

WWC EVIDENCE REVIEW PROTOCOL FOR MIDDLE SCHOOL MATHEMATICS INTERVENTIONS

VERSION 1.1¹

Topic Area Focus

The What Works Clearinghouse (WWC) review focuses on curriculum-based math interventions for middle school students that contain learning goals delineating the mathematics that students should know and be able to do, provide instructional programs and materials that organize the mathematical content, and assess mathematics achievement. Systematic reviews of evidence in this topic area address the following questions:

- Which curriculum-based interventions are effective in increasing the learning of mathematics content and skills (that is, what students should know and be able to do) among middle school students?
- Are some interventions more effective for certain types of students, particularly students who lag behind in mathematics achievement?

Key Definitions

Curriculum-Based Math Intervention

This review considers curriculum-based math interventions. A curriculum-based math intervention will be defined in this review as a replicable instructional program that

- is delivered to middle school students;
- delineates well the learning goals for students;
- directly assesses student outcomes related to mathematics achievement;
- influences instructional content (e.g., objective taught) and/or method (e.g., individual versus group delivery);
- covers one or more of the following content areas: number and operations, algebra, geometry, measurement, data analysis and probability; and

¹ This protocol is aligned with the WWC Procedures and Standards Handbook (Version 1.0).

- is based on text materials, manipulatives, computer software, videotapes, other materials, or any combination thereof.

Mathematics Achievement Domain

Mathematics achievement domain. Outcomes that fall in the mathematics achievement domain are those related to mathematics content and skills, commonly described as what students should know and be able to do. Mathematics content varies somewhat across curricula and grade level, but generally includes: number and operations, algebra, geometry, measurement, and data analysis and probability. Mathematics skills are the application of the learning of this content, as well as an understanding of mathematical concepts, procedures, and problem solving. These include: problem solving, reasoning and proof, making connections, oral and written communication, and uses of mathematical representation.

GENERAL INCLUSION CRITERIA

Populations to be Included

The WWC Middle School Mathematics area reviews interventions for middle school students, primarily defined as grades 6 through 8. Students in grades 5 or 9 are included in the review only if such students were classified in the study as middle school students.

Types of Interventions to be Included

The interventions included are determined after an exhaustive search of the published and unpublished literature by the Middle School Math review team, as well as a review of nominations submitted to the WWC. Only research on interventions that are replicable (i.e., documented well enough that they can be reproduced) and materials-based (although the materials may come in various forms) is reviewed. Examples of possible interventions to be included are as follows:

- textbooks and textbook series,
- software programs and other educational technology that serve as the basis for well-defined curricula, and
- materials including videotapes that serve as the basis for well-defined curricula.

Types of Research Studies to be Included

The middle school math literature search focuses on studies involving math interventions for students in middle schools (primarily defined as grades 6 – 8). To be included in the review, a study must meet several relevancy criteria:

Topic relevance. The study must focus on the effects of a curriculum-based math intervention on one or more measures of math achievement.

Timeframe relevance. The study must have been published in 1983 or later.

Sample relevance. The sample must include middle school grades. Middle school grades are defined primarily as grades 6 through 8. An intervention in grade 5 or 9 may be included if the study indicates that grade 5 or 9 is a middle school grade.

Language/geography relevance. Studies must have been conducted in English and in the United States (including the 50 states, the District of Columbia, territories, and tribal entities).

Study design relevance. The design must be an empirical study, using quantitative methods and inferential statistics, that includes a comparison group. Such designs include well-conducted randomized controlled trials (RCTs) and quasi-experiments with matching or equating of student samples on the pretest. The WWC is in the process of developing standards for reviewing and reporting on single-case design and regression discontinuity design studies; studies with these designs will be incorporated into the review.

Outcome relevance. The study is required to focus on student, not teacher, outcomes, and at least one of the outcome measures must be an achievement measure that demonstrates sufficient reliability or face validity.

SPECIFIC TOPIC PARAMETERS

The following parameters specify which studies are considered for analyses and which aspects of those studies are coded for the review.

1. Characteristics of middle school math interventions.

Commonly shared and/or theoretically derived characteristics of the intervention that should be reflected in its definition and implementation include:

- Materials-based curriculum targeted to grade levels 6 through 8 or labeled as a “middle school” curriculum
- Math curriculum that covers one or more of the following:

Content:

Number and Operations

Algebra

Geometry

Measurement

Data Analysis and Probability

Skills:

Problem Solving

Reasoning and Proof

Making Connections

Oral and Written Communication

Uses of Mathematical Representation

- Clearly defined learning goals (e.g., the curriculum spells out what students will be able to do after its implementation)
- Enough information provided so that the intervention is replicable

2. Elements of intervention replicability.

The important characteristics of the intervention that must be documented in a study to reliably replicate it with different participants, in other settings, at other times include the following:

- The intervention is “branded.”
- The intervention is not “branded” but meets the following conditions:
 - The intervention is described in general terms.
 - The duration of the intervention is described.
 - The characteristics of the individuals who are expected to deliver the intervention are described.

3. Outcomes relevant to middle school math.

Important classes of outcomes include measures of mathematics achievement. Three types of outcome measures are included:

- Standardized, nationally normed achievement tests that are appropriate for middle school students (e.g., Comprehensive Test of Basic Skills, Wide Range Achievement Test)
- Standardized state or local tests of math achievement
- Research-based or locally developed tests or instruments that assess students’ mathematical concepts or skills

A study needs to include at least one type of math achievement measure that involves direct student assessment. Subjective measures, such as student grades assigned by teachers, do not qualify as relevant outcome measures.

4. Reliability of outcome measures.

Reliability (internal consistency, temporal stability/test-retest reliability, and inter-rater reliability) will be assessed using the following standards determined by the WWC:

- Internal consistency: minimum of 0.60
- Temporal stability/test-retest reliability: minimum of 0.40
- Inter-rater reliability: minimum of 0.50

Studies must contain at least one relevant measure that has evidence of either face validity or reliability.

5. Timeframe of review.

Studies need to have a publication date of 1983 or later. This time interval is wide enough to allow for a baseline of data with regard to traditional curricula, National Assessment of Educational Progress (NAEP) trends, and data with regard to Standards-based curricula.

6. Defining characteristics of the target population.

A middle school curriculum is one that is taught to middle school students. However, because there is some variation across school districts around the nation on how middle school is defined and organized, for this review middle school is defined primarily as grades 6 through 8. Students in grade 5 or 9 are included in the review only if such students were classified as middle school students.

7. Characteristics relevant to equating groups.

The important characteristics of participants that might be related to the intervention's (i.e., curriculum's) effect and must be equated if a study does not employ random assignment include:

- Pretest of the outcome measure
- Grade level

To address concerns regarding the possibility of lack of equivalence between treatment groups and comparison groups, the Middle School Math review team also considers whether the groups are equivalent along various observable dimensions, such as:

- Gender

- Socioeconomic status
- Race
- Percentage of second-language students
- “At-risk” status
- Tracking level
- Special education
- Location
- Average class size

However, it is unlikely that all such information will be provided in the studies and therefore is not a requirement of the review.

The issue of when the equating was done must also be considered, as well as whether the equating procedure may have resulted in groups with extreme scores in measurements (because upon repeated measurements, these scores tend to move toward the average, even without an intervention taking place).

For a quasi-experimental design (QED) comparison study to be valid, groups of students being compared must be drawn from the same population of students. Consequently, groups must be roughly equivalent with regard to the pretest of the outcome measures or its proxy. Evidence that the groups in a QED comparison study differ substantially on these dimensions can result in the failure of a study because substantial differences suggest that the groups represent different populations. Evidence that the groups come from distinctly different settings, or statistically significant pretest differences, or reported mean pretest differences between groups of more than 1/2 the sample standard deviation suggests that the groups represent different populations.

The onus for demonstrating initial equivalence of groups for a QED comparison study rests with the investigator. Sufficient reporting of the factors should be included (or obtained) to establish the initial equivalence of the groups. A study employing a QED without at least a pretest is excluded from the review.

8. Effectiveness of the intervention across different groups.

An intervention’s effectiveness will likely vary by subgroups in the population, and a study that claims to test the effectiveness of an intervention should attempt to examine the effects of the intervention within important subgroups. Effects on subgroups do not affect the inclusion of a study for review or the rating given to the study. However, we will present in a technical appendix findings for subgroups of interest if the subgroups are equivalent with regard to pretest and grade level. Relevant subgroups of interest for this review include:

- Gender
- Socioeconomic status
- Racial/ethnic breakdown
- Percentage of second-language students
- Percentage of bicultural students
- “At-risk” status

Note: The definition of “at risk” is provided by the study authors. We capture the author’s definition in the coding guide.

9. Effectiveness of the intervention across different settings.

An intervention’s effectiveness will likely vary by location, and a study that claims to test the effectiveness of an intervention should attempt to examine the effects of the intervention across different settings. Effects in different settings do not affect the inclusion of a study for review or the rating given to the study. However, we will present in a technical appendix findings across settings of interest if the samples for settings are equivalent with regard to pretest and grade level. Relevant settings of interest for this review include:

- Location of the schools involved
- Homogenous groupings of students
- School type (public, private, religious)
- Average class size (small, medium, large)
- School SES (e.g., Title I school)
- School size

10. Measuring post-intervention effects.

A math intervention may have an immediate effect as well as a long-term impact on students' math achievement. Thus, measures taken at the end of an intervention, as well as measures taken any time thereafter, are included. Delayed measures taken several months or years after an intervention may be useful because they may provide strong evidence for an intervention's effectiveness. The Middle School Math review team codes the length of the time interval between the end of an intervention and assessment of the outcome measure.

11. Defining differential attrition.

Differential attrition is defined as being greater than 7% differential loss. If differential attrition is less than or equal to 7%, we assume that the bias associated with it is minimal. If it is greater than 7%, the burden of proof shifts, and the study authors need to show that differential attrition did not bias the effect size estimate. A post-attrition demonstration of group equivalence on the pretest is the primary way for the study authors to show that the differential attrition did not result in a biased estimate. A pretest difference between the post-attrition groups that is statistically significant or that is more than 1/2 the sample standard deviation suggests that the effect size estimate could be biased.

12. Defining severe overall attrition.

Severe overall attrition is defined as being greater than 20% loss. If overall attrition is less than or equal to 20%, we assume that the bias associated with it is minimal. If it is greater than 20%, the burden of proof shifts, and the study authors need to show that overall attrition did not bias the effect size estimate. A post-attrition demonstration of group equivalence on the pretest is the primary way for the study authors to show that the differential attrition did not result in a biased estimate. A pretest difference between the post-attrition groups that is statistically significant or that is more than 1/2 the sample standard deviation suggests that the effect size estimate could be biased.

13. Statistical properties important for computing accurate effect sizes.

- For most statistics (including d-indexes), normal distribution and homogeneous variances are important properties. For correlations, there are no required desirable properties, and for odds-ratios there are no required desirable properties except the minimum of 5 observations per cell.
- In the case where a misaligned analysis is reported (i.e., unit of analysis is not the same as the unit of assignment) and the author is not able to provide a corrected analysis, the effect sizes computed by the WWC will incorporate a statistical adjustment for clustering. The default intraclass correlation used for middle school math outcomes is 0.20. For an explanation about the clustering correction, see the Appendix C of the *WWC Procedures and Standards Handbook*.
- In the case where multiple comparisons are made (i.e., multiple outcome measures are assessed within an outcome domain in one study), the WWC accounts for this

multiplicity by adjusting the author reported statistical significance of the effect using the Benjamini-Hochberg correction. See Appendix D of the *WWC Procedures and Standards Handbook* for the formulas the WWC used to calculate statistical significance.

METHODOLOGY

Literature Search Strategies

The WWC employs comprehensive and systematic literature search strategies to identify the population of published and unpublished relevant studies. This section contains topic specific elements of the literature search (e.g., search terms, additional journals, and associations) performed prior to 2005. The final section describes an expanded search conducted in 2008.

Key Word List

Intervention	Mathematical skills
Instruction	Mathematical concepts
Curriculum	Mathematics instruction
Curriculum based assessment	Mathematic* ability
Curriculum evaluation	Spatial ability
Mathematics	Properties mathematics
Number	Properties
Numbers	Middle schools
Algebra	Middle grades
Geometry	Sixth grade
Measurement	Seventh grade
Data analysis	Eighth grade
Probability	Ninth grade
Reasoning	Outcomes of education
Proof	Mathematics achievement
Connections	Mathematics w outcome
Communication	Outcomes
Representation	Achievement
Disposition	Learn
Attitude skills	Impact
Concepts	Enhance
Problem solving	Attainment
Mathematical aptitude	Evidence
	Assessment

A combination of Boolean terms such as AND and OR are used with this keyword list. WWC staff are consulted as to the appropriate combination to use and then tailor according to each specific electronic database.

Topic-Specific List of Journals to be Hand Searched

1. Journal for Research in Mathematics Education
2. Journal of Mathematical Behavior
3. Mathematical Thinking and Learning
4. Educational Studies in Mathematics
5. Journal of the Learning Sciences
6. Cognition and Instruction
7. Cognitive Science
8. Instructional Science

During continuous review, additional journal(s) may be added to the supplementary list when a handful of articles are identified from a particular journal that is not on this supplementary journal list.

Topic-Specific List of Organizations

1. Eisenhower Clearinghouse

Topic-Specific List of Associations

1. Association for Supervision and Curriculum Development (ASCD)
2. National Council of Supervisors of Mathematics (NCSM)
3. Psychology and Mathematics Education (PME)

Personal Contacts

The WWC Middle School Math review team solicits studies directly from experts in the field of education who work on math curriculum interventions. The Principal Investigator (PI) identifies these experts. We also contact experts using listservs dedicated to this topic and whose members are scholars working in this area.

After the identification of studies to be reviewed, we contact the authors of these studies to request similar materials and to ask them to “snowball” the process to colleagues whom they recommend for their work in this area.

Direct Contact with Publishers and Developers

The National Council of Teachers of Mathematics Exhibitors' List

The National Council of Teachers of Mathematics Exhibitors' List is searched for textbook publishers and software developers who have either published or developed an elementary, middle, or secondary school math curriculum. Organizations of this type may have research results of either pretests of the curriculum or evaluations of the curriculum after it has been implemented in schools that may not appear in refereed journals. We search the websites of these exhibitors to determine if they have published or developed a curriculum-based mathematics intervention. We use the guidelines developed by the PI for determining whether the products offered by the exhibitors constitute relevant mathematics interventions. The results of this search are reviewed by the PI before the exhibitors are contacted. Initially, a standardized email is sent to the relevant publishers and developers requesting submissions of pertinent research to the What Working Clearinghouse website. A follow-up letter also is mailed to organizations that do not respond to our email request.

Note: Not all of the textbook publishers listed below are actually publishers, but they might provide information and links to textbook and curriculum series.

Textbook Publishers List

1. AAAS/Project 2061
2. Academic Systems Company
3. American Guidance Service, Inc.
4. AMME, Inc
5. Brooks/Cole Publishing Company
6. CCI Publishing (formally CORD Communications)
7. CharlesBridge Publishing
8. College Preparatory Mathematics
9. Continental Press
10. Curriculum Associates
11. Dale Seymour Publications—Pearson Learning Group
12. Developmental Studies Center
13. Didax, Inc
14. Digi-Block, LLC
15. Dimension 2000
16. Education Development Center
17. Encyclopedia Britannica
18. Evan-Moor Educational Publishing
19. Everyday Mathematics/SRA/McGraw-Hill
20. Foundation for Advancements in Science and Education (FASE)
21. Glencoe/McGraw-Hill
22. Globe Fearon Educational Publishing
23. Heinemann Educational Books
24. Holt Rinehart & Winston (part of Harcourt)
25. Houghton Mifflin (acquired DC Heath, publisher of Heath Mathematics Connection)
26. Key Curriculum Press
27. Lawrence Erlbaum Association, Inc.
28. Math Essentials
29. McDougal Littell
30. Options Publishing, Inc.
31. Pencil Point Press, Inc. (they already responded to say that they are not relevant)
32. Prentice Hall
33. Saddleback Educational, Inc.
34. Saxon Publishers, Inc.
35. Scholastic, Inc.
36. Scott Foresman/Addison Wesley/Silver Burdett Ginn
37. SRA/McGraw Hill
38. Teachers College Press
39. The Consortium for Mathematics and its Applications
40. W. H. Freeman & Company
41. William K. Bradford
42. Wright Group (acquired Creative Publications)

Software Developers List

1. Apple Computer, Inc.
2. Barnum Software
3. BestQuest Teaching Systems
4. Boxer Learning, Inc.
5. Carnegie Learning, Inc.
6. Edu2000 America, Inc.
7. Learning In Motion
8. MathMedia Educational Software, Inc.
9. Meridian Creative Group
10. New Century Education Corporation
11. Optical Data School Media
12. Riverdeep Interactive Learning
13. Steck-Vaughn
14. WestEd

Publishers and software developers are directed to submit their studies online at the WWC website. They are asked to call us if they have any concerns or need more information.

Expanded Literature Search

In early 2008, the Middle School Math review team conducted an expanded literature search to update the population of relevant studies published in 2005 or later. This expanded search focused on electronic databases. This section lists the key words and databases used.

Key Word List

The list below contains the key words used during the expanded literature search. These terms were put into the key word list of databases with the limitation that the publication date be after January 1, 2005.

Achievement
Algebra

Arithmetic
Assessment

Attainment	Mathematic* ability
Comparative math studies	Mathematical aptitude
Curriculum	Mathematical concepts
Curriculum evaluation	Mathematical skills
Curriculum-based assessment	Mathematics
Curriculum evaluation	Mathematics achievement
Eighth grade	Mathematics instruction
Fractions	Mathematics w outcome*
Geometry	Middle grades
Grade 6	Middle schools
Grade 7	Ninth grade
Grade 8	Outcomes
Grade 9	Outcomes of education
Impact	Properties mathematics
International math	Reasoning
Inquiry-based math	Remedial math
Instruction	Seventh grade
Intervention	Sixth grade
Kindergarten	Spatial ability

In addition to searching the above key words, we performed specific searches for each of the interventions identified in the 2007 Middle School Math topic report.

A combination of Boolean terms such as AND and OR were used with this keyword list. Libraries at MPR conducted the actual searching and should be consulted as to the appropriate combination to use for searching within each electronic database.

List of Electronic Databases Searched

1. Academic Search Premier
2. Business Source Corporate
3. Dissertation Abstracts
4. EBSCO Ed Research Complete
5. EconLit
6. Education Research
7. EJS E-Journals
8. ERIC

9. Google Scholar

10. Organizational websites:

- a. Abt Associates (abtassociates.com)
- b. American Enterprise Institute for Public Policy Research (aei.org)
- c. Edvantia (ael.org)
- d. American Institutes for Research (air.org)
- e. Brookings Institution (brookings.edu)
- f. California Institute for Federal Policy Research (calinst.org)
- g. Center for Comprehensive School Reform and Improvement (centerforcsri.org)
- h. Center on Instruction (centeroninstruction.org)
- i. Center on Education Policy (cep-dc.org)
- j. Center for Research in Educational Policy (crep.memphis.edu)
- k. Thomas B. Fordham Institute (edexcellence.net) (The Fordham Institute has assumed the work of the [Educational Excellence Network](#).)
- l. Thomas B. Fordham Institute (fordhaminstitute.org)
- m. Institute for Public Policy and Social Research (ippsr.msu.edu)
- n. Mid-continent Research for Education and Learning (mcrel.org)
- o. MDRC (mdrc.org)
- p. Learning Point Associates (ncrel.org)
- q. National Council of Teachers of Mathematics (nctm.org)
- r. Northwest Regional Educational Laboratory (nwrel.org)
- s. Public Policy Research Institute (ppri.tamu.edu)
- t. Public/Private Ventures (ppv.org)
- u. Pacific Resources for Education and Learning (prel.org)
- v. Public Education Network (publiceducation.org)
- w. RAND Corporation (rand.org)

- x. SEDL (sedl.org)
 - y. SRI International (sri.com)
 - z. Urban Institute (urban.org)
11. PolicyArchive
 12. SocAbstracts
 13. SocINDEX with Full Text
 14. WorldCat