

## CPM's 2023 Research Base Introduction

Since its inception in 1989, CPM has produced three research base reports: one each in 2006, 2013, and 2023. These research base documents reflect the shifting foci in mathematics education research. New research has continued to validate and add nuance to CPM's Three Pillars.

### **Collaborative Learning** ([Full Report](#); [Executive Summary](#))

- 2006: Initial learning of a concept is best supported by discussions within cooperative learning groups guided by a knowledgeable teacher.
- 2013: Students learn ideas more deeply when they discuss ideas with classmates.
- 2023: Students participate more fully in mathematics when they jointly construct mathematical ideas with their peers in inclusive classroom environments.

### **Problem-Based Learning** ([Full Report](#); [Executive Summary](#))

- 2006: Integration of knowledge is best supported by engagement of the learner with a wide array of problems around a core idea.
- 2013: Students learn ideas more usefully for other arenas when they learn by attacking problems—ideally from the real world.
- 2023: Students develop conceptual understanding and ownership of mathematical ideas when they are meaningfully involved in mathematical decision-making.

### **Mixed, Spaced Practice** ([Full Report](#); [Executive Summary](#))

- 2006: Long-term retention and transfer of knowledge is best supported by spaced practice or spiraling.
- 2013: Students learn ideas more permanently when they are required to engage and re-engage with ideas for months or even years.
- 2023: Students become increasingly proficient at identifying problem types and selecting appropriate strategies as they experience mathematical problems mixed within and spaced across assignments, lessons, chapters, and courses.

CPM's Three Pillars have driven the development of CPM curricula, and each year the importance of these pillars is better understood as researchers continue to investigate their influence on mathematics learning.

The following sections gloss the major shifts observable in CPM's 2023 Research Base Documents.

1. **Collaborative Learning.** Collaboration is distinct from cooperation: collaboration implies a joint production of ideas, and cooperation implies sharing of ideas. While sharing ideas and strategies is important, it falls short of collaboration because it can amount to a distribution of labor in which students take on different parts of the task but do not build on each other's ideas for problem solving. When students collaborate, they jointly produce ideas by making their ideas

public to their peers, responding to each other's ideas, and over time, generating shared understandings.

Centering equity is essential in collaborative learning environments and is best supported by a reflective teaching practice. When we center equity in collaborative mathematics learning, effort must be recast from an individual attribute to an attribute of group dynamics. Collaborative Learning affords teachers opportunities to create more inclusive classroom environments.

2. **Problem-Based Learning.** The distribution and delegation of power in mathematics classrooms and how it influences students' opportunities to learn is an important topic in educational research. This is often studied by examining whose mathematical knowledge is taken as true within teamwork and class discussions.

The general consensus amongst scholars of cognitive and sociocultural research is that allowing students to invent strategies and engage in productive struggle is more effective for learning than showing students how to solve problems.

3. **Mixed, Spaced Practice.** Mixed, Spaced Practice involves *mixed* problem sets (rather than blocked with similar problems grouped together) with similar types of problems *spaced* over multiple weeks or months (rather than massed with problem types being practiced at once and then left behind for new content).

Researchers continue to find overwhelming evidence for the benefits of increased retention (long-term memory) and transfer (recognizing problem types in unfamiliar problems) when students engage in Mixed, Spaced Practice rather than blocked and massed practice.