

# Frameworks for Mathematics and Collegiate Learning

## Selected Supporting Research

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Dana Center  
**Mathematics**  
PATHWAYS

*An annotated bibliography*

*Summer 2014*

### Overview

These annotated citations were developed by Dana Center staff<sup>1</sup> as a resource for practitioners and other professionals interested in learning more about the research underpinning the Dana Center Mathematics Pathways (DCMP). 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>

This document looks at the research that grounds the four pillars of the *Frameworks* course.

### About this bibliography

The *Frameworks for Mathematics and Collegiate Learning* course is built on four pillars or themes:

1. Building community and connecting to campus resources
2. Developing and maintaining motivation for success
3. Developing and using study strategies and skills
4. Finding your direction in college (and beyond)

These themes are woven throughout the course to create a coherent curriculum grounded in current research.

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

### **FRAMEWORKS PILLAR 1: Building community and connecting to campus resources**

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<sup>1</sup> See 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/nmp-curriculum-design-standards>

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

Learning is a social endeavor, and high-quality interactions among members of a learning community are essential to making a social learning environment work. Research demonstrates that student relationships with classroom instructors and with other campus community members can affect student academic achievement and persistence in college.

The *Frameworks* curricular materials provide opportunities for students, faculty, and campus personnel to foster positive relationships. Students explore campus resources inside and outside the classroom via face-to-face meetings with academic advisors and financial aid representatives and through visits to learning centers and libraries.

In addition, the early lessons in *Frameworks* strive to enhance students' sense of belongingness in math by establishing a classroom environment that honors and values individual contributions. Research supports the course's emphasis on building trusting relationships among student peers and instructors. The following articles highlight why it is important to student success that students build community and connect to campus resources.

**Kuh, G. D. (2003). What we're learning about student engagement from NSSE: Benchmarks for effective educational practices. *Change: The Magazine of Higher Learning*, 35(2), 24–32.**

George Kuh, director of the National Survey of Student Engagement (NSSE) at the Center for Postsecondary Research and Planning at Indiana University Bloomington, summarizes some of the findings that emerged as researchers analyzed NSSE survey data collected from approximately 285,000 students from more than 600 four-year colleges and universities.

This survey measures how engaged students are in college by asking them about the campus environment, the educational experiences available to them, their interactions with faculty, and the academic challenge and pedagogy of their coursework. Research analysis of this data concludes that student persistence is related to the extent to which students interact with supportive adults on campus, both inside and outside the classroom.

Kuh notes that both the nature and the frequency of these interactions matter; more specifically, Kuh notes that high-quality interactions are those that encourage students to devote greater effort to other educationally purposeful activities during college. Providing opportunities for these kinds of interaction is important, as other research has found that frequent student–professor interactions contribute to students' greater satisfaction with college life, a decreased likelihood of dropping out, and increased aspirations with respect to their careers.

The *Frameworks* course includes multiple opportunities for students to engage with faculty and staff from across campus. Some opportunities are more informal (e.g., briefly visiting offices across campus to become familiar with resources), while others include extended sessions with individuals with whom students should continue

working throughout their college careers (e.g., academic advisors, career counselors, research librarians).

These research findings speak to specific *Frameworks* lessons, including the following:

- *Lesson 2: Finding the Support to Be Successful*—Activity 3 (Introduction to the Scavenger Hunt)
- *Lesson 6: Meeting an Academic Advisor and a Career Counselor*—Activities 1 (Joint “Who We Are” Introduction by Guests), 2 (Making the Most of Academic Advising), 3 (What to Expect at the Career Center), and 4 (Preparing to Visit the Career Center and Assignment)
- *Lesson 10: Metacognition and Financial Advisor Visit*—Activity 3 (Visit from Financial Aid Office Representative)
- *Lesson 20: Site visit: Library Resources*—Activities 1 (Be Careful Who You Listen To!), 2 (Using Library Resources), and 3 (Success Team Work on Group Presentation)
- *Lesson 21: Using Library Resources and Group Presentation Preparation*—Activities 1 (Understanding Plagiarism, Citations, and Supporting Documentation) and 2 (Individual Work on Group Presentation)

**Additional resources:**

Chickering, A. W., & Reisser, L. (1993). *Education and identity* (2nd ed.). San Francisco, CA: Jossey-Bass.

Pascarella, E. T., & Terenzini, P. T. (2005). *How college affects students: A third decade of research*. San Francisco, CA: Jossey-Bass.

Rosenthal, G., Folse, E. J., Allerman, N. W., Boudreaux, D., Soper, B., & Von Bergen, C. (2000). The one-to-one survey: Traditional versus non-traditional student satisfaction with professors during one-to-one contacts. *College Student Journal*, 34(6), 315–312.

**Hausmann, L., Schofield, J., & Woods, R. (2007). Sense of belonging as a predictor of intentions to persist among African American and white first-year college students. *Research in Higher Education*, 48(7), 803–839.**

Researchers used a longitudinal experimental design to test the effects of an intervention aimed at increasing students' sense of belonging within an institution. Their approach included having university administrators write brief notes to students "emphasizing that they were valued members of the community" (p. 808).

These students also received small gifts emblazoned with the university's name, logo, and colors (p. 808). The researchers found that even these small connections positively affected students' perception of belonging on campus. Additionally, the researchers found that this sense of belonging significantly predicted students' commitment to the institution and their intention to persist.

This study demonstrates that the responsibility of helping students feel connected to the campus community should not solely be the responsibility of the classroom instructor. Even brief interactions with campus community members can positively affect students' dedication to the campus community and enhance their commitment to persist in their degree programs.

In *Frameworks*, early lessons focus on establishing a culture that encourages students to embrace their own backgrounds, share their background with their peers and instructor, and gradually begin engaging with others across campus. Activities include first having students gather general information about the services and expectations across the institution (via scavenger hunt) and then engaging students with more focused information from academic, career, and financial aid advisors.

Key to the *Frameworks* introduction of campus resources is having members of the campus community come to class to speak with students. The focus is on campus representatives (e.g., the registrar, advisors, librarians, and so on) who are most likely to help these students rather than representatives who are less likely to have subsequent face-to-face contact with students. *Frameworks* also builds in opportunities for instructors to collaborate with other instructors on campus and with members of the community outside campus.

- *Lesson 1: Building the Foundation for Our Success*—Activity 1 (My Story) and Activity 2 (Letting Go of Fears and Anxiety About Math)
- *Lesson 2: Finding the Support to Be Successful*—Activity 3 (Introduction to the Scavenger Hunt)
- *Lesson 6: Meeting an Academic Advisor and a Career Counselor*—Activities 1 (Joint "Who We Are" Introduction by Guests), 2 (Making the Most of Academic Advising), 3 (What to Expect at the Career Center), and 4 (Preparing to Visit the Career Center and Assignment)
- *Lesson 10: Metacognition and Financial Advisor Visit*—Activity 3 (Visit from Financial Aid Office Representative)

- *Lesson 20: Site visit: Library Resources*—Activities 1 (Be Careful Who You Listen To!), 2 (Using Library Resources), and 3 (Success Team Work on Group Presentation)
- *Lesson 21: Using Library Resources and Group Presentation Preparation*—Activities 1 (Understanding Plagiarism, Citations, and Supporting Documentation), and 2 (Individual Work on Group Presentation)
- *Lesson 22: Effective Oral Communication and Using Evaluation Rubrics*

**Additional resources:**

Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of College Student Personnel*, 25(3), 297–308.

**Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology*, 102(4), 700–717.**

The authors, psychologists who study the social forces and mindsets that shape academic achievement and motivation, conducted this lab-based study. They used a newly validated scale (“Math Sense of Belonging,” included in the article) to assess the impact of students’ sense of belonging on their academic achievement and intentions to persist in the discipline.

The authors define *sense of belonging* as the feeling that you fit in and that you are an accepted, valued, contributing member of a specific community. They hypothesized that regardless of gender, having a high sense of belonging positively relates to academic achievement outcomes. Their data support this hypothesis, showing that *math sense of belonging* did predict math achievement constructs such as anxiety, confidence, and usefulness. This sense of belonging also predicted students’ intentions to persist within the mathematics discipline, regardless of gender.

The researchers also discuss findings from a longitudinal study they conducted with calculus students to investigate the impact of environmental culture on sense of belonging, academic achievement, and intent to pursue study within the discipline. They found that “the more women perceived their math environments to convey either a high degree of stereotyping or a fixed view of math intelligence, the lower was their sense of belonging” (p. 712). The researchers go on to demonstrate that establishing a culture in which mathematics ability is seen as a malleable trait helped protect women from the effects of existing negative stereotypes about their abilities in math and contributed to a higher sense of belonging and a higher intention to continue studying mathematics in the future.

Taken together, these two studies underscore the importance of helping students feel valued within the mathematics community. Activities within the *Frameworks* curriculum seek to help instructors establish an academic community in which students feel welcome, reject stereotyped views, and endorse malleable beliefs about their mathematics ability.

Early *Frameworks* lessons include activities to help instructors establish a classroom culture that affirms and encourages students’ positive attitudes about their mathematical abilities and that helps students find the relevance of mathematics to their lives.

The first class meeting day sets the foundation for establishing a supportive culture by first acknowledging students’ prior mathematics experiences and, in subsequent lessons, studying the theory underlying the malleability of intelligence and applying it to students’ own transformation within mathematics study. As part of the course’s career project, students create an academic plan for how mathematics study supports their career aspirations, including determining which mathematics classes they should take in subsequent semesters.

- *Lesson 1: Building the Foundation for Our Success*—Activities 1 (My Story) and 2 (Letting Go of Fears and Anxiety About Math)
- *Lesson 3: Your Plastic Brain and Smart Thinking*—Activity 1 (Your Plastic Brain)
- *Lesson 8: Creating Motivating Goals and the Career Project*—Activities 1 (Ensuring that Your Goals Motivate You) and 2 (Introduction to the Career Project)
- *Lesson 10: Metacognition and Financial Advisor Visit*—Activity 3 (Visit from Financial Aid Office Representative)
- *Lesson 23: Career Project Sharing, Course Planning, and Guest Speaker*—Activities 1 (Career Project Sharing) and 2 (Planning What Courses to Take Next Semester)

**Tschannen-Moran, M., & Hoy, W. K. (2000). A multidisciplinary analysis of the nature, meaning, and measurement of trust. *Review of Educational Research*, 70(4), 547–593.**

The authors discuss the historical evolution of the concept of trust and build on their prior factor-analytic study (see additional resources below) establishing seven facets that together constitute “trust.”

According to these researchers, *trust* is defined as a student’s willingness to be vulnerable to his or her teacher based on the student’s confidence that the teacher is benevolent, reliable, competent, honest, and open. The article includes detailed explanations of the elements of trust, as well as the results of studies investigating how trust is established—and how it is violated.

Establishing a trusting relationship is important because students who view their professors as trustworthy will be more willing to engage with and be responsive to their professors’ messages. A high degree of trust between a student and an instructor could lead to students’ sharing more relevant, accurate, and complete information about problems they are facing. This kind of honest communication enables an instructor to provide relevant and helpful assistance.

Early *Frameworks* activities provide opportunities for instructors and campus community members to establish trusting relationships with students. This process is initiated in the course by having instructors and campus members share their own personal struggles and triumphs. Because this conceptualization of trust includes many complex elements, establishing and maintaining trust is, in turn, a complex, ongoing endeavor. Thus, the activities and dialogue are a starting point from which strong, productive classroom relationships can be built through repeated interactions across the semester.

- *Lesson 1: Building the Foundation for Our Success*—Activities 1 (My Story) and 2 (Letting Go of Fears and Anxiety About Math)
- *Lesson 6: Meeting an Academic Advisor and a Career Counselor*—Activities 1 (Joint “Who We Are” Introduction by Guests), 2 (Making the Most of Academic Advising), 3 (What to Expect at the Career Center), and 4 (Preparing to Visit the Career Center and Assignment)

**Additional resources:**

Tschannen-Moran, M., & Hoy, W. K. (1998). Trust in schools: A conceptual and empirical analysis of trust in schools. *Journal of Educational Administration*, 36(4), 334–352.



**FRAMEWORKS PILLAR 2:**  
**Developing and maintaining motivation for success**

Motivation theories exist to help us explain why people think and behave in certain ways. Numerous such theories exist, all shedding light on how students' values, beliefs, and attitudes influence their desire to perform and their actual performance in academic and nonacademic settings.

Within the *Frameworks* course, students study motivational theories and engage in activities that help them build and sustain motivation throughout the semester. Students identify values, beliefs, and attitudes about themselves as individuals and as students and learn how these values, beliefs, and attitudes influence their performance in college.

Students develop a system to monitor and manage their attitudes, emotions, and thoughts when faced with academic challenges. They work to curtail self-defeating habits (such as attributing failure to uncontrollable factors) and to create a productive mindset by focusing on controllable behaviors. These activities help students within their DCMP courses and prepare them to maintain that motivation throughout college and life.

While the *Frameworks* course focuses on self-efficacy, attributions, interest, value, and goal setting, deeper study of other such motivational theories would be appropriate extensions. The following articles highlight the importance of developing and maintaining motivation for success with all students.

**Dweck, C. S. (2008). Can personality be changed? The role of beliefs in personality and change. *Current Directions in Psychological Science*, 17(6), 391–394.**

Dweck proposes that we can enhance our understanding of an individual's personality if, instead of thinking of *personality* as broad traits or habits, we focus on it as a collection of individually held core beliefs.

According to Dweck and other researchers cited in this article, *core beliefs* are an individual's mental representations of how things work. Thus, core beliefs can include beliefs about the self (e.g., "I am smart"), others ("she is good at math") and events ("this class is a waste of time"). These beliefs can inform behavior and thought patterns by shaping individuals' choices of which goals to pursue and by influencing how they interpret and respond to environmental factors that affect that striving toward goals.

To demonstrate how beliefs affect goals and experiences, Dweck cites a variety of studies investigating beliefs about the malleability of personal attributes such as intelligence. For example, students who view intelligence as a characteristic that can change with effort (that is, as malleable) perform better when faced with academic challenges, are more open to learning, stick with difficult tasks, and bounce back from failure better than do students who endorse a view that their intelligence is fixed or unchangeable (p. 392).

Dweck goes on to discuss a study that shows that it is possible for students to change their "theory of mind" from a view that intelligence is fixed to a view that it is malleable.

Research exploring perceptions and beliefs about the malleability of various traits is ongoing and continues to influence how ideas about such traits are presented to students.

In the *Frameworks* course, students engage in an activity (similar to an activity described in the article) demonstrating that it is possible to teach that the mind is malleable. In *Frameworks*, students are shown a video of how the brain is capable of adapting and changing over the course of a person’s life; students then engage in discussions about the conditions that lead to these brain changes as well as recent neuroscience findings about brain plasticity. Additional study of how the brain works follows in later lessons, but instructors are encouraged to continually prompt students in all lessons (not just in those lessons focused on the brain) to think about how their brains can be malleable.

- *Lesson 3: Your Plastic Brain and Smart Thinking*—Activities 1 (Your Plastic Brain) and 2 (Introduction to Smart Thinking)
- *Lesson 11: Build a Better Memory Part 1: Attention and Deep Processing*—Activities 1 (Our Complex Brains), 2 (The Difference Between Deep and Shallow Processing), and 3 (Making Information Meaningful)
- *Lesson 12: Build a Better Memory Part 2: Elaboration and Organization Strategies*—Activities 1 (Elaboration and Organization Strategies), 2 (Practice Using Think-Alouds), and 3 (Creating Flash Cards)

**Additional resources:**

Dupeyrat, C., & Mariné, C. (2005). Implicit theories of intelligence, goal orientation, cognitive engagement, and achievement: A test of Dweck’s model with returning to school adults. *Contemporary Educational Psychology, 30*(1), 43–59.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. Philadelphia, PA: Psychology Press.

Mueller, C. M., & Dweck, C. S. (1998). Praise for intelligence can undermine children’s motivation and performance. *Journal of Personality and Social Psychology, 75*(1), 33–52.

**Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist*, 26(3/4), 207–231.**

Self-efficacy theory posits that an individual’s confidence in his or her ability to be successful at a given task influences how that person thinks and behaves. This confidence can exert tremendous influence on an individual’s thoughts and behaviors, including on their choice to participate in a specific activity and their persistence in the face of adversity.

Research indicates that this sense of self-efficacy is influenced by four factors: an individual’s own prior experiences, their vicarious experiences (what they have seen others do or experience), personally experienced persuasion (someone telling the individual that they can be successful), and their own internal physiological cues (symptoms of anxiety, for example).

In this article, Dale Schunk reviews Albert Bandura’s early work establishing the concept of self-efficacy and demonstrates how self-efficacy relates to other motivation constructs, including an individual’s perceived control of a situation, their understanding of the causes of outcomes, their perceived value of those outcomes (e.g., “is it worth it?”), and their self-concept.

The *Frameworks* course provides multiple opportunities for students to analyze their own confidence or sense of self-efficacy and further develop it via mastery experiences that are spiraled throughout the course. The following activities are two examples, with the “Value of Goals” activity providing an opportunity for students to dig deeper into the theoretical foundations of self-efficacy.

- *Lesson 1: Building the Foundation for Our Success*—Activity 2 (Letting Go of Fears and Anxiety About Math)
- *Lesson 7: Identifying Your Impact on the World*—Activity 2 (Value of Goals)

**Additional resources:**

Usher, E. L., & Pajares, F. (2008). Sources of self-efficacy in school: Critical review of the literature and future directions. *Review of Educational Research*, 78(4), 751–796.

Schunk, D. H. (2008). Attributions as motivators of self-regulated learning. In D. H. Schunk and B. J. Zimmerman (Eds.), *Motivation and self-regulated learning: Theory, research, and applications* (pp. 245–266). New York: Lawrence Erlbaum Associates.

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal*, 29(3), 663–676.

**Weiner, B. (1985). An attribution theory of achievement motivation and emotion. *Psychological Review*, 92(4), 548–573.**

Attribution theory describes how an individual’s motivation to achieve is affected by what they believe leads to that achievement (e.g., luck versus hard work). In this article, Weiner establishes the foundation of an attribution theory of motivation by presenting empirical evidence showing that individuals can and do explain achievement outcomes in relation to what they think caused the outcome.

He outlines previous research to identify examples of these dominant attributions within the literature, including attributions of effort, ability, luck, interest, and use of strategy as causes of outcomes. He then categorizes these perceived causes of successes and failures along three dimensions: internal or external to an individual, controllable or uncontrollable by the individual, and stable or unstable over time.

In addition, Weiner discusses the impact that emotion has on an individual’s attributions and the influence that both emotions and attributions have on an individual’s subsequent behaviors. Accurately assessing the cause of an outcome helps students take control of their learning, replicate the behaviors or processes that lead to success, and avoid the behaviors or processes that resulted in undesired outcomes.

In the *Frameworks course*, students identify and share the attributions they make for their successes and failures and develop a process through which they can begin to systematically reflect on the beliefs, attitudes, and behaviors that affect their desired outcomes.

- *Lesson 1: Building the Foundation for Our Success—Activity 2 (Letting Go of Fears and Anxiety About Math)*
- *Lesson 3: Your Plastic Brain and Smart Thinking—Activities 1 (Your Plastic Brain) and 2 (Introduction to Smart Thinking)*
- *Lesson 18: Midterm Exam Debrief—Activities 1 (Design a Review Process) and 2 (Apply Your Review Process)*

**Additional resources:**

Wilson, T. D., Damiani, M., & Shelton, N. (2002). Improving the academic performance of college students with brief attributional interventions. In J. Aronson (Ed.), *Improving academic achievement: Impact of psychological factors on education* (pp. 89–108). San Diego, CA: Academic Press.

Weiner, B. (2010). The development of an attribution-based theory of motivation: A history of ideas. *Educational Psychologist*, 45(1), 28–36.

**Hulleman, C. S., Godes, O., Hendricks, B. L., & Harackiewicz, J. M. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology, 102*(4), 880–895.**

This article expands on work conducted by J. Eccles, A. Wigfield, and others (see additional resources below) regarding the effects of students' expectancy beliefs about tasks. *Expectancy beliefs* are an individual's beliefs about what the outcomes of certain tasks will be and what the value of those outcomes are for them.

The authors of this report discuss findings from a classroom intervention in which students are encouraged to write about how the course material is relevant to their lives in an effort to increase the value that students perceive for the activity. Early expectancy value research established that an individual's perceived importance of a task, or *task value*, is four-pronged and includes utility value, intrinsic value, attainment value, and cost.

The authors focus on *utility value*, or an individual's perception about the usefulness of a task (or aspects of a task) for future tasks they will engage in. The findings indicate that encouraging students to apply course material to their own lives helps them feel that the material is useful, which in turn influences their interest—and performance in—the course. Beyond course performance, increased utility value and the *perceived instrumentality* (defined as how the task or skill is perceived as useful in achieving a goal) of a task have also been linked to a student's interest in an academic major and subsequent enrollment intentions.

Throughout the semester in *Frameworks*, students complete short writing assignments as part of informal journaling. Just as in the study described here, these writing exercises are part of the course syllabus and are completed for course credit. The suggested writing prompts encourage students to write about the relevance of the class material to their own lives. In addition, the following activities afford students opportunities to explore their interests and make the course personally meaningful.

- *Lesson 7: Identifying Your Impact on the World*—Activities 2 (Value of Goals) and 3 (Nine Boxes)
- *Lesson 8: Creating Motivating Goals and the Career Project*—Activities 1 (Ensuring that Your Goals Motivate You) and 2 (Introduction to the Career Project)
- *Lesson 23: Career Project Sharing, Course Planning, and Guest Speaker*—Activities 1 (Career Project Sharing) and 2 (Planning What Courses to Take Next Semester)
- *Lesson 30: Where Will You Be in 10 Years?*—Activity 1 (Let's Party Like Our Successful Future Is Now: The 10-Year Class Reunion)

**Additional resources:**

Eccles, J., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75–146). San Francisco, CA: Freeman.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, 53(1), 109–132.

Elliot, A. J. (2005). A conceptual history of the achievement goal construct. In A. Elliot & C. Dweck (Eds.), *Handbook of competence and motivation* (pp. 52–72). New York: Guilford Press.

Hulleman, C. S., Durik, A. M., Schweigert, S. B., & Harackiewicz, J. M. (2008). Task values, achievement goals, and interest: An integrative analysis. *Journal of Educational Psychology*, 100(2), 398–416.

**Oyserman, D., Bybee, D., & Terry, K. (2006). Possible selves and academic outcomes: How and when possible selves impel action. *Journal of Personality and Social Psychology*, 91(1), 188–204.**

The phrase *possible selves* refers to an individual's ideas about who he or she might become in the future, including both who they would like to become and who they fear they may become. In this intervention study, *possible selves* researcher Oyserman and her team build upon previous research findings that possible selves that are academically oriented are positively linked to school outcomes and school connectedness.

In the intervention, students, in a series of ten workshops, generated academic possible selves—visions of themselves in the future that include or rely on academic success. The students then identified skills and abilities they already possessed that could help them be successful, acknowledged negative forces and challenges that could stand in their way, articulated specific strategies they could enact in order to attain their possible selves (planning for the anticipated obstacles), and created timelines to guide their future actions.

Researchers found that students in the intervention had improved grades and demonstrated an increase in academic initiative, an effect sustained over a two-year follow-up period. The authors concluded that these results were possible because students identified that the careers they wanted to have and the lives they envisioned for themselves require mastering academic work. Students also linked their academic possible selves to specific strategies for success, came to view difficulties as normal, and came to view academic success as consistent with their social identities. When encouraging students to think about and plan for their future possible selves, it is important to have them address these elements as well.

In the *Frameworks* course, identifying future possible selves and developing a plan to attain that future version of oneself is central to the course's career project, which includes three main activities: identifying possible career paths by completing a possible selves mind map and reflection, analyzing one of the possible selves mind map branches by completing a SWOT (strengths, weaknesses, opportunities, and threats) analysis, and developing an action plan (focusing on degree plan and necessary coursework) to acquire the skills and knowledge necessary for successfully becoming the possible self. In addition, students publicly share the results of their work to strengthen their commitment to enacting the plans they created within the project in the following two lessons:

- *Lesson 23: Career Project Sharing, Course Planning and Guest Speaker—Activities 1 (Career Project Sharing) and 2 (Planning What Courses to Take Next Semester).*
- *Lesson 30: Where Will You Be in 10 Years?—Activity 1 (Let's Party Like Our Successful Future Is Now: The 10-Year Class Reunion)*

#### **Additional resources:**

Markus, H., & Nurius, P. (1986). Possible selves. *American Psychologist*, 41(9), 954–969.

### **FRAMEWORKS PILLAR 3: Developing and using study strategies and skills**

A sizable body of research demonstrates that students' use of learning strategies promotes academic achievement. In addition, researchers have demonstrated that students can effectively use learning strategies by studying the elements that contribute to self-regulation—cognition, metacognition, and motivation—and applying these ideas.

The *Frameworks* course is designed to help students become self-regulated learners who understand themselves as learners, who monitor and regulate their own learning, and who are empowered to analyze their learning environment and choose from a variety of learning strategies as they respond to various environmental factors.

Within *Frameworks*, students begin to assemble a toolbox of learning strategies that they can draw upon as they engage in activities in and out of school. Some *Frameworks* classroom activities focus on how the brain works, including memory and brain plasticity. Others enable students to demonstrate critical thinking skills and work to enhance their self-regulatory thoughts and behaviors.

Students also identify, select, and implement appropriate strategies for time management, procrastination reduction, reading, note taking, test taking, and oral and written communication. The following articles highlight the importance of helping students to develop and use study strategies and skills, including self-regulation skills.

**McKeachie, W. J., Pintrich, P. R., & Lin, Y. G. (1985). Teaching learning strategies. *Educational Psychologist*, 20(3), 153–160.**

In this article, McKeachie and colleagues provide insight into their early work creating a college-level course in strategic learning. They briefly summarize how strategic learning frameworks courses improve student outcomes by focusing on the study and application of cognitive psychology concepts.

The authors reference foundational cognition, metacognition, and motivation articles in order to build the case for creating a systematic course that helps students identify and build a toolbox of learning strategies. The authors include preliminary results demonstrating the impact of one such course that included teaching students about cognition and metacognition to help them to develop as strategic learners. Students who enrolled in this “Learning to Learn” course reported greater use of learning strategies as well as decreased anxiety compared to those students enrolled in a general introductory psychology course.

The authors point out that the “Learning to Learn” students' academic performance in subsequent semesters did not differ substantially from what would be expected from a traditional study skills course, providing valuable feedback that has been used to refine and expand the content and pedagogy used within success courses. Strategic learning courses have evolved since the publication of this article, and the *Frameworks* curriculum builds on this work as well as on recent trends in success course offerings.



In the *Frameworks* course, students engage with key concepts from cognition, metacognition, and motivation theory. In addition to studying these theories, students complete activities that help them apply what they are studying to their own lives. While *theory of mind* content is included in every *Frameworks* lesson, it is the primary focus within the following lessons. The semester-long group project also provides an opportunity for students to dig deeper into the theory and application; more information on those lessons is available in the course curriculum.

- *Lesson 1: Building the Foundation for Our Success*—Activity 2 (Letting Go of Fears and Anxiety About Math)
- *Lesson 7: Identifying Your Impact on the World*—Activities 2 (Value of Goals) and 3 (Nine Boxes)
- *Lesson 8: Creating Motivating Goals and the Career Project*—Activities 1 (Ensuring that Your Goals Motivate You) and 2 (Introduction to the Career Project)
- *Lesson 10: Metacognition and Financial Advisor Visit*—Activity 3 (Visit from Financial Aid Office Representative)
- *Lesson 11: Build a Better Memory Part 1: Attention and Deep Processing*—Activities 1 (Our Complex Brains), 2 (The Difference Between Deep and Shallow Processing), and 3 (Making Information Meaningful)
- *Lesson 12: Build a Better Memory Part 2: Elaboration and Organization Strategies*—Activities 1 (Elaboration and Organization Strategies), 2 (Practice Using Think-Alouds), and 3 (Creating Flash Cards)

**Additional resources:**

Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.) (pp. 315–327). New York: Macmillan.

Hodges, R. B., Dochen, C. W., & Sellers, D. C. (2001). Implementing a learning framework course. In J. L. Higbee (Ed.), *2001: A developmental odyssey* (pp. 3–13). Warrensburg, MO: The National Association for Developmental Education.

**Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology*, 95(4), 667–686.**

The author begins this article by describing how our understanding of the factors that affect learning has evolved from a focus on cognitive factors to a focus that now also includes motivational and affective factors under the umbrella of self-regulated learning.

Pintrich then outlines the general assumptions of this perspective and discusses in depth a cyclical process of self-regulated learning. Among the assumptions is the idea that self-regulated students are active throughout learning activities, mentally monitoring and exerting control not only over their actions but also over the affect, beliefs, attitudes, and thoughts that underlie those actions. He describes a model of self-regulated learning that includes four phases (*forethought, monitoring, control, and reaction/reflection*) and discusses other researchers' work that examines how learners attempt to monitor, control, and regulate the cognitive, motivational, behavioral, and contextual elements of self-regulated learning.

The self-regulation model included within the *Frameworks* course uses an adaptation of the self-regulation model outlined in this article; specifically, *Frameworks* condenses the phases of this model into *planning, implementing and monitoring, and evaluation*. In the *planning* (or *forethought*) phase, individuals select appropriate learning strategies to employ in order to achieve learning goals. Self-motivation beliefs (self-efficacy, goal orientations, outcome expectations, and value) and task analysis (goal setting, strategic planning) are key within this phase.

In the *implementing and monitoring* phase, individuals use the selected strategies, continuously monitoring task performance and comprehension. They observe their own behavior and determine the amount of effort they will expend in an effort to reach the target goals they set during the planning phase.

Finally, in the *evaluation* (or self-reflection) phase, individuals evaluate the product of the performance stage. They judge the outcome, take stock of their own emotional reactions, and determine what actions led to this outcome. These evaluations feed forward into the planning phase of the next self-regulation cycle. Students routinely engage in self-regulatory activities within the *Frameworks* course, as illustrated in the following three lessons.

- *Lesson 10: Metacognition and Financial Advisor Visit*—Activity 3 (Visit from Financial Aid Office Representative)
- *Lesson 16: Where We've Been, Where We're Going*—Activity 2 (Reflection and Strategy Modification)
- *Lesson 18: Midterm Exam Debrief*—Activities 1 (Design a Review Process) and 2 (Apply Your Review Process) and goal modification assignment

**Additional resources:**

- Zimmerman, B. J. (1989). Models of self-regulated learning and academic achievement. In B. J. Zimmerman and D. H. Schunk (Eds.), *Self-regulated learning and academic achievement: Theory, research, and practice* (pp. 1–25). New York: Springer-Verlag.
- Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation: Theory, research, and applications* (pp. 13–39). San Diego, CA: Academic Press.

**Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, 34(10), 906–911.**

In this seminal article on metacognition, Stanford University psychologist John Flavell proposes a model to capture how individuals engage in higher-order thinking to actively control their cognitive processes in learning situations. Often simplified as “thinking about thinking,” the model proposed in this article was the impetus for extensive research into metacognition, and today, two components of metacognition are generally accepted within the field: *knowledge of cognition* and *regulation of cognition*.

*Knowledge of cognition*, also known as metacognitive knowledge, includes declarative (factual) knowledge about oneself as a learner, procedural knowledge (knowledge of how to do things), and conditional knowledge (knowledge of when and why to do things). Flavell elaborates on these ideas and discusses the influence that metacognitive knowledge can have on an individual’s choice of goals and tasks as well as on his or her evaluation and reflection regarding whether the goal or task is complete. For more information about regulation of cognition, the description of self-regulated learning included under the Pintrich (2003) entry has relevant information.

In *Frameworks*, many activities in the first half of the course are designed to help students make their thinking processes more transparent. These activities prepare them for Lesson 10, in which they identify key components of metacognition and apply knowledge and regulation strategies to new situations.

- *Lesson 10: Metacognition and Financial Advisor Visit*—Activity 3 (Visit from Financial Aid Office Representative)

**Additional resources:**

- Schraw, G. (1994). The effect of metacognitive knowledge on local and global monitoring. *Contemporary Educational Psychology*, 19(2), 143–154.
- Schraw, G. (1998). Promoting general metacognitive awareness. *Instructional Science*, 26(1–2), 113–125.
- Veenman, M. V., Van Hout-Wolters, B. H., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning*, 1(1), 3–14.

**FRAMEWORKS PILLAR 4:**  
**Finding your direction in college (and beyond)**

Some students enter college with a clear idea of the work they want to do after graduating. A large number of students, however, expect to explore career paths while in school. The *Frameworks* course meets students where they are and provides opportunities for students to set goals and develop plans for attaining those goals.

In the course, students spend time identifying factors that contribute to their own goal setting and, over the course of the entire term, assess their interests, set goals, collect data relevant to their goals, and use that information to devise strategies to employ on their path to attaining those aspirations.

Students also connect with knowledgeable career advisors at the college and participate in activities structured to help them explore career areas so that they can confidently move forward in implementing their programs of study. The following articles highlight the importance of supporting students in finding their direction in college.

**Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal*, 29(3), 663–676.**

In this seminal study of goal setting, researchers investigate the link between goal setting and self-efficacy beliefs. They build on prior research on goals, including studies demonstrating that setting proximal goals positively affects self-efficacy, achievement, and interest.

Goal setting can influence students' reactions to their successes and failures, because goals serve as a guide that indicates what individuals define as personal success. Researchers conducted a path analysis using survey and course-grade data gathered from 116 high school students and found that personal goals significantly influenced students' grades in school.

They found that students who had high confidence in their ability to monitor and regulate their behavior also had high confidence in their ability to achieve academically. This confidence about academic achievement positively affected both the grade goals that students set for themselves and their final course grade. This connection between confidence and goal setting (and ultimately achievement) underscores how important it is for students to build confidence and to set goals to shape their behavior.

The *Frameworks* course incorporates goal theory, goal setting, and long-term planning throughout, including in class discussion, individual homework, and project assignments. After guided discussion about the value of clarifying short- and long-term intentions, students work to operationalize their goals by identifying specific actions they can take to pursue them. Class discussions of other motivation-related concepts (including self-efficacy, as described in this article) directly tie into the future planning discussions in the following lessons.

- *Lesson 7: Identifying Your Impact on the World*—Activities 2 (Value of Goals) and 3 (Nine Boxes)
- *Lesson 8: Creating Motivating Goals and the Career Project*—Activities 1 (Ensuring that Your Goals Motivate You) and 2 (Introduction to the Career Project)
- *Lesson 10: Metacognition and Financial Advisor Visit*—Activity 3 (Visit from Financial Aid Office Representative)
- *Lesson 18: Midterm Exam Debrief*—Activities 1 (Design a Review Process) and 2 (Apply Your Review Process)

**Additional resources:**

Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting and task performance*. Englewood Cliffs, NJ: Prentice Hall.

**Morisano, D., Hirsh, J. B., Peterson, J. B., Pihl, R. O., & Shore, B. M. (2010). Setting, elaborating, and reflecting on personal goals improves academic performance. *Journal of Applied Psychology, 95*(2), 255–264.**

The authors, industrial organizational psychologists, report findings of a yearlong randomized-control intervention on goal setting conducted with full-time college students. All participants reported experiencing academic difficulty and had either been on academic probation or had had a grade point average below 3.0.

Students who completed the intervention, a self-paced series of eight steps in which they set multiple goals in self-selected domains and determined specific strategies to achieve those goals, reported statistically significant differences from students in the control group during the post-intervention semester.

These differences included “(a) an increased GPA, (b) higher probability of maintaining a full course load, and (c) reductions in reported negative affect” (p. 260)—elements that have previously been positively linked to student persistence and completion. The *Frameworks* course builds on the concepts from this one-time intervention by engaging students throughout the semester in a series of activities focused on intentionally setting and pursuing goals.

Similarly to this described intervention, *Frameworks* students set goals for all aspects of their lives, not just the academic portion. These goal-setting activities empower them to identify and work toward outcomes they personally value. Much of this work takes place as part of the individual career project in which students identify the competencies necessary for the field they are interested in, collect data about the field, and plan for how they will strategically use their time in college to prepare for the realities of that working environment.

- *Lesson 6: Meeting an Academic Advisor and a Career Counselor*—Activities 1 (Joint “Who We Are” Introduction by Guests), 2 (Making the Most of Academic Advising), 3 (What to Expect at the Career Center), and 4 (Preparing to Visit the Career Center and Assignment)
- *Lesson 7: Identifying Your Impact on the World*—Activities 2 (Value of Goals) and 3 (Nine Boxes)
- *Lesson 8: Creating Motivating Goals and the Career Project*—Activities 1 (Ensuring that Your Goals Motivate You) and 2 (Introduction to the Career Project)
- *Lesson 23: Career Project Sharing, Course Planning, and Guest Speaker*—Activities 1 (Career Project Sharing) and 2 (Planning What Courses to Take Next Semester)

**Additional resources:**

Latham, G. P., & Locke, E. A. (2007). New developments in and directions for goal-setting research. *European Psychologist, 12*(4), 290–300.

**Ducote, J. M. (1984, November). Career indecision among adolescent/college students: A literature review and suggested interventions. Paper presented at the Annual Meeting of the Mid-South Educational Research Association, New Orleans, LA.**

In this review of career development literature, J. M. Ducote identifies characteristics of indecisive students and discusses research that supports one of two views of career indecision: one, that it is a normal task of development and two, that indecision is related to psychological constructs including anxiety, self-perceptions, and external attributions (p. 14).

Three interventions are proposed to help indecisive students make career-related decisions. First, help students gain self-knowledge, including understanding of their cultural and family influences as well as their own confidence and fears about failure or success. Second, help students gather information about possible opportunities and careers open to them, which includes helping students identify actual and perceived barriers to entering that field. Third, help students prepare for their careers (p. 14).

Many college students enter college undecided on their major (or consider their major out of reach because of their struggles in math). Therefore, guidance on career decision-making is embedded within the *Frameworks* course. In *Frameworks*, instructors are encouraged to create a culture of growth and learning within their classes. In addition to cultivating the trust necessary for students to interact with one another and with the instructor, such a culture also helps students feel safe exploring identity issues, including their purpose in life and the effect they wish to have on their world, especially within their chosen career field. As part of their career project, students use campus resources to explore possible career fields, and they plan for how they will use their college experiences to prepare for their careers.

- *Lesson 1: Building the Foundation for Our Success—Activity 2 (Letting Go of Fears and Anxiety About Math)*
- *Lesson 7: Identifying Your Impact on the World—Activities 2 (Value of Goals) and 3 (Nine Boxes)*
- *Lesson 8: Creating Motivating Goals and the Career Project—Activities 1 (Ensuring that Your Goals Motivate You) and 2 (Introduction to the Career Project)*
- *Lesson 23: Career Project Sharing, Course Planning, and Guest Speaker—Activities 1 (Career Project Sharing) and 2 (Planning What Courses to Take Next Semester)*

**Luzzo, D. A. (1999). Identifying the career decision-making needs of nontraditional college students. *Journal of Counseling & Development*, 77(2), 135–140.**

Students in college classrooms bring with them a diversity of experiences, attitudes, and behaviors, some of which are specific to their career search process. The author summarizes existing research on traditional and nontraditional students' career-related needs and indicates that these groups both share some attributes related to their future careers, but also differ in key ways that need to be considered.

For example, there are studies indicating that a student's age does not impact their knowledge of their preferred occupation or their level of career indecision (p. 135). Age does, however, affect students' attitudes toward career decision making (including their own self-efficacy in such decision making) and career commitment.

Older students tend to lack the anxiety, fear, and insecurity that younger students feel about making career decisions; older students also tend to be more committed to their chosen careers and are confident in their ability to make decisions about their careers. On the other hand, older students are more likely than their younger peers to recognize that there could be barriers that prevent them from proceeding down a career path.

These comparisons suggest that all students could benefit from gathering and analyzing information about career fields and possible barriers, but that such information-gathering should be structured flexibly enough to meet the diverse needs of the students engaging in the activity. While age is the primary focus of this article, other factors influence students' career planning needs as well, only heightening the need for flexibility within a career project.

The *Frameworks* career project is constructed to meet the needs of all students in the course. It is flexible enough that students with a clear vision for what they want out of college (including older, returning students) and students (often younger students) just starting to think about their career path will benefit from the exercise. Within the project, students spend time gathering data to help them make decisions and plan for their futures.

- *Lesson 1: Building the Foundation for Our Success—Activity 2 (Letting Go of Fears and Anxiety about Math)*
- *Lesson 7: Identifying Your Impact on the World—Activities 2 (Value of Goals) and 3 (Nine Boxes)*
- *Lesson 8: Creating Motivating Goals and the Career Project—Activities 1 (Ensuring that Your Goals Motivate You) and 2 (Introduction to the Career Project)*
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## About this resource

### Authors

Nancy Stano, *Frameworks* project lead and curriculum author

Jennifer Dorsey, senior evaluation analyst

### Editing and production

Ophella Dano, lead editor

Rachel Jenkins, consulting editor

William Christopher Lee, proofreader

Erica Moreno, production

### 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 the 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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