

**REVIEW PROTOCOL FOR
TEACHING ALGEBRA PRACTICE GUIDE
VERSION 3.0 (MARCH 1, 2014)**

This review-specific protocol guides the review of research that informs the What Works Clearinghouse (WWC) practice guide “Teaching strategies for improving algebra knowledge in middle and high school students.” The review-specific protocol is used in conjunction with the [WWC Procedures and Standards Handbook \(version 3.0\)](#).

PURPOSE STATEMENT

This review focuses on algebra interventions designed for use with students in sixth through twelfth grades. The review will examine the effect of interventions on the following types of outcomes: conceptual knowledge, procedural knowledge, and procedural flexibility. The following research question guides this review: “Which instructional practices improve students’ algebra skills, conceptual understanding, and reasoning?”

PROCEDURES FOR CONDUCTING THE LITERATURE SEARCH

The *WWC Procedures and Standards Handbook* discusses the procedures for conducting a literature search in Section II: Developing the Review Protocol and Identifying Relevant Literature (p. 4) and in Appendix B: Policies for Searching and Prioritizing Studies for Review.

Search Terms

The following table presents the search terms by category.

Category	Search Terms
Study Design	<ul style="list-style-type: none"> • Control group* • Comparison group* • Matched group* • Treatment* • Random* • Assignment • Baseline • Experiment* • Evaluation* • Impact* • Effect* • Causal • Post*test* • Pre*test* • Randomized controlled trial* • RCT • Quasi*experiment* • QED • Regression discontinuity • Changing criterion • Intrasubject replication • Multiple baseline • Multi*element • Single case • Single subject • ABAB • Alternating treatment • Simultaneous treatment • Reversal design • Withdrawal design
Topic	<ul style="list-style-type: none"> • Algebra* • Expression*¹ • Polynomial*¹ • Rational function*¹ • Equation*¹ • Inequalit*¹
Intervention	<ul style="list-style-type: none"> • Intervention* • Curricul* • Program* • Strateg* • Instruct* • Teach* • Train* • Technique* • Approach* • Practice* • School* • Education • Classroom* • Student* • Child*
Population	<ul style="list-style-type: none"> • Middle school* • Eighth*grade*

¹ Term must be found within 10 words of “algebra*.”

	<ul style="list-style-type: none"> • High school* • Secondary school* • Junior high • Sixth*grade* • Seventh*grade* 	<ul style="list-style-type: none"> • Ninth*grade* • Tenth*grade* • Eleventh*grade* • Twelfth*grade*
Outcomes	<ul style="list-style-type: none"> • Outcome* • Attainment* • Math* 	<ul style="list-style-type: none"> • Assess* • Achieve* • Test*

Additional Sources

In addition to those databases listed in the *WWC Procedures and Standards Handbook*, Appendix B,² this review searched the EJS E-Journals electronic databases.

In addition to those websites listed in the *WWC Procedures and Standards Handbook*, Appendix B,³ this review also searched the following websites:

- Council of Chief State School Officers
- McKinsey and Company
- Meadow Center for Preventing Educational Risk
- National Academy of Education
- National Council of Teachers of Mathematics

The review team also solicited study recommendations from panel members. Studies must be available to the public.

ELIGIBILITY CRITERIA

Eligible Populations

In this review, the following populations are of interest:

- **Grade range.** Students in grades six through twelve. Studies that contain students in other grades will not be included unless (a) study results disaggregate the results of students in eligible grades, or (b) students in eligible grades represent the majority of the aggregated mixed-age sample. If the study does not make explicit the number of students in each grade, a study will be included if 50% or more of the grades included in the sample falls within the eligible grade range.

² The search did not include two electronic databases listed in Appendix B: SAGE or ProQuest.

³ The search did not include two websites listed in Appendix B: Carnegie Corporation of New York and Policy Study Associates.

- **Location.** Studies can occur outside the United States, and practices and interventions can be administered in any language.

Potential subgroups of interest for this review include:

- Characteristics of students:
 - Non-English speaking students
 - Students at risk for math difficulties
 - Gifted, talented, or promising students.

Eligible Interventions

Only interventions that are replicable (i.e., can be reproduced) that can be implemented by an algebra teacher in an algebra classroom are eligible for review. The following characteristics of an intervention must be known to reliably reproduce the intervention with different participants, in other settings, and at other times:

- Intervention description: skills being targeted, approach to enhancing the skill(s) (e.g., strategies, activities, and materials), unit of delivery of the intervention (for example, whole group, individual), medium/media of delivery (for example, teacher-led instruction or software), and targeted population
- Intervention duration and intensity
- Description of individuals delivering or administering the intervention

This review only includes interventions that are practices. A practice is a named approach to promoting children’s development that educators implement by interacting with children and materials in classrooms. The review will include named practices that are clearly described, commonly understood, and used in published works by more than one investigator or team of investigators. Several terms may be used in the literature to refer to the same practice. A named practice may also refer to an array of specific procedures.

The review excludes (1) curricula or policies (such as requiring 8th grade Algebra I for all students), as these are multi-faceted interventions that are often determined by the school board or school principal, and (2) other interventions not appropriate for a teacher’s practice guide on math, such as comprehensive school reform.

Both “branded” and “non-branded” interventions will be reviewed. Branded interventions are commercial or published practices that may possess any of the following characteristics:

- An external developer who provides technical assistance (e.g., instructions/guidance on the implementation of the intervention) or sells or distributes the intervention
- Trademark or copyright

Eligible Research

The *WWC Procedures and Standards Handbook* discusses the types of research reviewed by the WWC in Section II: Developing the Review Protocol and Identifying Relevant Literature (p. 4). Additionally, in this review, the following additional parameters define the scope of research studies to be included:

- **Topic.** The recommendations in the practice guide will focus on instructional strategies that improve students' algebra skills and knowledge.
- **Time frame.** The study must have been published between 1993 and September 2013; earlier or later work will be reviewed if suggested by a panelist.
- **Sample.** The study sample must meet the requirements described in the "Eligible Populations" section above.
- **Language.** The study must be available in English to be included in the review. Studies examining instruction in other languages will be included in the review, as long as the study is written in English.
- **Location.** Studies can occur outside the United States, and practices and interventions can be administered in any language, but the study must be published in English.
- **Publication.** Dissertations are ineligible, unless specifically requested by a panelist.

Eligible Outcomes

This review includes outcomes in the following domains:

- **Conceptual knowledge** includes understanding algebraic ideas, operations, procedures, and notation. Conceptual knowledge is expressed by being able to explain operations and ideas, and identifying relationships among them.
- **Procedural knowledge** includes choosing operations and procedures to solve algebra problems, and applying the operations and procedures to arrive at the correct solution to problems.
- **Procedural flexibility** includes identifying and implementing multiple methods to solve algebra problems, and choosing the most appropriate method.

Unless the outcome clearly measures conceptual knowledge or procedural flexibility, the outcome will be assumed to measure procedural knowledge.

EVIDENCE STANDARDS

Eligible studies are assessed against WWC evidence standards, as described in the *WWC Procedures and Standards Handbook* Section III: Screening and Reviewing Studies (pp. 8 – 21).

Sample Attrition

The *WWC Procedures and Standards Handbook* discusses the sample attrition standards used by the WWC in Section III: Subsection B.2 Sample Attrition: Is the combination of overall and differential attrition high? (pp. 11–15).

This review uses the conservative boundary for attrition. This boundary was based on the assumption that most attrition in studies of algebra practices was due to factors that were strongly related to intervention status. For example, students may change classes or subjects because of the algebra intervention. The *WWC Procedures and Standards Handbook* contains a figure illustrating the attrition boundary and an associated table with attrition levels that define high and low attrition. Based on the choice of the boundary, the study review guide calculates attrition and whether it is high or low.

Baseline Equivalence

If the study design is a randomized controlled trial or regression discontinuity design with high levels of attrition or a quasi-experimental design, the study must demonstrate baseline equivalence of the intervention and comparison groups for the analytic sample. The onus for demonstrating equivalence in these studies rests with the authors. The *WWC Procedures and Standards Handbook* discusses how authors must demonstrate baseline equivalence in Section III: Subsection B.3 Baseline Equivalence: Is equivalence established at baseline for the groups in the analytic sample? (pp. 15 and 16).

Baseline equivalence must be demonstrated for the intervention and comparison groups in the analytic sample on the following pre-intervention (or baseline) characteristics:

- A pretest of the outcome measure or on another measure that is highly correlated with the outcome measure
- Grade level

This review requires that in a domain that requires statistical adjustments, the adjustment is made only for that outcome. For example, if A, B, and C are available as pre- and post-intervention measures, and the pre-intervention difference in B requires statistical adjustment, only the analysis of outcome B must adjust for B.

Review team leadership should be notified if a study has baseline differences greater than 0.25 SD in any of the following characteristics, since it could be evidence that the populations were

drawn from different settings and that the intervention and comparison groups are not sufficiently comparable for the purpose of the review:

- Percentage of students with low socioeconomic status
- Race or ethnicity
- Percentage of students who speak English as a second language

Review team leadership may decide the differences indicate that the comparison group is not adequate for the purposes of this review.

Studies with an analytical model that includes the pretest score as a statistical covariate (e.g., ANCOVA) but do not demonstrate baseline equivalence will be considered when determining the evidence level, as there is evidence that these analyses can adequately control for selection (Fortson et al., 2012).

Outcomes

The *WWC Procedures and Standards Handbook* discusses the types of outcomes, criteria the outcome must meet, and how outcomes are reported by the WWC in Section 3: Subsection B.4 Outcome Eligibility and Reliability (pp. 16–19). In this review, the general guidance regarding reliability, outcomes measured at different points in time, impacts measured at different points in time, composite and subscale scores, subgroup findings, categorical ordinal measures, and estimated effects using imputed data are followed.

Measures collected after the intervention ends are acceptable for this guide. To consistently examine effects across different interventions, immediate post-intervention findings will affect the level of evidence, but delayed outcome findings will also be reported in the guide appendix. Statistical adjustments to control for multiple comparisons will be computed within individual follow-up periods. Separate adjustments will be computed for the following follow-up periods, where appropriate: 2 weeks to 1 month, more than 1 to 3 months, more than 3 to 6 months, and more than 6 months. All outcomes within 2 weeks of the end of the intervention will be included in the immediate posttest adjustment. We will also report transfer outcomes—those that require students to apply concepts to new contexts—separately.

The guide will include studies that report on at least one type of mathematics achievement measure that involves direct student assessment in algebra. Other measures of algebra achievement, such as student grades assigned by teachers, do not qualify as relevant outcome measures.

Statistical Adjustments

The *WWC Procedures and Standards Handbook* discusses the types of adjustments made by the WWC in Section IV: Subsection B. Statistical Significance of Findings (p. 24).

Other Study Designs

Studies that use regression discontinuity or single-case designs are eligible for review using the appropriate pilot standards.

The *WWC Procedures and Standards Handbook* discusses the pilot standards for reviewing regression discontinuity design studies in Appendix D.

The *WWC Procedures and Standards Handbook* discusses the pilot standards for reviewing single-case design studies in Appendix E.

Citation

Fortson, K., Verbitsky-Savitz, N., Kopa, E., & Gleason, P. (2012). *Using an experimental evaluation of charter schools to test whether nonexperimental comparison group methods can replicate experimental impact estimates* (NCEE Technical Methods Report 2012-4019). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.