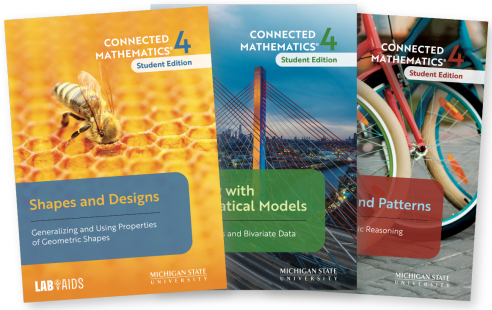
MICHIGAN STATE UNIVERSITY

Connected Mathematics: A Research Overview



The Connected Mathematics Project (CMP) at Michigan State University (MSU) has been working for over 35 years to design, develop, field-test, evaluate, and disseminate mathematics materials for middle school students and teachers. The development of CMP1 and CMP2 was supported by funding from the National Science Foundation, for development, research, and professional development. With CMP1, CMP2, CMP3, and CMP4 the MSU authors and administration have used the CMP royalties to establish MSU Mathematics Education Endowment Funds which support research and development in mathematics and science education.

The Overarching Goal of CMP

The overarching goal of CMP is to help students and teachers develop mathematical knowledge, understanding, and skill along with an awareness of and appreciation for the rich connections among mathematical strands and between mathematics and other disciplines. The CMP curriculum development has been guided by our single mathematical standard:

> *All students should be able to reason and communicate proficiently in mathematics. They should have knowledge of and skill in the use of the vocabulary, forms of representation, materials, tools, techniques, and intellectual methods of the discipline of mathematics, including the ability to define and solve problems with reason, insight, inventiveness, and technical proficiency.*

Co-Development with Teachers and Students

The unique development process spans repetitive years of design, field trials, and data feedback cycles pictured in the diagram. This includes feedback from teachers, administrators, researchers, parents, and students from across the country. CMP4 was field-tested by over **500 teachers**, from **22 states** and **six international territories**. These interactions between teachers and students with the materials are the most compelling parts of the materials.

Most Widely Used Middle School Curriculum

CMP is used in all 50 of the United States as well as several foreign countries. The use of CMP in teacher education courses, research, and professional learning settings continues to grow.

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Research Findings on CMP

A substantial number of research studies have been conducted since the release of CMP1 in 1996.

300 research articles and reports,
57 books and book chapters,
63 conference proceedings,
108 dissertations and theses, and
37 evaluation studies.

The growing body of published work includes evaluation, efficacy, student reasoning, classroom discourse, and teacher knowledge.

- Compared to their peers using conventional middle school mathematics curricula, students in CMP classrooms achieve greater conceptual gains that require mathematical modeling, mathematical reasoning, and/or careful articulation of mathematical thinking. These gains on a variety of learning measures also show that students do as well or better on procedural skills (Ben-Chaim, Fey, Fitzgerald, Benedetto, & Miller, 1998; Cai, Moyer, Hwang, Nie, & Garger, 2012; Cain, 2002; Conklin, Grant, Rickard, & Rivette, 2006; Eddy, Berry, Aquirre, Wahlstrand, Ruitman, & Majajan, 2008; Reys, Reys, Lapan, Holliday, & Wasman, 2003).
- The effects on student learning performance typically improves more after multiple years of using CMP within schools (Bray, 2005; O'Clair, 2005; Reys et al., 2003; Tarr, Reys, Reys, Chavez, Shih, & Osterlind, 2008).
- The advantages in conceptual understanding and problem-solving persist as students enter high school. CMP students performed better than or as well as non-CMP students on a variety of learning measures (Cai, 2014).
- In a longitudinal study in a large urban area that followed CMP and Non-CMP middle school students through high school found that significantly greater percentages of CMP students than non-CMP students maintained a positive attitude toward mathematics (Moyer, Robison, & Cai, 2018).
- Compared to conventional mathematics classrooms, there is a greater focus on students communicating mathematical ideas. (Cady & Hodges, 2015; Cai, 2014). CMP students had more positive experiences and were more satisfied in their mathematics classes than non-CMP students (Covington Clark, 2001). After seeing the mathematics students are able to do, teachers do not favor returning to a conventional curriculum (Schneider,1998).
- The evidence on successful implementation of problem-centered curricula like CMP points to the need for consistent and sustained professional development and collaboration between teachers and administrators in a variety of forms (Heck, Banilower, Weiss, & Rosenberg, 2008). When students learned from CMP teachers with less teaching experience but who attended more professional development and team planning as promoted by CMP, students had higher mathematics scores (O'Clair, 2005).