Core-Plus Mathematics
Key Evaluation and Research Findings

For over 20 years, with funding from the National Science Foundation, the Core-Plus Mathematics Project (CPMP) has been engaged in iterative cycles of research, design, and development; pilot testing in Michigan high schools, followed by revisions and refinement; and national field testing and further refinement prior to publication. The national field test sites involved 49 urban, suburban, and rural middle and high schools with diverse student populations in Alaska, California, Colorado, Georgia, Idaho, Iowa, Kentucky, Michigan, Missouri, Ohio, South Carolina, Texas, and Wisconsin.

Formative and summative evaluations have been a central feature of our development work. Individual school districts have also set into place trend studies of the effectiveness of Core-Plus Mathematics. In addition, we have been fortunate that mathematics education researchers have been attracted to our problem-based, inquiry-oriented approach to high school mathematics and have independently conducted and published efficacy research studies comparing the performance of CPMP students with comparable students using publisher-generated conventional high school mathematics programs (organized as Algebra I, Geometry, Advanced Algebra, and Precalculus).

Key Research Findings 1992–2012

Summarized below are key comparative evaluation and independent research findings reported during the last 20 years. Of particular note is the consistency of the findings in terms of students’ conceptual understanding, reasoning, mathematical problem solving, college readiness, and dispositions toward mathematics.

Core-Plus Mathematics students:

• performed significantly better on tests of problem solving, applications, and conceptual understanding.

• elected to enroll in more high school mathematics courses.

• had positive attitudes and perceptions about mathematics.

• at the end of Course 3, performed significantly better on measures of conceptual understanding and problem solving in applied settings, but (using field-test materials) scored significantly lower than Algebra II students on a subtest of paper-and-pencil skills.

• performed as well on tests of paper-and-pencil algebraic skills (using published Core-Plus Mathematics texts).

• at the end of Course 3, performed at the level of the top-scoring country, the Netherlands, on a test composed of released 1995 TIMSS Twelfth-Grade Mathematical Literacy items.

• performed significantly better on the SAT Mathematics Test and as well on the ACT Mathematics Test.
• at the end of Course 4, outperformed comparable students on the calculus readiness portion of a mathematics placement test at a large midwestern university. Of the 20 calculus readiness items, group means differed significantly on 12 of them, 11 in favor of CPMP students. The items were drawn from a bank of items available from the Mathematical Association of America.

• performed significantly better on a Test of Common Objectives in the areas of problem solving and reasoning and on a standardized test, ITED Mathematics: Concepts and Problem Solving, than did students from publisher-produced, single-subject texts.

For individual abstracts of the evaluation and research studies on which these findings are based, please see www.glencoe.com/glencoe_research/Math/cpmp.html.

College Readiness Indicators

Core-Plus Mathematics is an international-like four-year high school mathematics program intended to prepare students for college, careers, and daily life in contemporary society. In this section, several studies focusing on college readiness are highlighted.

ACT Test

Districts have monitored the ACT test performance of their students as they implemented CPMP and compared that performance to the performance of prior students in the district who had used a conventional mathematics program. Below is a portion of the trend data showing increasing participation rates and increasing average mathematics ACT scores for a suburban district in the Minneapolis, MN area. This trend has continued.

For additional district-conducted trend studies, see www.wmich.edu/cpmp/schoolreports.html
College Placement Tests

- CPMP students performed as well as comparable students from conventional programs on a college placement test at a large midwestern university on basic algebra and advanced algebra subtests and performed significantly better on the calculus readiness portion of the test (Schoen & Hirsch, 2003).

- At the end of Course 4, Preparation for Calculus, CPMP student performed exceptionally well on the independently developed and research-based PCA Functions Test—a test related to understanding function concepts as a precursor to calculus. CPMP students outperformed comparable students on 21 of 25 questions (Engelke et al., 2005).

College Course Completions

- Results from a five-year longitudinal study showed that CPMP students after graduation from high school, completed first-year collegiate mathematics courses at about the same rate and with similar grades as all freshmen students with the same number of high school mathematics courses in two major research universities in two different states (Schoen, Ziebarth, Hirsch, & BrckaLorenz, 2010).

- The Minnesota Mathematics Achievement Project (MNMAP) researched the impact of curricula studied in high school (commercially developed, NSF-funded, or UCSMP) on the difficulty levels and grades of post-secondary students’ mathematics courses. Most students in the MNMAP had studied the Core-Plus Mathematics program. When taking into account student background factors, no differences across high school curricula with respect to university mathematics grades or difficulty levels across 8 semesters of college study were found. There also was no relationship between high school curricula and the number of college mathematics courses completed (Harwell et al., 2009; Post et al., 2010).

AP Calculus and AP Statistics

Trend data supplied by districts consistently show increased enrollments in AP Calculus and AP Statistics and that their students complete AP Calculus and AP Statistics at a higher rate and with a greater percentage of high scores on the AP examinations since Core-Plus Mathematics was adopted. ([www.wmich.edu/cpmp/schoolreports.html](http://www.wmich.edu/cpmp/schoolreports.html))

Performance Trends Continue

In 2013, two comparison studies of Core-Plus Mathematics and more conventional curricula were completed by independent researchers at the University of Missouri–Columbia. The research was reported in the March and July 2013 issues of the prestigious Journal for Research in Mathematics Education. Abstracts of the two related studies follow.
This study examined the effect of 2 types of mathematics content organization on high school students’ mathematics learning while taking account of curriculum implementation and student prior achievement. The study involved 2,161 students in 10 schools in 5 states. Within each school, approximately one half of the students studied from an integrated curriculum [Core-Plus Mathematics] (Course 1) and one half studied from a subject-specific curriculum [and publisher-generated: Glencoe/McGraw-Hill, McDougal Littell, Holt, Prentice Hall] (Algebra 1). Hierarchical linear modeling with 3 levels showed that students who studied from the integrated curriculum were significantly advantaged over students who studied from a subject-specific curriculum on 3 end-of-year outcome measures: Test of Common Objectives, Problem Solving and Reasoning Test, and a standardized achievement test. Opportunity to learn and teaching experience were significant moderating factors.
The Effects of Content Organization and Curriculum Implementation on Students’ Mathematics Learning in Second-Year High School Courses

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We examined curricular effectiveness in high schools that offered parallel paths in which students were free to study mathematics using 1 of 2 content organizational structures, an integrated approach [Core-Plus Mathematics] or a (traditional) subject-specific approach [and publisher-generated: Glencoe/McGraw-Hill, McDougal Littel, Holt, Prentice Hall]. The study involved 3,258 high school students, enrolled in either Course 2 or Geometry, in 11 schools in 5 geographically dispersed states. We constructed 3-level hierarchical linear models of scores on 3 end-of-year outcome measures: a test of common objectives, an assessment of problem solving and reasoning, and a standardized achievement test. Students in the integrated curriculum scored significantly higher than those in the subject-specific curriculum on the standardized achievement test. Significant student-level predictors included prior achievement, gender, and ethnicity. At the teacher level, in addition to Curriculum Type, the Opportunity to Learn and Classroom Learning Environment factors demonstrated significant power in predicting student scores, whereas Implementation Fidelity, Teacher Experience, and Professional Development were not significant predictors.

Content and Pedagogical Analyses of Core-Plus Mathematics

In October 1999, following an extensive content analysis and review of the evaluation studies completed to date, the U.S. Department of Education recognized Core-Plus Mathematics as one of six Exemplary School Mathematics Programs in the U.S.

A year later, AAAS reported findings of Project 2061’s mathematics textbook evaluations related to high school algebra. The 12 textbooks evaluated included problem-based texts such as those from the Core-Plus Mathematics Project and the Interactive Mathematics Program (IMP), and also conventional, often more skill-oriented, Algebra 1 texts such as those from UCSMP (Scott Foresman), McDougal Littell, Glencoe/McGraw Hill, and Prentice Hall.

This study evaluated each book’s potential for teaching critical algebraic concepts, such as representing variable quantities and modeling with functions, and analyzed how well the content was developed through instructional strategies that are consistent with research on how students learn. Of the 12 texts evaluated, 7 were identified as having “potential for helping students learn algebra.” Of these 7 texts, Core-Plus Mathematics: Contemporary Mathematics in Context received the highest rating.

Further detail on this textbook evaluation study can be found at www.project2061.org.

Meta-Evaluation Studies of Core-Plus Mathematics

Two meta-evaluations of the research on the efficacy of 1st edition Core-Plus Mathematics have been conducted. Although each used somewhat different criteria, the direction of the reported findings is in general agreement.
The corpus of evaluation studies of Core-Plus Mathematics was included in an exhaustive, “best evidence” review of hundreds of published and unpublished papers by Slavin, Lake, and Groff (2008). The review had stringent inclusion criteria for classroom studies, including only those studies that met the following criteria:

- Schools or classrooms using each program had to be compared to randomly assigned or well-matched control groups.
- Study duration had to be at least 12 weeks.
- Outcome measures had to be assessments of the mathematics being taught in all classes. Almost all are standardized tests or state assessments.
- The review placed particular emphasis on studies in which schools, teachers, or students were assigned at random to experimental or control groups.

The Core-Plus Mathematics program was one of just two Standards-based curricula placed in the “Limited Evidence of Effectiveness” category. All others for which evidence was reviewed were in lower categories such as “Insufficient Evidence” or “No Qualifying Studies” (Slavin et al., 2008).

Finally, as of April 2014, following an extensive review of research on education-related programs by the American Institute for Research and Strategic Ed Solutions for the Business-Higher Education Forum, the Core-Plus Mathematics program was recognized as one of 12 curriculum programs (and one of four mathematics programs) in the U.S. that increase academic alignment and rigor as a means to improve college and career readiness.

See: http://www.strategicedsolutions.org/.

Selected References


