
This retrospective study examined the impact of prior mathematics achievement on the relationship between high school mathematics curricula and student postsecondary mathematics performance. The sample (N = 4,144 from 266 high schools) was partitioned into 3 strata by ACT mathematics scores. Students completing 3 or more years of a commercially developed, University of Chicago School Mathematics Project, or National Science Foundation-funded curriculum comprised the sample. Of interest were comparisons of the difficult level and grade in their initial and subsequent college mathematics courses, and the number of mathematics courses completed over 8 semesters of college work. In general, high school curriculum was not differentially related to the pattern of mathematics grades that students earned over time or to the difficulty levels of the students’ mathematics course-taking patterns. There also was no relationship between high school curricula and the number of college mathematics courses completed.


The current study examined the mathematical achievement of high school students enrolled for 3 years in one of the three 1st edition NSF-funded Standards-based curricula (IMP, CPMP, MMOW). The focus was on traditional topics in mathematics as measured by subtests of a standardized achievement test and a criterion-referenced test of mathematics achievement. Students generally scored at or above the national mean on the achievement subtests. Hierarchical linear modeling results showed that prior mathematics knowledge was a significant but modest predictor of achievement, student SES had a moderate effect, and increasing concentrations of African American students in a classroom were associated with a stronger effect of attendance on achievement. No differences on the standardized achievement subtests emerged among the Standards-based curricula studied once background variables were taken into account. The two suburban districts providing data for the criterion-referenced test achieved well above the national norm.

This paper discusses the case of one teacher, Jackie, whose instructional practices illuminate the importance of textbooks and student/parent expectations in shaping pedagogy. Jackie teaches in the Plainview district, which offers parents and students a choice between a reform-oriented, integrated curriculum (*Core-Plus Mathematics*) and a more conventional algebra sequence (the University of Chicago series). Each day, Jackie teaches two very different sections of accelerated eighth-grade mathematics using each of these curricular materials. Drawing from students’ survey responses, classroom observations, and teacher interview data, we show ways in which Jackie’s pedagogy differs considerably between the two courses and we shed light on reasons underlying this variation. By examining one teacher who enacts different practices in each of the two curricular contexts, this paper highlights factors that contribute to teachers’ enacted curricula factors that have been understated in previous mathematics education research on teacher development. The study establishes the importance of distinguishing between global and local teacher change, and suggests implications for future studies of teaching and reform.


This paper briefly discusses the recent history of mathematics reform in high school, and then reports on research evidence for one of the new NSF-funded curriculum projects, the *Core-Plus Mathematics Project* (CPMP). Implications for collegiate mathematics are also discussed.

A summary of the results of several studies using a range of achievement measures comparing CPMP students to comparable students in more conventional high school mathematics curricula is given on page 114:

"Thus, research to date indicates that CPMP students perform particularly well [and better than the comparison students] on measures of conceptual understanding, interpretation of mathematical representations and calculations, and problem solving in applied contexts. Their performance is also relatively strong in content areas like statistics and probability that are emphasized in the curriculum. On measures of algebraic manipulative skills, CPMP students usually, but not always, score as well as students in more conventional curricula."

A study of student performance on a mathematics placement test used at a major midwest university is summarized on page 116:

"On the algebra subtest, the means of the [conventional] precalculus students and the CPMP Course 4 students were virtually identical. On the intermediate algebra subtest, the mean of the precalculus group was greater than that of the Course 4 group. The only statistically significant difference in means was on the calculus readiness subtest (*t* = 4.93, *p* < 0.01). That difference favored the CPMP students."

“Group [calculus readiness test] item means differed significantly on twelve of the twenty calculus readiness items, eleven in favor of the CPMP students and one in the other direction.” (p. 117)

This paper reports results from a study of instructional practices that relate to student achievement in high school classrooms in which a standards-based curriculum (Core-Plus) was used. Regression techniques were used to identify teachers’ background characteristics, behaviors, and concerns that are associated with growth in student achievement and further described these associations via graphical representations and logical analysis. The sample consisted of 40 teachers and their 1,466 students in 26 schools. Findings support the importance of professional development specifically aimed at preparing to teach the curriculum. Generally, teaching behaviors that are consistent with the standards’ recommendations and that reflect high mathematical expectations were positively related to growth in student achievement.


Students in CPMP 1st edition Course 3 classes and those in more conventional Algebra II classes, matched on measures of eighth-grade mathematics achievement, were administered a researcher-developed test of algebraic understanding, problem solving and procedural skill at the end of the school year. CPMP students scored significantly better on the subtests of understanding and problem solving, and Algebra II students scored significantly better on the subtest of paper-and-pencil manipulation of algebraic expressions when those expressions were presented free of application context. Scores and student work are discussed by item in this paper.


This article describes CPMP perspectives on a new curriculum organization for high school mathematics, identifies implications of these perspectives for promoting access and equity for all students, and reports some of the supporting oral data from the ongoing formative evaluation of the curriculum. The focus is on diversity issues related to ability, prior knowledge, gender, interests, and learning styles.

**Other Peer-Reviewed Journal Articles**


This study examines students’ and parents’ choices in one district that recently began offering a new problem-centered high school mathematics program aligned with the National Council of Teachers of Mathematics Standards, in addition to its traditional mathematics sequence. Despite the district’s previous implementation of Standards-based instruction in grades K through 8, the vast majority of students and parents have chosen the traditional high school sequence. Survey data from more than 300 students
and parents were analyzed with attention to parent education level and option chosen. Parents with limited formal education were less likely than college-educated parents to access information about the options but were more likely to rank college preparation as a top factor in their decision. Additionally, although college-educated parents were more likely than other parents to discuss the options with teachers, they were less likely to be influenced by teachers’ comments. Parents who chose the traditional sequence expressed more concern about college preparation, whereas parents who chose the Standards-based sequence placed a higher priority on student understanding and enjoyment of mathematics. Overall, many parents and students in the district held strong, persistent antireform beliefs. This study highlights the difficulties and dilemmas of introducing change into the firmly entrenched mathematics curriculum, particularly at the high school level.


An interesting question concerns how well NCTM-oriented students do on standardized mathematics tests. Another important question that has received less attention is: Are standardized tests truly measuring the skills that NCTM-oriented students have? Would other tests reveal skills that differentiate NCTM-oriented students from traditional students? Moreover, what are these skills? This paper contributes to the answers to these questions, and finds that students in one NCTM-oriented curriculum displayed such qualities as engagement, eagerness, communication, flexibility, and curiosity to a much higher degree than traditional students did. The implication given is that not only should we use standardized tests, but we should revise them and/or supplement them to measure the qualities that are not currently being measured.


The authors examine five reform high school mathematics textbook series, including the Core-Plus Mathematics Project texts, *Contemporary Mathematics in Context* (CMIC), to determine how well they are aligned with the NCTM's *Principles and Standards for School Mathematics* (*PSSM*). CMIC was rated highest among the four programs in each of the process standards, that is, problem solving, reasoning and proof, communication, connections, and representations. CMIC was also rated a '+' for inclusion of all content topics from *PSSM*.


This article revisits the historical background for the development of the 1989 NCTM Curriculum and Evaluation Standards, including the attempts at gaining a consensus among professional organizations with interest in mathematics and its related fields. Specific features of a 9–12 curriculum developed by the Core-Plus Mathematics Project that is aligned with the NCTM Standards are described. Finally, some results from the evaluation of the CPMP curriculum that have a bearing on some of the main issues raised by critics of the NCTM reform effort are presented and discussed.
Books and Book Chapters Reporting Research


The study reported in this volume adds to the growing body of evaluation studies that focus on the use of NSF-funded *Standards*-based high school mathematics curricula. Most previous evaluations have studied the impact of field-test versions of a curriculum. Since these innovative curricula were so new at the time of many of these studies, students and teachers were relative novices in their use. These earlier studies were mainly one year or less in duration. Students in the comparison groups were typically from schools in which some classes used a *Standards*-based curriculum and other classes used a conventional curriculum, rather than using the *Standards*-based curriculum with all students as curriculum developers intended.

The volume reports one of the first studies of the efficacy of *Standards*-based mathematics curricula (in this case, *Core-Plus Mathematics*) with all of the following characteristics:

- The study focused on fairly stable implementations of a first-edition *Standards*-based high school mathematics curriculum that was used by all students in each of three schools.
- It involved students who experienced up to seven years of *Standards*-based mathematics curricula and instruction in middle school and high school.
- It monitored students’ mathematical achievement, beliefs, and attitudes for four years of high school and one year after graduation.
- Prior to the study, many of the teachers had one or more years of experience teaching the *Standards*-based curriculum and/or professional development focusing on how to implement the curriculum well.
- In the study, variations in levels of implementation of the curriculum are described and related to student outcomes and teacher behavior variables.

Among the findings, *Core-Plus Mathematics* students:

- At the end of Year 1, on the standardized mathematics subtest of the *Iowa Tests of Educational Development (ITED) called Ability to Do Qualitative Thinking*, or *ITED-Q*, grew about the same as the nationally representative norm group.
- At the end of Year 2, scored higher overall on the Educational Testing Services (ETS) *End-of-Course Algebra Examination* than the group of all first year algebra students in the country who completed the test that year.
- At the end of Year 3, had nearly the same mean on 12 released *TIMSS* mathematical literacy tasks as the Netherlands, the top scoring country in the 1995 TIMSS. The means of the *Core-Plus Mathematics* sample were much higher than those of the representative U.S. 12th-grade sample. Students in this study often scored considerably better than the international average on all subtests.
- At the end of Course 3 and Course 4, were considerably more positive than the initial responses of 3.5 on all seven scales of the *Conceptions of Mathematics Inventory* (Grouws, Howald, and Colangelo, AERA, 1996).
• At the end of Year 4, on both the advanced mathematics and the reasoning tests scored significantly higher than the conventional precalculus comparison group.
• In their first year of college, completed various college mathematics courses through Calculus 2 at similar frequencies and with similar success rates as students from more conventional high school mathematics programs.

Item data and all unpublished testing instruments from this study are available at www.wmich.edu/cpmp/ for use as a baseline of instruments and data for future curriculum evaluators or Core-Plus Mathematics users who may wish to compare results of new groups of students to those in the present study on common tests or surveys. Taken together, this volume, the supplement at the CPMP Web site, and the first edition Core-Plus Mathematics curriculum materials (samples of which are also available at the Web site) serve as a fairly complete description of the nature and impact of an exemplar of first edition NSF-funded Standards-based high school mathematics curricula as it existed and was implemented with all students in three schools around the turn of the 21st century.


This book presents a historical perspective on what is perhaps a unique effort in curriculum development in this country. The directors or associates for fifteen comprehensive curriculum development projects, fourteen of which were funded by the National Science Foundation, offer perspectives on the design principles that guided their work as well as insights into the challenges they faced and the barriers to their success. The book furnishes useful guidance to future curriculum developers and documents an important historical record of school mathematics.

Chapter 10 of this book discusses the design principles and development process for the Core-Plus Mathematics curriculum. A companion volume (next entry) describes the impact of the field-test version of the curriculum on student learning and dispositions.


This chapter provides an overview of the CPMP curriculum in terms of its theoretical framework and a profile of student outcomes. Achievement results are reported from the three-year Core-Plus Mathematics field test (1994–97) for each subtest of the standardized Ability to Do Quantitative Thinking (ATDQT) test and for students who scored in the top, middle, and bottom third on the ATDQT pretest. Results on measures of students' understanding of algebraic and geometric concepts and methods and of statistics, probability and discrete mathematics are also presented. Students' perceptions and attitudes about mathematics and about their mathematics course are summarized. Finally, SAT and ACT scores of students in CPMP are compared to those in more conventional curricula. On all measures except paper-and-pencil algebra skills, students in CPMP do as well as or better than those in more conventional curricula.
Other Book Chapters


This paper reports research that examined students' conceptions about learning, knowing, and doing mathematics after studying four years of *Contemporary Mathematics in Context* (©1998) and how those conceptions influenced college mathematics experiences. Upon graduation from high school the students (n = 256) believed that mathematical concepts, principles, and generalizations were slightly more important than facts, formulas, and algorithms, that learning mathematics was more about constructing understanding than memorizing, that doing mathematics was more about making sense out of situations than just solving problems and that mathematics was useful. The *Conceptions of Mathematics Inventory* developed by Grouws, Howald and Colangelo was used in the research. Case studies of six students', from five different high schools, experiences and thinking throughout the first semester of mathematics at two major midwestern universities are also reported. Among the findings were that none of the six students had difficulty making the transition from this *Standards*-based curriculum to college mathematics.


This chapter investigates secondary mathematics teacher's interactions with authors of the *Core-Plus Mathematics* curriculum as the materials are being developed. Attention is focused on the ways in which the intended curriculum is negotiated by highlighting how teachers participate in the curriculum development process from early drafts to a final published commercial product.

The authors describe some of the changes in content, teaching, and assessment that are common to the new reform high school programs, with examples from the Core-Plus Mathematics Project. They also consider implications for the role that middle school mathematics education plays in the development of common themes.

Papers Presented at Research Conferences


The research reported in this paper describes the mathematical experiences of 9 students who moved from a traditional mathematics program in junior high school to a high school mathematics program structured by current reforms in curriculum and teaching. We will refer to the high school site of this work as Logan High (though the name is fictitious). Logan has for some years implemented the Core-Plus Mathematics...
Project materials for most of its grade 9–12 students, including some (but not all) students who come out of the “advanced” mathematics track in the junior high school. We recruited 24 Logan student volunteers starting in January 2000 and have tracked these students in their mathematics work for 2.5 semesters.

We report on the experiences of 9 of these students, drawing on a maximum of 3 semesters of mathematics coursework (Spring 2000, Fall 2000, and Spring 2001). We have analyzed their mathematical experiences along 4 dimensions: (1) performance in mathematics, (2) disposition towards the subject, (3) approach to learning the subject, and (4) differences students see between traditional and Core-Plus mathematics curricula and teaching. All of our 9 students reported differences between their past and present mathematics programs as they moved into Core-Plus, but in only 2 cases was there any significant change in performance across the curricular shift.


Achievement results are reported for the three-year Core-Plus field test (1994–97) on the Standardized Ability to Do Quantitative Thinking (ATDQT) test for all schools with school means as the statistical unit. ATDQT results are also reported by school setting (urban, rural, or suburban), by make-up of classes (heterogeneous, high ability, low ability, and so on), by gender, by English or non-English first language, and for three classrooms of students with exceptionally high mathematical aptitudes. Results are also given for the various subtests of both the CPMP Posttest, an open-ended assessment instrument, and a test comprised of released items from the 1992 National Assessment of Educational Progress.

**CPMP Technical Reports**


In 1997, the Core-Plus Mathematics Project began a five-year longitudinal study of students in three high schools in which the first edition of *Core-Plus Mathematics* was used with all students. Of special interest was the impact of the curriculum on students’ mathematical literacy. This interim report begins by reviewing the literature that makes the case for the importance of mathematical (or quantitative) literacy for all adults in contemporary society and outlines the attributes of mathematical literacy.

Next a short summary is provided of the performance of Course 1, Course 2, and Course 3 field-test students on different versions of the Ability to do Quantitative Thinking subtest of the nationally-normed Iowa Tests of Educational Development.

Finally, development of a test of released items from the TIMSS assessment of general mathematical knowledge and its scoring are described. The test results of end-of-Course 3 students in the three longitudinal study schools are reported and compared to the performance of end-of-high school students in the U.S., the Netherlands, and the total International cohort. *Core-Plus Mathematics* students outperformed both the U.S.
and International samples. Their performance was closest to that of the Netherlands, the top scoring country on the TIMSS general mathematical knowledge assessment.


This booklet summarizes the methodology and main results of the national field tests of Courses 1–4 of the Core-Plus Mathematics Project curriculum. Included are results of studies reporting the performance of CPMP students and comparable students in more conventional curricula on the ITED *Ability to Do Quantitative Thinking* subtest, a NAEP-based test, the SAT, the ACT, and a university mathematics department placement test, and in beginning college mathematics courses. Also reported are findings from a study of attitudes and beliefs of CPMP students and comparable students in more conventional curricula at the end of their second year of high school mathematics.


This booklet consists of eight reports. The first report summarizes results from the national field test of Courses 1–3 of the Core-Plus Mathematics Project curriculum. The remaining reports contain firsthand accounts by teachers of how the curriculum was implemented in their schools. These reports focus on the positive experiences that teachers and students enjoyed as a result of their use of the *Contemporary Mathematics in Context* curriculum materials. They also comment on issues of implementation, community involvement, tracking, test results, student and teacher attitudes, and enrollment patterns.


This report focuses on standardized achievement test results aggregated across 33 field test schools who were on a regular two-semester schedule. On the *Ability to Do Quantitative Thinking*, the mathematical subtest of the *Iowa Tests of Educational Development*, CPMP students in both Course 1 and Course 2 performed better across the distribution than comparison students in more conventional mathematics classes. CPMP students also grew more from the beginning of grade 9 to the end of each of grades 9, 10, and 11 than the nationally representative norm group for this test. At the end of Course 3, CPMP students performed particularly well on NAEP-developed measures of data analysis, probability and statistics and on measures of conceptual understanding. Their performance was somewhat lower in some other content areas and on items assessing procedural outcomes, but still considerably higher than a nationally representative sample of twelfth-grade students.

This report focuses on performance assessments of student achievement aggregated across 33 field test schools who were on a regular two-semester schedule. On project-developed open-ended posttests of mainly algebraic and geometric content, CPMP students in both Course 1 and Course 2 performed significantly better on conceptual, application and problem-solving tasks than comparison students in more conventional mathematics classes. At the end of Course 1, the comparison students performed somewhat better on tasks assessing algebraic procedures, but that difference had disappeared by the end of Course 2. Problem-based interviews were used to gain a better insight into the differences in the mathematical understanding of the CPMP and comparison students.


Achievement results based on standardized tests (ITED) and CPMP tests compare traditionally tracked students and Core-Plus Mathematics students. Results from both Course 1 and Course 2 are discussed.

**Dissertations**


This study examines the understandings of high school students about correlation and explores how the use of context in mathematics curricula relates to these understandings. Students were in four groups depending upon their academic year (sophomore or juniors), school, and mathematics course enrolled in during the year of the study (Course 2 or Course 3 of the CPMP curriculum or Algebra II). Overall, students were successful on tasks involving interpretation of scatterplots and estimating correlation coefficients. Students performed better on descriptive tasks than on numeric and analytic tasks. Students used both statistical and non-statistical arguments when drawing and evaluating conclusions and tended to focus on the direction of association rather than the strength of association. Between group differences favoring CPMP students were found in some content categories.


This study assessed proof competence and approaches to proof of 315 end-of-year juniors in three high school sites. In each site, roughly half of the students were enrolled in CPMP Course 3 and the other half in traditional Advanced Algebra. In each site, proof was very difficult for most students, and no significant difference for demonstrated overall competence with proof or for perceiving the need for mathematical proof was found between the groups. Analysis of written answers and interview data suggested
several student misconceptions regarding proof and provided some insight into how the teaching of proof could be improved.

**Other Publications**


This brief article provides an overview of the *Core-Plus Mathematics* program in terms of first edition evaluation results, recent major changes in the outcome expectations and background conditions for mathematics education at the high school and undergraduate levels, and how those forces influenced improvements in the second edition of *Core-Plus Mathematics*. Of particular note is the active involvement of mathematicians and a statistician in the design and review of revised units for each of the four second edition courses.

The article provides links to influential curriculum recommendations (in PDF form) from Achieve, the American Association of Two-Year Colleges, the American Statistical Association, the College Board, and the Mathematical Association of America.


This brochure describes how the *Contemporary Mathematics in Context* (CMIC) curriculum provides a balanced approach to mathematics education. Each section of the brochure identifies one important issue in contemporary mathematics education and describes how it is addressed by CMIC. Section topics include integrated mathematics, algebra, basic skills, practice, logic and proof, theory and applications, technology, effective teaching methods, access and challenge, and preparation for college. A brief summary of research results is given.