students in accelerated programs. The author uses the research in the field to argue that there is a need for accelerated programs in higher education, particularly for adult learners.

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Wlodkowski, R. J., Mauldin, J. E., & Campbell, S. (2002). *Early exit: Understanding adult attrition in accelerated and traditional postsecondary programs*. Retrieved from <http://www.luminafoundation.org/publications/synopsis/Earlyexit02.pdf>

This analysis of 370 adult learners explores the causes of adult attrition from postsecondary programs. Wlodkowski and colleagues found that the length of time to graduation is a prominent reason for adult attrition in postsecondary programs. The Dana Center Mathematics Pathways model mitigates the length of time to graduation through an accelerated course sequence. The paper authors also found that better integration of students with their peers correlates with persistence across institutions, which may be addressed by the DCMP model's recommendation that students take *Frameworks for Mathematics and Collegiate Learning* and *Foundations of Mathematical Reasoning* with the same group of students.

**Hern, K., & Snell, M. (2010). *Exponential attrition and the promise of acceleration in developmental English and math*. Berkeley, CA: The Research and Planning Group for the California Community Colleges.**

Hern and Snell's study offers an in-depth look at models of acceleration in two California community colleges, finding that with each additional developmental course a student has to take, the chances of degree completion decrease. Students in accelerated English pathways passed their developmental English courses at a rate double that of their peers in traditional sequences and were equally as successful in college-level courses as students who came through traditional pathways.

Hern and Snell argue it is important to re-evaluate developmental courses to determine which aspects of developmental curriculum are necessary for student success in college-level courses. In addition to speaking to the DCMP principle of acceleration, this study is also relevant to the ideas of offering multiple pathways and re-evaluating developmental curriculum in order to prepare students for courses such as statistics, not just algebra and calculus.

**Edgecombe, N. (2011). *Accelerating the academic achievement of students referred to developmental education (CCRC Working Paper No. 30)*. New York: Community College Research Center, Teachers College, Columbia University.**

This review of the literature on community colleges' use of acceleration in developmental education suggests that low completion rates for developmental sequences can be largely attributed to structural barriers, including the number of potential exit points. Findings reviewed here suggest that acceleration interventions reduce the number of exit opportunities for students and are associated with improved student outcomes. For example, several studies demonstrate that a greater number of students in accelerated developmental courses pass their developmental classes than do students in traditional sequences.

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This report also explores the benefits of acceleration in the form of curriculum reorganization and diversified instructional approaches. The DCMP reduces the number of exit points in a developmental math sequence, reorganizes curriculum to make it more relevant to college-level courses such as statistics, and uses diversified instructional approaches—all of which are in line with the recommendations of this study.

**Jenkins, D., Speroni, C., Belfield, C., Jaggars, S. S., & Edgecombe, N. (2010). *A model for accelerating academic success of community college remedial English students: Is the Accelerated Learning Program (ALP) effective and affordable?* (CCRC Working Paper No. 21). New York: Community College Research Center, Teachers College, Columbia University.**

Over half of the high school graduates who enroll in postsecondary education through community college enroll in at least one developmental course. Passing rates for these developmental courses are typically low. This multivariate, cost-benefit analysis of the Accelerated Learning Program (ALP) explores the effects of accelerated learning programs for developmental English students.

This report found that the ALP model reduced time to developmental English completion from two semesters to one. Sixty percent of students participating in ALP passed the first level of college English compared to only 25 percent of students in regular developmental English tracks. A cost-benefit analysis of this accelerated model found that while individual semester costs were greater for the ALP program because of small class sizes (an enrollment of 8 instead of 20), overall the program saved the college money over time. The college's cost per successful student in this sample averaged \$3,122 for students in traditional developmental courses and \$2,680 for students taking accelerated courses through the ALP model.

These savings were due not only to the acceleration, but to the lower percentage of students who needed to retake failed courses. The authors conclude that community colleges should focus on expanding accelerated programs for students. While these findings were from a program focused on developmental English, the findings for acceleration are relevant to the overall structure of the DCMP and its emphasis on acceleration. The cost benefit for a program like DCMP may be even more dramatic because DCMP does not have the same course size recommendations.



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**Biswas, R. R. (2007). *Accelerating remedial math education: How institutional innovation and state policy interact* (An Achieving the Dream policy brief). Boston, MA: Jobs for the Future.**

This policy brief looks at the efforts of three community colleges to improve their developmental math programs using a variety of methods including acceleration models. Using data from approximately 46,000 students at Achieving the Dream Schools, Community College Research Center analysis determined that over 70 percent of students took developmental mathematics courses, and almost half of those students were placed in courses “three levels below college-level math. Of those, fewer than a fifth (18 percent) attempted a college algebra course and only 14 percent completed that course” (p. 1).

Biswas suggests that students who face three levels of developmental math can become frustrated and struggle to advance to college-level courses. She concludes that community colleges need to prioritize creating opportunities to help students move more quickly through developmental requirements. DCMP reduces the number of courses that students at this level take from three to two courses while still preparing students for college-level math courses.

### **PRINCIPLE III:**

#### **Intentional use of strategies to help students develop skills as learners**

To help students develop as learners, the Dana Center Mathematics Pathways model uses intentional strategies such as having students enroll in both a developmental mathematics course (*Foundations of Mathematical Reasoning*) and a supporting student success course (*Frameworks for Mathematics and Collegiate Learning*).

Additional strategies to help students develop as learners are embedded within the curricular materials for the DCMP mathematics courses (e.g., Foundations, Statistical Reasoning, Quantitative Reasoning, and STEM-Prep). Examples of such strategies include establishing classroom routines that scaffold learning for students (and encourage their constructive persistence when that scaffolding is judiciously withdrawn) and deliberately asking students to monitor and assess their readiness and confidence.

The following studies serve to highlight the impact of these course-level and task-level strategies within developmental education. Additional information on the learning strategies that students develop within the DCMP mathematics courses and the *Frameworks for Mathematics and Collegiate Learning* course can be found in the annotated bibliographies for *Frameworks* and for the DCMP mathematics curriculum design standards.

**Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research*, 63(2), 167–199.**

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The authors emphasize the need for integration of motivational constructs and an attention to classroom contextual factors to support student learning. Pintrich and colleagues argue that models for classroom teaching that focus on cognition too often do not address constructs such as students' goals, intentions, purposes, expectations, or needs. When these constructs are not acknowledged through course materials or teacher actions, students can adopt goals and purposes for their schoolwork that are different than what teachers intend, or students may not develop any goals for the course at all.

It is important to use classroom structure and organization to begin building the connections between motivational and cognitive components of student learning. This article underscores the importance of examining motivational beliefs and classroom contexts as factors that moderate students' conceptual change in their content coursework. This study speaks to the DCMP's inclusion of goal setting and its emphasis on motivation in the coursework for *Foundations of Mathematical Reasoning* and other DCMP mathematics courses.

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**Zeidenberg, M., Jenkins, D., & Calcagno, J. C. (2007). *Do student success courses actually help community college students succeed?* (Brief No. 36). New York: Community College Research Center, Teachers College, Columbia University. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/success-courses-help-students-succeed-brief.pdf>**

This brief from the Community College Research Center includes an in-depth analysis of the relationship between enrollment in student success courses and student outcomes in community colleges in Florida. A large number of students enter community college needing developmental education. A National Center for Education Statistics report states that “42 percent of entering first-time students at public two-year colleges in fall 2000 took at least one ... ‘developmental’ course” (quoted on page 1 in brief). In addition to facing academic challenges, many students also may not have developed effective goal-setting and/or study skills and may not have general awareness of how to succeed in college.

The authors of this brief investigate the relationship between completing a student success course and measures of school success in a sample of over 34,000 students. They use regression analysis to control for additional factors that may affect student outcomes. The authors’ results suggest that enrollment in a student success course “has a positive marginal effect on a student’s chances of earning a credential, persisting, or transferring” (p. 5). Students in this sample enrolled in a student success course were eight percent more likely than were their peers to earn a credential.

Importantly, this result also holds true for students enrolled in one or more credits of developmental coursework. Enrollment in a student success course is associated with a five percent increase in the probability of success for students in developmental courses. This study speaks to the DCMP strategy of having students co-enroll in *Frameworks*, a student success course designed to accompany and support the *Foundations* developmental mathematics course.

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**Cho, S., & Karp, M. M. (2013). Student success courses in the community college: Early enrollment and educational outcomes. *Community College Review*, 41(1), 86–103.**

This article examines whether student success course enrollment has a positive relationship with student outcomes, including persistence and credits earned. Cho and Karp gathered data on a sample of over 23,000 students from the Virginia Community College System.

They describe the student success courses offered, including information about what kinds of assistance the courses offered students in academic and career planning, what techniques the courses taught for improving study habits, and what opportunities the courses offered to develop quantitative life skills such as basic financial literacy. In addition, the researchers provide descriptive information about the students and the institutions students' attended.

Controlling for gender, ethnicity, age, socioeconomic status, first language, previous enrollment in a student success course, and whether the institution is urban or rural, Cho and Karp found that all developmental mathematics students are more likely to earn credits if they enrolled in a student success course in their first semester.

The effect was least evident for students in the lowest level of developmental mathematics (little to no effect), and most evident for students in the highest level.

Moreover, students in the “highest level of developmental mathematics were seven percentage points more likely to persist into the second year [of college] if they enrolled in a student success course in the first semester” (p. 97). These findings are relevant to the DCMP program's requirement that students be co-enrolled in *Frameworks for Mathematics and Collegiate Learning*, a student success course, during their first semester of an DCMP pathway.

**Zimmerman, B. J., Moylan, A., Hudesman, J., White, N., & Flugman, B. (2011). Enhancing self-reflection and mathematics achievement of at-risk urban technical college students. *Psychological Test and Assessment Modeling*, 53(1), 141–160.**

Barry Zimmerman, an expert in the psychology of self-regulation, and colleagues used a randomized control study to test an intervention aimed at improving community college mathematics students' confidence and achievement. Using a classroom-based intervention, they tested the effect of a self-regulated learning (SRL) intervention on developmental and introductory mathematics students and conducted separate analyses to determine the effect of the intervention for each group.

The researchers embedded self-regulation processes in elements of the course by having students in the intervention group assess their confidence while completing problems on exams, report on the strategies they used to solve problems, and

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analyze the errors that they made during examinations. Students in the intervention were prompted to analyze not only the work that they completed but also their assessments of their own confidence.

Over time, developmental and introductory students in the SRL intervention groups demonstrated less overconfidence in their abilities than did their control group counterparts. Ultimately, students in the SRL intervention outperformed their control group counterparts on periodic course examinations and on the final examination. The result was the same for developmental students and introductory students.

Embedding self-regulated learning strategies (i.e., assessing confidence, reviewing strategy use, correcting conceptual errors) in mathematics courses helps students to develop skills as learners and improves their academic achievement. These strategies are focused on changing student perceptions of their ability to learn and improve, rather than on their ability to earn a specific course grade. This research provides evidence for the use of self-regulating strategies such as assessing confidence in both the DCMF developmental math course and in the DCMF *Frameworks for Mathematics and Collegiate Learning* course.

### **For further reading on learning framework courses:**

Hodges, R. B., Dochen, C. W., & Sellers, D. C. (2001). Implementing a learning framework course. In J. L. Higbee, D. B. Lundell, I. M. Duranczyk, and D. Banerjee-Stevens (Eds.), *2001: A Developmental Odyssey* (pp. 3–13).

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### **PRINCIPLE IV:**

#### **Curriculum design and pedagogy based on proven practice**

Each aspect of the Dana Center Mathematics Pathways design is based on research and proven practice. The four pillars or themes that inform the *Frameworks for Mathematics and Collegiate Learning* course, the eight design standards for the mathematics courses, and the four guiding DCMP principles are all grounded in a substantial research base, as documented in these annotated bibliographies.

The overall DCMP program design is grounded in empirical research, and the program curriculum for each DCMP course is being designed and revised using teacher feedback from beginning to end. Veteran faculty members from institutions in Texas and across the nation are participating in DCMP curriculum design teams. These faculty set curriculum design standards and establish the learning outcomes for each course. All curriculum authors are current or former faculty at two- and four-year secondary institutions.

Faculty from nine codeveloper colleges in Texas that have been implementing DCMP courses are providing feedback. In addition, course developers are using feedback from site visits, surveys, and in-person meetings in the revision process for each course. The following studies highlight the importance of creating curriculum based on both empirical research and faculty experience.

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**Slavin, R. E. (2008). Perspectives on evidence-based research in education—What works? Issues in synthesizing educational program evaluations. *Educational Researcher*, 37(1), 5–14.**

This study by R. E. Slavin, the director of the Center for Research and Reform in Education at Johns Hopkins University, reinforces the importance of incorporating teaching practices and curriculum based on proven techniques. The author describes a historical trend in education to base practices on ideology, faddism, politics, and marketing, rather than on evidence. Slavin contrasts this approach with other disciplines, including medicine and agriculture, which require evidence as a basis for practice and decisions in the field.

Recently, the education field has placed greater importance on the adoption of evidence-based programs and practices. Many organizations, including the Institute for Educational Sciences sponsored by the U.S. Department of Education, have advocated for expanding research, evaluation, and the use of findings in education practices. The U. S. Department of Education, the British government, and international collaborations have also sponsored several initiatives to gather and synthesize educational research, including the What Works Clearinghouse (WWC), the Best Evidence Encyclopedia (BEE) and the Evidence for Policy and Practice Information Co-ordinating Centre (EPPI-Centre).

This article advocates for the expansion of research in education and suggests guidelines for conducting research to ensure that recommended practices are truly *proven* through rigorous processes. This article is relevant to the DCMP principle that curriculum design and pedagogy should be based on proven practice.

**Schwartz, W., & Jenkins, D. (2007). *Promising practices for community college developmental education: A discussion resource for the Connecticut Community College System*. New York: Community College Research Center, Teachers College, Columbia University. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/promising-practices-developmental-education.pdf>**

This resource from the Community College Research Center provides an outline of proven practices in developmental education. About 60 percent of students who enter postsecondary education through community colleges need to complete at least one developmental course. The authors note that “despite the prevalence of students who take developmental courses at community colleges, there is surprisingly little definitive research evidence on what makes for effective developmental education practice” (p. 2).

Schwartz and Jenkins provide examples of rigorous experimental research and suggest that research-based practices have had positive effects on developmental education outcomes. They argue that to ensure that proven practices make sense in the real-world developmental education context, experimental research should be

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supplemented by collaborations with experienced educators who work daily with developmental students.

In addition to advocating for research on new programs and pedagogical approaches, the authors stress the importance of continuous evaluation of existing programs to ensure that programs are achieving the desired outcomes. This guide speaks to the DCMP principle that curriculum design and pedagogy should be based on proven practice.

In addition to basing course principles on research practice, the DCMP model includes teachers in the design and revision of course materials, creating the opportunity for experienced educators to help ensure that DCMP courses are not only based on research, but are also critiqued based on proven teacher practice.

**Hodara, M. (2011). *Improving pedagogy in the developmental mathematics classroom* (Brief No. 51). New York: Community College Research Center, Teachers College, Columbia University.**

This brief from the Community College Research Center (CCRC) provides a summary of research-based approaches that have had positive effects on developmental education.

Hodara highlights the low completion rates in developmental math courses and argues for a more widespread use of research-based practices in developmental education. She provides guidelines for conducting rigorous research on education initiatives and also encourages researchers to collect information on student abilities and demographics in order to determine whether results are actually related to the intervention or program.

Hodara offers recommendations for future research to continue building the knowledge base on proven practices in developmental education. This CCRC brief is relevant to the DCMP principle that curriculum design and pedagogy should be based on proven practice.

**For further reading on developing research-based mathematics curricula:**

Clements, D. H. (2007). Curriculum research: Toward a framework for “Research-based curricula.” *Journal for Research in Mathematics Education*, 38(1), 35–70.



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#### Authors

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#### About these bibliographies

In these annotated bibliographies, we provide information on selected research underpinning the Dana Center Mathematics Pathways. These Summer 2014 bibliographies address

- The DCMP's four fundamental principles that shape the overall initiative
- The DCMP's eight curriculum design standards that inform the design of all courses developed by the DCMP

The DCMP's *Frameworks for Mathematics and Collegiate Learning* course's four pillars (or themes)

#### About the 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 Dana Center Mathematics Pathways, see [www.dcmathpathways.org](http://www.dcmathpathways.org)
- about the Texas Association of Community Colleges, see [www.tacc.org](http://www.tacc.org)

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