What Works Clearinghouse

Detailed Study Report

Reviewed Study: **Riordan, J., & Noyce, P. (2001). The impact of two standards-based mathematics curricula on student achievement in Massachusetts. *Journal for Research in Mathematics Education, 32*(4), 368–398.**

WWC Study Reports are intended to support decision making; neither the What Works Clearinghouse (WWC) nor the U.S. Department of Education endorses any interventions. No single Study Report should be used as a basis for making policy decisions because (1) few studies are designed and implemented flawlessly and (2) all studies are tested on a limited number of participants, using a limited number of outcomes, at a limited number of times, so generalizing from one study to any context is very difficult. To highlight these issues, the WWC Study Reports describe in detail the specifics of each study, focusing primarily on studies that provide the best evidence of effects (randomized controlled trials). Systematic reviews of the evidence will be conducted to summarize the results of the individual studies.

See the WWC Brief Study Report (PDF) for a summary of this study.

Topic:	Curriculum-Based Interventions for Increasing K–12 Math Achievement—Middle School
Intervention:	Connected Mathematics Project
Research Design:	Quasi-Experimental Design with Matching
Study Rating:	✓
Date Released:	March 4, 2005
Summary of Results:	Riordan and Noyce (2001) report that schools that used the Connected Mathematics Project (CMP) for two to three years had greater gains in math achievement overall than those in the comparison group. Riordan and Noyce do not report whether this difference was statistically significant. However, *t* tests calculated by the WWC using data provided by Riordan and Noyce indicate that the difference is not statistically significant. In additional analyses, Riordan and Noyce compared performances on four mathematics topics covered by the outcome measure and found that students in the CMP schools scored statistically significantly higher in all of these areas.

✓✓ = Meets Evidence Standards ✓ = Meets Evidence Standards with Reservations X = Does Not Meet Evidence Standards

Intervention: Connected Mathematics Project

Operational Features

Between 1991 and 1997, the Connected Mathematics Project (CMP) received funding from the National Science Foundation to develop a mathematics curriculum for middle school (grades 6 through 8). The CMP, developed at Michigan State University, is reported to adhere to the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards.

The key feature of the CMP is that it is a problem-centered curriculum that provides skills practice. The CMP is a comprehensive mathematics curriculum that has 24 units, with eight units at each of three grade levels. Each unit contains four to seven investigations. Each investigation in turn contains one to five problem sets and ends with a mathematical reflection activity.

Support for implementing the CMP curriculum includes professional development prior to implementation and follow-up professional development each summer after implementation. In addition, pilot sites in this study provided regular meetings with their teachers throughout the school year.

In this study, students in the intervention group used the CMP curriculum and students in the comparison group used a mix of traditional math curricula.

People, Settings, and Timing

The CMP is designed to be used in grades 6 through 8. The students in this study were all in 8th grade in regular education and were drawn from schools in Massachusetts. Riordan and Noyce (2001) do not indicate where in Massachusetts the schools were located or whether the schools were in a variety of settings. The schools were in relatively privileged areas, with low rates of students participating in the free and reduced-price lunch program. The students are described as predominantly white, but no information was provided about the gender ratio or the percentage of students who had limited proficiency in English.

Cost Information

Cost information is not reported in this study.

Intended Duration

Each year's CMP curriculum consists of eight units, and the developer describes the units as cumulative, with each unit building on the previous one. Full implementation consists of covering all eight units during the school year, although the developer indicates that schools can phase in the program slowly and work up to having the full number of units per year.

Scientific Rationale

The key hypothesis of this study is that students in standards-based curricula will perform better on standardized tests than students in traditional curricula, and schools with standards-based curricula will show greater increases in math achievement over time. Standards-based curricula are aligned with the standards created by the National Council of Teachers of Mathematics and are based on the idea that students learn better through their own investigations, which contrasts with traditional curricula that emphasize memorization and lectures.

Overview of the Study

Purpose

The central question tested in this study was whether or not a difference would exist in the average standardized test scores in math at schools that had implemented the CMP curriculum when compared with the average scores at schools that used a mix of traditional math curricula. Riordan and Noyce hypothesize that students using the CMP curriculum will perform better on state standardized tests than students using the traditional curriculum.

Intervention Fidelity

According to the report, the curriculum was implemented differently from the way the developer intended. Riordan and Noyce indicate that schools had to have implemented at least 11 CMP units in grades 6 through 8 (by 1998–99)

to be included in the intervention group. Although schools could vary the number of units implemented per grade, the schools were unable to implement the full eight units that the CMP has available for each grade.

Outcome Measures

The primary outcome measure for this study was the Massachusetts Comprehensive Assessment System (MCAS). This standardized test was the only posttest measure used in the study. Riordan and Noyce do not indicate when the outcome measure was administered.

Research Design

To identify schools using the CMP curriculum, Riordan and Noyce obtained a list of middle schools using this curriculum from the Center for the Enhancement of Science and Mathematics Education (CESAME). The list was compared to the results from the 1999 Mathematics, Science, and Technology Survey. To be included in the study, a school had to appear on the CESAME list and be reported by the survey or the publisher as using the curriculum. Because the CMP is a modular program, schools can implement a few modules at a time. Telephone interviews were conducted with school personnel to determine how many CMP units they were implementing. Through this process, 21 of 408 middle schools in Massachusetts were selected as the intervention group. One of these schools had implemented the CMP curriculum earlier than the others and was analyzed separately by Riordan and Noyce. This school is not included in this report.

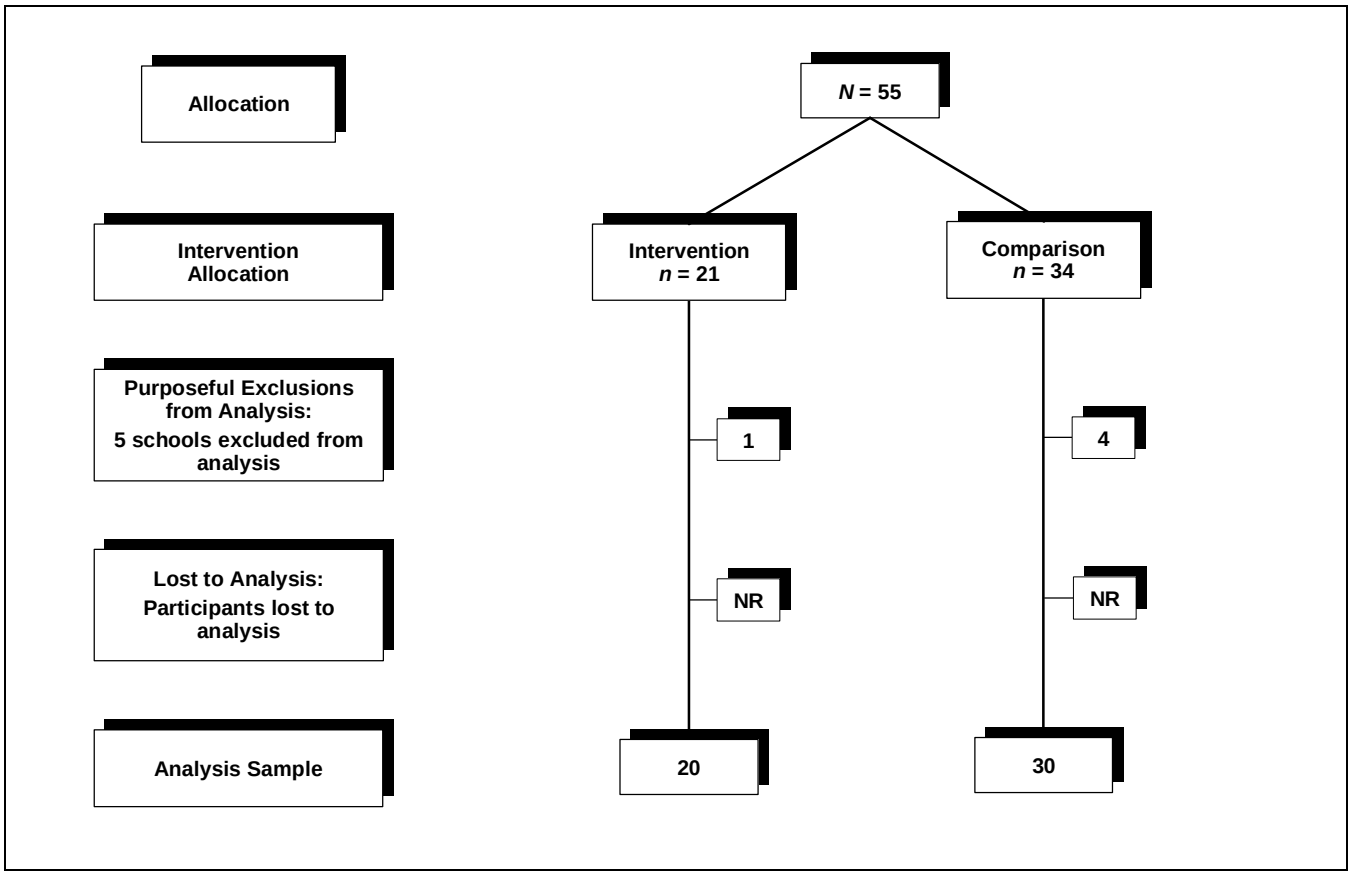
The comparison group of schools was determined through a series of steps. First, Riordan and Noyce performed a regression analysis to determine the strongest predictors of achievement. Then the intervention and comparison schools were matched on the basis of (1) their average Massachusetts Educational Assessment Program (MEAP) scores in the last year preceding the curriculum implementation[1] and (2) the percentage of students receiving free and/or reduced-price lunch. The textbooks most commonly used by the comparison group were published by Heath, Addison-Wesley, Prentice Hall, and Houghton Mifflin.

Participant Flow

Riordan and Noyce added schools to the comparison group because the schools in the intervention and comparison groups differed in size. Riordan and Noyce do not indicate that any attrition from the sample occurred. Participant flow is presented in Figure 1.

[1] The Commonwealth of Massachusetts legislated in 1993 a requirement that new assessments should be more in-line with new state standards. One result was the Massachusetts Comprehensive Assessment System (MCAS), which was first administered in 1998. For this reason, the pretest is a different assessment from the posttest.

Figure 1. Participant Flow (Schools)



Note. One intervention school implemented the CMP curriculum earlier than the others and was analyzed separately by Riordan and Noyce. This school and its matched comparison schools were excluded from the analysis at the school level. NR = not reported.

Reference Periods

This study covers the time period from 1996 to 1999. The group of schools discussed in this report had implemented the CMP curriculum for two to three years by the time of the posttest.

Baseline Data

At the baseline, there were no significant differences in the 1996 MEAP scores of the intervention and comparison groups. Both the intervention and comparison schools had average scores that were above the state mean. About 10% of students in the intervention group participated in the free and reduced-price lunch program, compared with 11% in the comparison group. This difference was not statistically significant. About 81% of students in the intervention group were white, while about 89% of the students in the comparison schools were white. This difference was statistically significant.

Statistical Methods

Two types of analyses were done: one at the student level and one at the school level. This WWC Study Report focuses only on the school-level analyses, because assignment occurred at the school level.

In their study, Riordan and Noyce compared *Z* scores at the school level to assess the relative change in average scores. Riordan and Noyce also compared the percentage of possible points scored, on average, in the four mathematical topic areas: number sense, patterns and functions, geometry, and statistics. Only regular education students were included in the analyses.

Outcomes and Estimation

Table 1 presents the effects of the CMP curriculum on math achievement, as reported by Riordan and Noyce. In a follow-up request by the WWC, Riordan and Noyce provided school-level math achievement means in addition to the *Z* scores they reported in their study. The WWC performed *t* tests on this information, which indicate that the difference was not statistically significant.

Table 2 presents the results of Riordan and Noyce's analysis of differences between the scores of the CMP schools and comparison schools across four mathematics topic areas on the MCAS. Riordan and Noyce only present information about whether the CMP schools scored significantly better or worse than the comparison schools, not the actual average scores for the schools. Because the magnitude of the differences was small, Riordan and Noyce chose to represent the differences as: (+) when the CMP schools scored significantly better than the comparison schools, (–) when the CMP schools scored significantly worse than the comparison schools, and (0) when there was no significant difference.

Although there are many legitimate ways to calculate effects, the WWC uses the same analysis strategies for computing effect sizes for all studies, to facilitate comparison and aggregation of effects across different studies. The WWC reanalyzed the data to produce estimates of effect sizes. (See Table 3 and Figure 2.) Table 3 presents unadjusted effect size calculations for the average of the scores for all schools. In computing effect sizes, the WWC created a standardized mean difference estimate using the pooled standard deviation of the groups as the denominator. Only means and standard deviations were used to calculate the effect sizes.

Table 1. Impact Reported by Riordan and Noyce (2001): Posttest on Math Achievement

Posttest on Math Achievement	Intervention Group (*SD*)	Comparison Group (*SD*)	Intervention Group Estimated Effect Size
Mean MCAS Math Score, 1999	238.20 (9.08)	233.85 (10.57)	NR

Note. MCAS = Massachusetts Comprehensive Assessment Program. NR = not reported.

Table 2. Differences Reported by Riordan and Noyce (2001) Between CMP Schools and Comparison Schools on Four Mathematics Topics

Mathematics Topic	Difference	Significance
Number Sense	+	$p < .001$
Patterns and Functions	+	$p < .001$
Geometry	+	$p < .001$
Statistics	+	$p < .001$

Table 3. Impact Calculated by WWC: Posttest on Math Achievement

Posttest on Math Achievement	Intervention Group Mean Score (n = 20 schools)	Comparison Group Mean Score (n = 30 schools)	Estimated Effect[a]			
			Mean Difference	Effect Size[b]	CI[c]	*p* Value[d]
Mean MCAS Math Score, 1999	238.20	233.85	4.3	.43	+/- .57	> .05

Note. MCAS = Massachusetts Comprehensive Assessment Program.

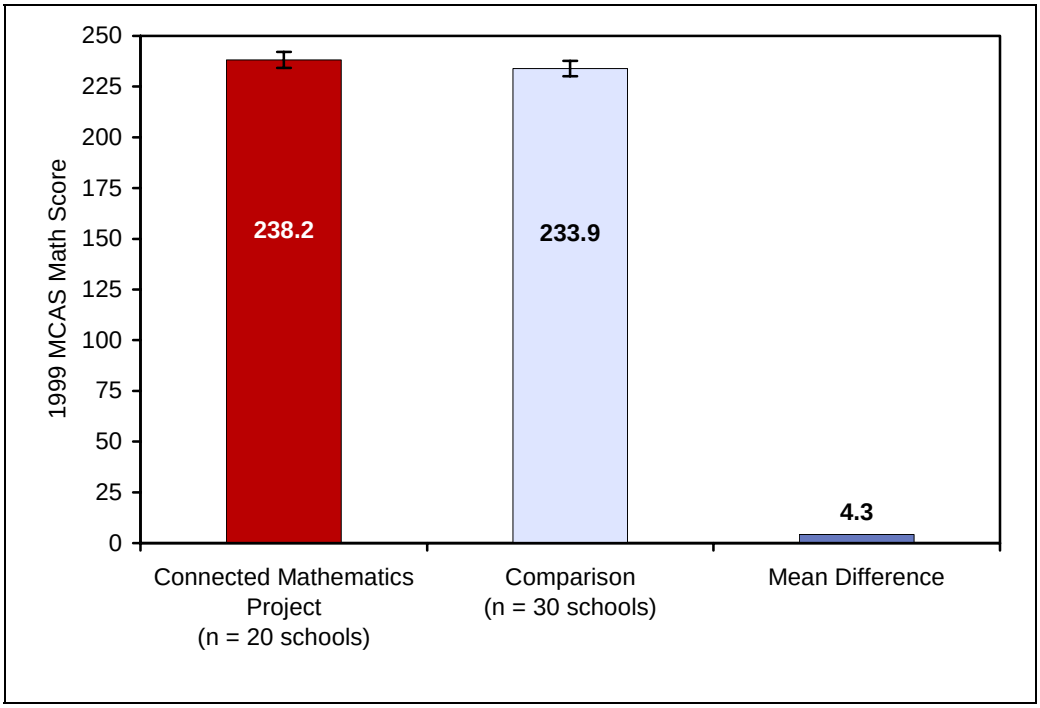
[a] Effect shown both as the mean difference between the intervention and comparison groups and as a relative effect size, which is equal to the ratio of the mean difference to the standard deviation of the outcome measure.

[b] All estimates of effect size are based on the *d*-index.

[c] Confidence Interval around the effect size estimate.

[d] Reflects significance level of the effect size estimate.

Figure 2. Impact Calculated by Riordan and Noyce (2001)[a]: Posttest Math Scores



Note. Riordan and Noyce did not report whether the difference between the groups was significant.
MCAS = Massachusetts Comprehensive Assessment Program.

[a] Confidence intervals were calculated by the WWC.

Intervention Developer Contact Information

Riordan and Noyce do not package, distribute, or provide technical assistance on the CMP. The CMP curricula materials are distributed by:

Pearson Prentice Hall, Inc.
1-800-848-9500
www.phschool.com/math/cmp/index.html

Related Studies

See reports on other studies of the Connected Mathematics Project.

See reports on other studies of Middle School Math curricula.

Report Production

Date created: March 4, 2005

Topic area reviewed under: Curriculum-Based Interventions for Increasing K–12 Math Achievement—Middle School

WWC Study Ratings[a]: Riordan & Noyce (2001)

Causal Validity: Meets WWC Evidence Standards with Reservations, Quasi-Experimental Design with Matching

Both assignment and matching were performed at the school level. Schools were first matched based on their average scores on the Massachusetts Educational Assessment Program test for the year prior to the introduction of the Connected Mathematics Project (CMP). Schools were also matched on the percentage of students in each school that were eligible for free and reduced-price lunch. Riordan and Noyce do not report any extraneous events that might have confounded the intervention's effects.

Other Study Characteristics	Study Rating	Study-Specific Information
Intervention Fidelity	●	The CMP curriculum is well designed and implemented and meets the definition of middle school math, but the intervention was not implemented in the way it was intended. None of the schools implemented the full eight units the CMP has available for each grade. The schools also differed from each other in the number of units they implemented.
Outcome Measures	●●	One math achievement outcome measure, the Massachusetts Comprehensive Assessment Program, was used in this study. There was evidence that this outcome was sufficiently reliable and that it was properly aligned to the intervention. Riordan and Noyce do not report when the outcome measure was administered.
People, Settings, and Timing	●	Although some important characteristics of the target population were captured in this study, many were not. Riordan and Noyce present information at the school level about the overall percentage of white students in the schools and the percentage of students receiving free and reduced-price lunch in the schools. Riordan and Noyce do not report variation by such characteristics as gender and limited English proficiency. Not enough detail was given in the article to determine whether there was variation in settings. A reasonable range of content areas was included in the outcome measure.
Testing within Subgroups	●	The effectiveness of the intervention was tested across the sample of schools but not within important subgroups.
Analysis	●	The unit of assignment (school) matched the units of statistical analysis (school). The statistical assumptions necessary for analysis were met. The sample of schools was small, therefore the precision of statistical estimates is limited.
Statistical Reporting	●●	Riordan and Noyce provide the unadjusted means and standard deviations of the achievement posttest. Riordan and Noyce also report sample sizes for each group; thus an effect estimate could be calculated.

Note. ●● Fully meets criteria; ● Meets minimum criteria; **X** Does not meet criteria.

[a] For more information on the criteria used to rate this study, see the WWC Evidence Standards: Middle School Math.