

Core-Plus Mathematics

Summary of Key Research Findings 1993–2010

The field-test evaluation of the 1st edition of *Core-Plus Mathematics* involved 36 high schools in 11 states, over 3,000 students, and over 125 teachers in rural, suburban, and urban settings. Evaluation of each of the four courses involved an iterative cycle of testing, revision, further testing, and further revision. Final curriculum materials were improved based on field-test evaluation results and face-to-face meetings with field-test teachers from the test sites. In addition to results from the field-test evaluation of the 1st edition, the summary below provides key findings of studies based on the use of the published 1st edition of *Core-Plus Mathematics*. That is followed by results from the field-test evaluation of the 2nd edition of *Core-Plus Mathematics*. Findings from use of the published 2nd edition materials are just beginning to become available.

Formative and Summative Evaluation of the 1st Edition (1993–2002)

In comparative studies of students who studied *Core-Plus Mathematics* and comparable students who studied more conventional curricula (organized as Algebra 1, Geometry, Advanced Algebra, and Precalculus), *Core-Plus Mathematics* students:

- performed significantly better on tests of problem solving, applications, and conceptual understanding.
- performed significantly better on the SAT Mathematics Test and as well on the ACT Mathematics Test.
- 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 1st edition *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 (using published 1st edition CPMP texts).
- 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.

Summary of Achievement by Various School and Student Groups

CPMP students outperformed comparison students on the mathematics subtest of the nationally standardized Iowa Tests of Educational Development (ITED) Quantitative Thinking Test. Data was broken out and reported by various subgroups. The *adjusted effect sizes* reported below are the number of pretest standard deviations the cohort grew beyond the average growth of the nationally normed group. (Schoen, Hirsch, & Ziebarth, 1998)

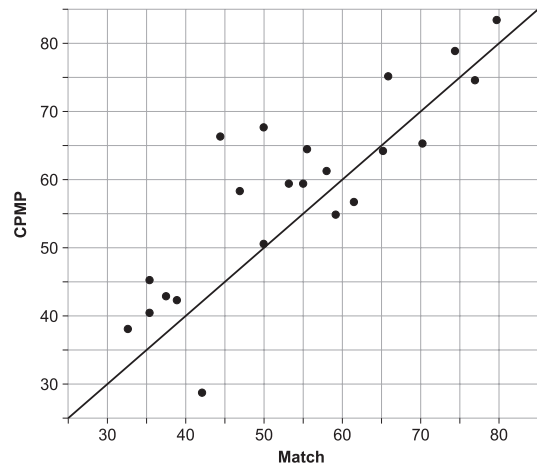
- *By school type:* Rural +0.71 Urban +0.59 Suburban +0.30
- *By gender:* No statistically significant difference

- *By minority status:* African American, Hispanic, Asian American, Native Alaskan or American. Adjusted effect sizes were small but positive. The Hispanic group had the highest effect size.
- *By high mathematical aptitude:* In spite of an expected regression to the mean effect due to very high pretest scores, the posttest growth was about double that of the ninth-grade norm group. The growth of the mean from pretest to posttest was 0.25 standard deviations higher for CPMP cohort.

A Matched-Pairs Study of Washington State 10th-Grade Assessment Scores of Students in Schools Using the 1st Edition of the *Core-Plus Mathematics* Program

Twenty-two high schools in the state of Washington that were in at least their second year using *Core-Plus Mathematics* and 22 Washington schools using conventional high school curricula were matched on prior mathematics achievement, percent of students from low-income families, percent of underrepresented minorities, and student enrollment

The pass rate in mathematics was higher in the schools using *Core-Plus Mathematics*. This was evident for both students from low-income families and those from other families. (Nelson, 2007)

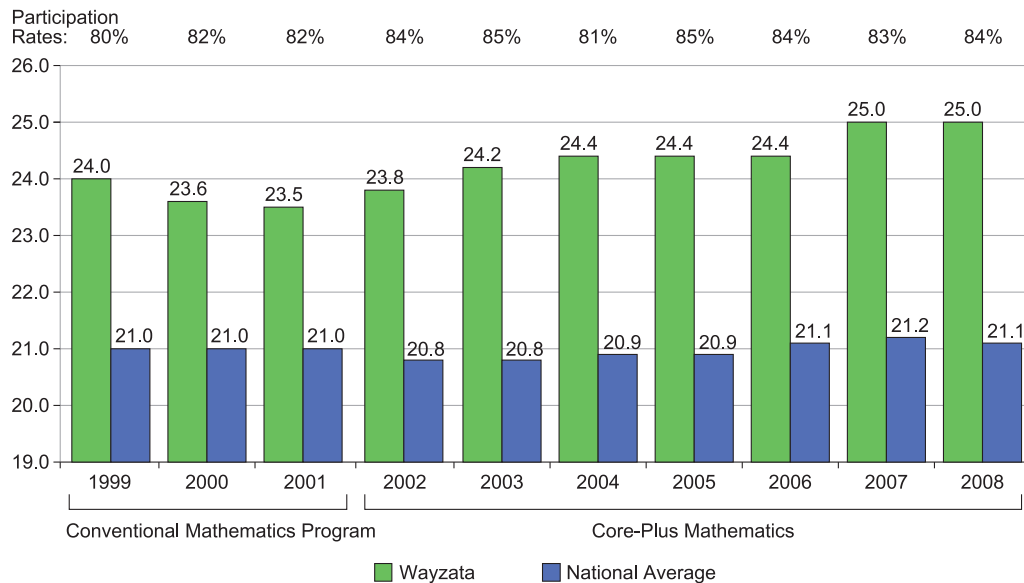


— CPMP = Match
WASL Math Pass Data, Grade 10, 2004–05

College Readiness Indicators

ACT Test

Districts have monitored the ACT test performance of their students as they implemented CPMP. Below is one example showing increasing participation rates and increasing average mathematics ACT scores for a suburban district in the Minneapolis, MN area.



College Placement Test

- CPMP students performed as well as comparable students 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).

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 (MNMAMP) 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 MNMAMP 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. (<http://www.wmich.edu/cpmp/schoolreports.html>)

Meta-Evaluation of Studies of 1st Edition *Core-Plus Mathematics*

To date, three 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 are in general agreement.

This 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).

In June 2009, 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 35 programs in the United States that increase student achievement and improve college readiness.

The U.S. Department of Education Institute of Educational Sciences, What Works Clearinghouse (WWC) publishes reports that evaluate research on mathematics programs, products, practices, and policies. Due to the WWC screening process and standards of evaluation, few research reports qualify for consideration by WWC. Thus, as of September 2010, of the 52 middle and high school curricula for which studies were sought and considered 41 had either no studies reported or no studies meeting the WWC evidence standards. Of the remaining 11 products, one received a “positive” rating, *Core-Plus Mathematics* along with two others received a rating of: “potential positive effects: evidence of a positive effect with no overriding contrary evidence.” Four mathematics interventions received ratings of “no discernable effects” and three received ratings of “mixed effects”.

The Improvement Index for the 1st edition of *Core-Plus Mathematics* reported by WWC was an *average of 15 percentile points*. The improvement index is an alternative presentation of the effect size of an intervention (treatment). Where the effect size represents the change in an average student's outcome that can be expected if the student is given the treatment, the improvement index reflects the change in an average student's percentile rank that can be expected if the student is given the treatment.

Field-Test Evaluation of the 2nd Edition (2002–2009)

Core-Plus Mathematics 2nd edition students:

- at the end of Course 1, showed gains above the national norming group on the *Iowa Tests of Educational Development Ability to Do Qualitative Thinking* subtest.
- at the end of Course 2, outperformed multiple groups of algebra students involved in the 2004–2005 administration of the ETS *Algebra End-of-Course Assessment*.
- at the end of Course 3, outperformed the national and state-specific norming groups on the ACT preparation for college test.
- at the end of Course 4, outperformed comparison groups on three different measures of college readiness in mathematics (basic skills, pre-calculus, and functions).
- performed exceptionally well on the independently developed and research-based PCA Functions Test (Engelke et al., 2005)—a test related to understanding functions concepts. CPMP students outperformed comparable students on 21 of the 25 questions.
- outperformed CPMP 1st edition students on measures of paper-and-pencil algebraic skills and geometry concepts and skills targeted for improvement in the revision work.

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