# Summary of research on the effectiveness of math professional development approaches

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This comprehensive literature review identified 643 studies of professional development interventions related to math in grades K–12. Thirty-two of the studies used a research design for assessing the effectiveness of math professional development approaches, and five of those met What Works Clearinghouse evidence standards. Of the five, only two found positive effects on student math proficiency.

This study used a systematic process modeled after the What Works Clearinghouse (WWC) study review process to answer the question: What does the causal research say are effective math professional development interventions for K–12 teachers aimed at improving student achievement? The study identified and screened 910 research studies in a comprehensive literature search for effectiveness studies[1] of math professional development approaches. (See appendix A for details of the search, screening, and review process.)

Of these 910 studies, 643 examined professional development approaches related to math in grades K–12 and were conducted in the United States. Of the 643 studies, 32 focused primarily on math professional development provided to teachers and used a research design for examining effectiveness (see appendix B for a list of the 32 studies). Five of those were determined to have met WWC evidence standards (version 2.1) either with or without reservations (appendix C).[2] And of those five, only two found positive effects on students' math proficiency.

Thus, there is very limited causal evidence to guide districts and schools in selecting a math professional development approach or to support developers' claims about their approaches. The limited research on effectiveness means that schools and districts cannot use evidence of effectiveness alone to narrow their choice. Instead, they must use their best judgment until more causal evidence becomes available.

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## The effects of five professional development approaches on student math proficiency

Of the five math professional development approaches that had effectiveness studies that met WWC standards, two had statistically significant positive effects, one had limited effects, and two had no discernible effect (table 1).[3]

**Table 1. Summary of findings for the five effectiveness studies of math professional development approaches that met What Works Clearinghouse evidence standards**

| Findings of the effectiveness study | Professional development approach |
|---|---|
| Statistically significant positive effects[a] | • Intensive math content courses accompanied by follow-up workshops (Sample McMeeking, Orsi, & Cobb, 2012).<br>• Lesson study focused on linear (measurement) model of fractions (Perry & Lewis, 2011). |
| Limited effects[b] | • Cognitively Guided Instruction (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Jacobs, Franke, Carpenter, Levi, & Battey, 2007).[c] |
| No discernible effect[d] | • America's Choice (Garet et al., 2010, 2011).<br>• Pearson Achievement Solutions (Garet et al., 2010, 2011). |

**a.** Implies that the researchers are confident that there is a real, causal relationship between the professional development approach and any subsequent changes in student performance and that the probability of observing such a result by chance is very slim. For more information, see U.S. Department of Education (2011) and WWC Glossary of Terms (http://ies.ed.gov/ncee/wwc/Glossary.aspx).

**b.** The effects were limited to knowledge of the equal sign. None of the measures of broader mathematics proficiency were significant.

**c.** The findings described differ from those reported in Yoon, Duncan, Lee, Scarloss, & Shapley (2007), which evaluated studies of professional development from 1986 to 2006 using standards similar to but less rigorous than those of the WWC standards (personal communication with Kwang Suk Yoon).

**d.** Implies that there was no evidence that the professional development approach had an effect on student math proficiency. For more information, see U.S. Department of Education (2011) and WWC Glossary of Terms (http://ies.ed.gov/ncee/wwc/Glossary.aspx).

**Source:** Authors' literature review (see appendix A).

### Statistically significant positive effects on student math proficiency

*Intensive math content courses accompanied by follow-up workshops (Sample McMeeking, Orsi, & Cobb, 2012).* This approach, stemming from a Mathematics Science Partnership grant funded by the National Science Foundation, combines math content courses and workshops. Teacher participants selected and enrolled in one or two university summer courses in math (lasting two to three weeks). The courses were geared toward the needs of middle school and upper elementary school teachers (for example, math modeling, algebraic patterns and functions, geometry). Each course focused 80 percent on math content, with time spent on math principles and math problems, and 20 percent on pedagogy. Fall follow-up workshops, held on four Saturdays, focused on designing lessons using the content from the summer courses. The fall courses were taught by university instructors, and the follow-up sessions were directed by both university instructors and district personnel approved by the university. This intensive professional development effort resulted in significant improvement in student math achievement as measured by the statewide assessment. The effect was found only for teachers who enrolled in two full math courses during the summer; there was no effect for teachers who enrolled in only one course.

*Lesson study focused on linear (measurement) model of fractions (Perry & Lewis, 2011).* In the lesson study approach small groups of teachers observed and analyzed fractions lessons that they planned collaboratively. The lesson study groups met 12–14 times over five months during the school year. Unlike the previous approach, where university instructors or district personnel provided intensive training and follow-up,

teachers took turns leading the group, following the lesson study cycle outlined in the intervention materials. Instructors and consultants provided the intervention materials (including a fractions toolkit that included materials to help students learn how to represent fractions on a number line[4]) and were available to answer teachers' questions as they led their teacher study groups. Implementation was thus similar to actual practice in a school or district. This study resulted in a significant increase of fractions knowledge on a test at the end of the year in grades 2, 3, and 5 but not in grade 4.

#### Limited effects on student math proficiency

*Cognitively Guided Instruction (Carpenter et al., 1989; Jacobs et al., 2007).* Cognitively Guided Instruction focused on helping teachers understand how students think about math, what informal knowledge teachers bring to the classroom, and how algebraic principles can be linked to the arithmetic taught in elementary school. Carpenter et al. (1989) examined the effectiveness of Cognitively Guided Instruction provided in a four-week summer workshop. Jacobs et al. (2007) looked at an approach in which teachers met once a month, receiving onsite support from a facilitator one-half day a week. In both cases researchers from local universities conducted the professional development. Neither study provided the information needed to calculate effect sizes using WWC standards (version 2.1).[5] Jacobs et al. (2007) found a statistically significant positive effect on student performance on a test focused on one specific, fairly limited topic: understanding the equals sign for simple addition problems.

#### No discernible effect on student math proficiency

*America's Choice (Garet et al., 2010, 2011).* America's Choice asks teachers to solve sets of math problems both individually and in small groups, use precise definitions, give short oral presentations explaining how they solved the problems, and receive feedback on their approach. Teachers present their solutions and discuss the most common student misconceptions associated with the topic. This approach was adapted to conform to the requirements of a national research study on rational numbers for grade 7 students. The adaptations included retooling the scope and sequence of the professional development approach. On a test of student knowledge of rational numbers, no statistically significant effect was observed at the end of either year 1 or year 2.

*Pearson Achievement Solutions (Garet et al., 2010, 2011).* Each professional development segment of Pearson Achievement Solutions (also referred to as Lesson Lab) focuses on a single problem or task. Each task is designed to elicit multiple approaches, which are intended to fuel extended discussions on the core ideas, common student approaches, and potential misconceptions associated with the task. The tasks were open-ended, and facilitators used their expertise to structure the discussions and determine whether to extend a professional development segment to address teacher responses. Extensive time was devoted to lesson planning, which was supplemented by videos. As in the America's Choice study, this approach was adapted to conform to the requirements of a national research study on rational numbers for grade 7 students. The adaptations included retooling the scope and sequence of the professional development approach. On a test of student knowledge of rational numbers, no statistically significant effect was observed at the end of either year 1 or year 2.

## Implications of the findings

Until more causal evidence becomes available, schools and districts must supplement the limited evidence of effectiveness with their best judgment. Schools and districts should be encouraged to rigorously evaluate professional development approaches themselves and, when possible, to report the findings publicly to build up the knowledge base on the topic.

## Appendix A. The search, screening, and review process

The research question that guided the systematic review of evidence outlined below was: What does the causal research say are effective math professional development interventions for K–12 teachers aimed at improving student achievement?

### Study eligibility criteria

To be included in this review, studies had to meet four relevancy criteria:

- *Topic.* Each study included an intervention, program, or product focused on providing math professional development to teachers. The professional development had to focus on improving teacher content knowledge and instruction in math in order to improve student learning in math.
- *Time.* Math professional development studies had to be published between January 2006 and July 2012 or be identified in Yoon et al. (2007) as having met standards similar to earlier What Works Clearinghouse (WWC) evidence standards.[6]
- *Sample.* The sample had to include math teachers and their students in grades K–12 in the United States.
- *Study design.* Only studies that used a randomized controlled trial or a quasi-experimental design with a comparison group were included.

### Reviewing studies using What Works Clearinghouse evidence standards

Studies were reviewed using the *WWC Procedures and Standards Handbook (version 2.1)* for group design studies (U.S. Department of Education, 2011) . Although each study that met the screening criteria was reviewed by a WWC-certified reviewer, this report is not a WWC review but was modeled after the WWC approach to reviewing causal evidence. Studies that the first reviewer determined to have met standards were reviewed independently by a second reviewer. A senior reviewer double-checked each completed review to ensure its accuracy and to reconcile any differences between the reviewers. The summary of programs described in this report includes only professional development approaches with studies that reviewers determined met WWC evidence standards (version 2.1), with or without reservations.

### Screening the research studies

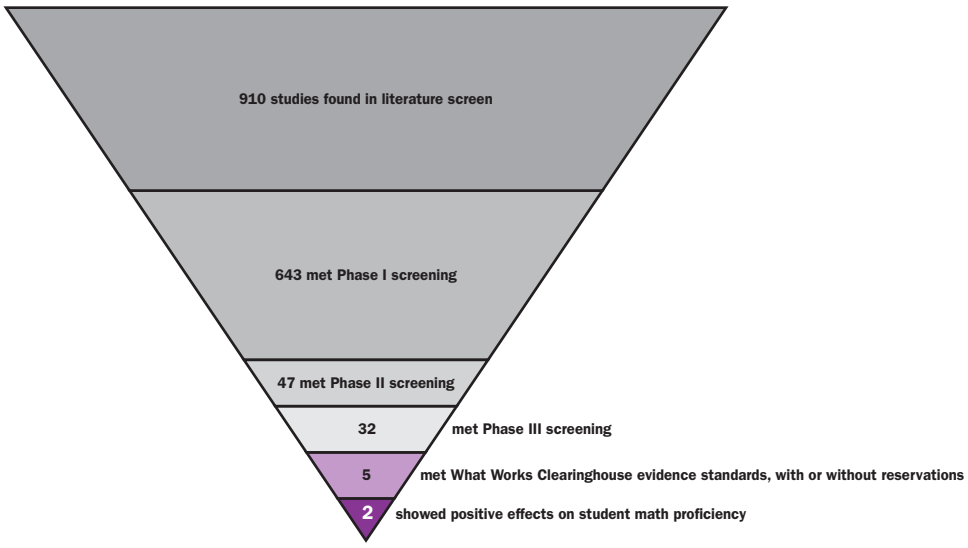
Initially, 910 research studies were located through a comprehensive literature search (figure A1). Studies were then screened using a three-phase process:

- 643 studies met Phase I screening, which means that they:
  - Included an intervention related to math.
  - Were published between January 2006 and July 2012 or were identified in Yoon et al. (2007) as having met standards similar to earlier WWC evidence standards.
  - Examined students in grades K–12.
  - Were conducted in the United States.
- 47 studies met Phase II screening, which means that they:
  - Included an intervention, program, or product focused primarily on providing math professional development to teachers.
  - Used a relevant design (randomized controlled trial or quasi-experimental design).
- 32 studies met Phase III screening, which means the nature of the math professional development approach was relevant to this brief. (15 studies from Phase II were excluded because the professional development approach was either generic professional development that did not focus on math—for example, school reform focused on strategic plans—or professional development that

was associated with implementing a specific curriculum.) These 32 studies were reviewed using WWC evidence standards (version 2.1).

- 5 studies met WWC evidence standards (version 2.1), with or without reservations. One two-year study was discussed in two reports, each focused on one year of the project (Garet et al., 2010, 2011). This was treated as one study, but two professional development approaches were involved. Impacts were reported separately for each approach. One professional development approach (Cognitively Guided Instruction) was included in two studies.
- 2 studies (representing two professional development approaches) met WWC evidence standards (version 2.1), with or without reservations, and showed positive impacts on student math proficiency.

**Figure A1. Screening funnel**




**Source:** Authors.

## Appendix B. Thirty-two final studies reviewed using What Works Clearinghouse standards

Of the 910 studies identified in the literature search, 643 examined interventions related to math in grades K–12 and were conducted in the United States. Of the 643 studies, the 32 studies listed in this appendix focused primarily on math professional development provided to teachers and used a research design for examining effectiveness. Five of those were determined to have met What Works Clearinghouse evidence standards (version 2.1) either with or without reservations; these are identified with an asterisk.


Balfanz, R., Mac Iver, D., & Byrnes, V. (2006). The implementation and impact of evidence-based mathematics reforms in high-poverty middle schools: A multi-site, multi-year study. *Journal for Research in Mathematics Education, 37*(1), 33–64. http://eric.ed.gov/?id=EJ765472

Bell, C., Wilson, S., Higgins, T., & McCoach, D. (2010). Measuring the effects of professional development on teacher knowledge: The case of developing mathematical ideas. *Journal for Research in Mathematics Education, 41*(5), 479–512. http://eric.ed.gov/?id=EJ902109

Blank, R., Smithson, J., Porter, A., Nunnaley, D., & Osthoff, E. (2006). Improving instruction through schoolwide professional development: Effects of the data-on-enacted-curriculum model. *ERS Spectrum, 24*(2), 9–23. http://eric.ed.gov/?id=EJ795681

Boston, M., & Smith, M. (2009). Transforming secondary mathematics teaching: Increasing the cognitive demands of instructional tasks used in teachers' classrooms. *Journal for Research in Mathematics Education, 40*(2), 119–156. http://eric.ed.gov/?id=EJ833624

Broyles, M. (2009). *The effect of teacher participation in the Gateway Institute of Algebra on student academic achievement.* (Doctoral dissertation, Union University, 2009). *ProQuest* UMI No. 3323764.

Campbell, P., & Malkus, N. (2011). The impact of elementary mathematics coaches on student achievement. *Elementary School Journal, 111*(3), 430–454. http://eric.ed.gov/?id=EJ963689

*Carpenter, T., Fennema, E., Peterson, P., Chiang, C-P, & Loef, M. (1989). Using knowledge of children's mathematics thinking in classroom teaching: An experimental study. *American Educational Research Journal, 26*(4), 499–531. http://eric.ed.gov/?id=ED292683

Dominguez, P., Nicholls, C., & Storandt, B. (2006). *Experimental methods and results in a study of PBS TeacherLine math courses.* Syracuse, NY: Hezel Associates. http://eric.ed.gov/?id=ED510045

Figueroa, M. (2008). *Examination of a new method to teach elementary students mathematics.* (Doctoral dissertation, Northern Arizona University, 2008). *ProQuest* UMI No. 3318482.

*† Garet, M., Wayne, A., Stancavage, F., Taylor, J., Eaton, M., Walters, K., et al. (2011). *Middle school mathematics professional development impact study: Findings after the second year of implementation* (NCEE 2011–4024). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. http://eric.ed.gov/?id=ED519923

*† Garet, M., Wayne, A., Stancavage, F., Taylor, J., Walters, K., Song, M., et al. (2010). *Middle school mathematics professional development impact study: Findings after the first year of implementation* (NCEE

2010–4009). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. http://eric.ed.gov/?id=ED509306

Harvey-Buschel, P. (2009). *A quantitative examination of factors that impact technology integration in urban public secondary mathematics classrooms.* (Doctoral dissertation, Bowie State University, 2009). *ProQuest* UMI No. 3365812. http://eric.ed.gov/?id=ED512800

Heller, J. I., Curtis, D. A., Rabe-Hesketh, S., & Verboncoeur, C. (2007). *The effects of "Math Pathways and Pitfalls" on students' mathematics achievement: National Science Foundation final report.* Washington, DC: U.S. Department of Education, National Center for Education Statistics. http://eric.ed.gov/?id=ED498258

*Jacobs, V., Franke, M., Carpenter, T., Levi, L., & Battey, D. (2007). Professional development focused on children's algebraic reasoning in elementary school. *Journal for Research in Mathematics Education, 38*(3), 258–288. http://eric.ed.gov/?id=EJ765495

Laumakis, P., & Herman, M. (2008). The effect of a calculator training workshop for high school teachers on their students' performance on Florida state-wide assessments. *International Journal for Technology in Mathematics Education, 15*(3), 87–93. http://eric.ed.gov/?id=EJ837650

McBride Martin, A. (2008). *The effects of professional development to create standards-based curriculum on student achievement in fourth and fifth grade mathematics classrooms.* (Doctoral dissertation, Indiana State University, 2008). *ProQuest* UMI No. 3299648.

McIntosh, T. (2010). *Math matters: A study of a professional development program for a group of K–8 teachers in the Alum Rock School District.* (Doctoral dissertation, Fielding Graduate University, 2010). *ProQuest* UMI No. 3371266.

*Perry, R. R., & Lewis, C. C. (2011). *Improving the mathematical content base of lesson study. Summary of results*. Retrieved January 24, 2013, from http://www.lessonresearch.net/IESAbstract10.pdf

Phelan, J., Choi, K., Niemi, D., Vendlinski, T., Baker, E., & Herman, J. (2012). The effects of POWERSOURCE© assessments on middle-school students' math performance. *Assessment in Education: Principles, Policy & Practice, 19*(2), 211–230. http://eric.ed.gov/?id=EJ962954

Phelan, J., Choi, K., Vendlinski, T., Baker, E., & Herman, J. (2011). Differential improvement in student understanding of mathematical principles following formative assessment intervention. *Journal of Educational Research, 104*(5), 330–339. http://eric.ed.gov/?id=EJ934894

Phelan, J., Vendlinski, T., Choi, K., Dai, Y., Herman, J., & Baker, E. L. (2011). *The development and impact of POWERSOURCE©: Year 5* (CRESST Report No. 792). Los Angeles: University of California, Los Angeles, National Center for Research on Evaluation, Standards, and Student Testing. http://eric.ed.gov/?id=ED520532

Ribeiro, J. (2009). *How does a co-learner delivery model in professional development affect teachers' self-efficacy in teaching mathematics and specialized mathematics knowledge for teaching?* (Doctoral dissertation, Johnson & Wales University University, 2009). *ProQuest* UMI No. 3387318. http://eric.ed.gov/?id=ED528371

Ross, J., & Bruce, C. (2007). Professional development effects on teacher efficacy: Results of a randomized field trial. *The Journal of Educational Research, 101*(1), 50–60. http://eric.ed.gov/?id=EJ776274

Sample McMeeking, L., Cobb, R. B., & Basile, C. (2010). Evaluating long-term complex professional development: Using a variation of the cohort control design. *Evaluation & Research in Education, 23*(4), 273–285. http://eric.ed.gov/?id=EJ903678

*Sample McMeeking, L., Orsi, R., & Cobb, R. B. (2012). Effects of a teacher professional development program on the mathematics achievement of middle school students. *Journal for Research in Mathematics Education, 43*(2), 159–181. http://eric.ed.gov/?id=EJ978876

Santagata, R., Kersting, N., Givvin, K., & Stigler, J. (2011). Problem implementation as a lever for change: An experimental study of the effects of a professional development program on students' mathematics learning. *Journal of Research on Educational Effectiveness, 4*(1), 1–24. http://eric.ed.gov/?id=EJ911538

Saxe, G., Gearhart, M., & Nasir, N. (2001). Enhancing students' understanding of mathematics: A study of three contrasting approaches to professional support. *Journal of Mathematics Teacher Education, 4*(1), 55–79. http://eric.ed.gov/?id=EJ622169

Smithson, J., & Blank, R. (2006). *Indicators of quality of teacher professional development and instructional change using data from surveys of enacted curriculum: Findings from NSF MSP-RETA project*. Washington, DC: Council of Chief State School Officers.

Stone, J., Alfeld, C., & Pearson, D. (2008). Rigor and relevance: Enhancing high school students' math skills through career and technical education. *American Educational Research Journal, 45*(3), 767–795. http://eric.ed.gov/?id=EJ807311

Stone, J., Alfeld, C., Pearson, D., Lewis, M., & Jensen, S. (2006). *Building academic skills in context: Testing the value of enhanced math learning in CTE*. Columbus, OH: National Dissemination Center for Career and Technical Education, Ohio State University. http://eric.ed.gov/?id=ED493604

Topping, K., Miller, D., Murray, P., & Conlin, N. (2011). Implementation integrity in peer tutoring of mathematics. *Educational Psychology, 31*(5), 575–593. http://eric.ed.gov/?id=EJ932919

Vendlinski, T. P., & Phelan, J. (2011). *Using key conceptual ideas to improve teacher use of formative assessment data* (CRESST Report No. 794). Los Angeles: University of California, Los Angeles, National Center for Research on Evaluation, Standards, and Student Testing. http://eric.ed.gov/?id=ED520526

Williams, L. (2010). *Building connections between sociomathematical norms and cognitive demand to improve the quality of whole class mathematics conversations*. (Doctoral dissertation, University of Wisconsin-Milwaukee, 2010). *ProQuest* UMI No. 3437973. http://eric.ed.gov/?id=ED523425

† Garet et al. (2010) and Garet et al. (2011) are together considered one study because the same two-year study appears in both reports. Each report focuses on one year of the project. However, because two different professional development approaches were involved in this study, the impacts for each approach are reported separately in this report.

**Table C1. Intensive math content courses accompanied by follow-up workshops: potentially positive effects (professional development approach more effective for teachers enrolled in two math courses than for those enrolled in just one)**

| Full citation | Research design | Analysis sample | Actual implementation | Nature of the counterfactual | Student outcome measures | Effect size (Hedges's g)[a] | Statistically significant at $p < .05$? |
|---|---|---|---|---|---|---|---|
| Sample McMeeking, L., Orsi, R., & Cobb, R. B. (2012). Effects of a teacher professional development program on the mathematics achievement of middle school students. *Journal for Research in Mathematics Education, 43*(2), 159–181. | Quasi-experimental design[b] | 23 teachers and 2,319 students in grades 5–8 from four districts | Participants took either one or two university courses<br><br>Two to three weeks per course in the summer; four half-day follow-up sessions on Saturdays during the school year | No participation in the content-based math courses or follow-up sessions | Colorado Student Assessment Program proficiency rates (for teachers who completed only one summer math course) | 0.09 | No |
| | | | | | Colorado Student Assessment Program proficiency rates (for teachers who completed two summer math courses) | **0.20** | Yes |

a. Bolded values are substantively important; effect sizes of 0.25 or greater are considered substantively important, regardless of statistical significance, according to What Works Clearinghouse (WWC) evidence standards (version 2.1).

b. Meets WWC evidence standards (version 2.1) with reservations.

**Source:** Authors' literature review (see appendix A).

**Table C2. Lesson study focused on linear (measurement) model of fractions: potentially positive effects (one study with significant impact on student achievement)**

| Full citation | Research design | Analysis sample | Actual implementation | Nature of the counterfactual | Student outcome measures | Effect size (Hedges's *g*)[a] | Statistically significant at $p < .05$? |
|---|---|---|---|---|---|---|---|
| Perry, R. R., & Lewis, C. C. (2011). *Improving the mathematical content base of lesson study summary of results.* Retrieved January 24, 2013, from http://www.lessonresearch.net/IESAbstract10.pdf[b] | Randomized controlled trial | 213 teachers and 1,059 students in grades 2–5 from 27 districts | Lesson study on fractions (with fractions resource kit and lesson study tools)<br><br>Actual duration (ranging from 7 to 42 hours) and scheduling varied by site<br><br>Recommended duration: 12–14 meetings over five months of the school year | Counterfactual 1:<br><br>Lesson study on locally chosen topic (with lesson study tools).<br><br>No fractions toolkit. Teachers were told to choose a topic other than fractions for their lesson study sessions, but teachers still taught fractions to their students. | Fractions knowledge—a test developed by researchers | **0.84** | Yes[c] |
| | | | | Counterfactual 2: Business as usual (locally chosen professional learning other than lesson study on locally chosen topic). Teachers were told to choose a topic other than fractions for their professional learning work, but teachers still taught fractions to their students.<br><br>Teachers attended a wide range of activities, including self-study and activities offered locally or at conferences. | Fractions knowledge—a test developed by researchers | **0.71** | Yes[c] |

**a.** Bolded values are substantively important; effect sizes of 0.25 or greater are considered substantively important, regardless of statistical significance, according to What Works Clearinghouse (WWC) evidence standards (version 2.1).

**b.** This document is a publicly available summary of the study; however, most of the data were obtained through an author query. The authors expect to publish their research in a peer-reviewed journal in the near future.

**c.** In subgroup analyses, researchers reported that results were statistically significant in grades 2, 3, and 5 but not in grade 4.

**Source:** Authors' literature review (see appendix A).

**Table C3. Cognitively Guided Instruction: limited effects (one study had no significant impact on any aspect of math proficiency; the other study had a significant impact on a brief measure of concepts of equality but no impact for any other aspects of math)**

| Full citation | Research design | Analysis sample | Actual implementation | Nature of the counterfactual | Student outcome measures | Statistically significant at $p < .05$? |
|---|---|---|---|---|---|---|
| Carpenter, T., Fennema, E., Peterson, P., Chiang, C. P., & Loef, M. (1989). Using knowledge of children's mathematics thinking in classroom teaching: An experimental study. *American Educational Research Journal, 26*(4), 499–531. | Randomized controlled trial | 40 teachers and approximately 480 grade 1 students from 24 schools | Four-week summer workshop, four days per week, five hours per day | Two two-hour workshops (one in September and one in February) focused on solving nonroutine problems using various heuristics. The counterfactual differed from Cognitively Guided Instruction in terms of focus, duration, extent of coverage, and purpose. According to the authors, "The goal was to provide control teachers with some sense of participation in the project and give them some immediate reward for their participation" (p. 507). | Iowa Test of Basic Skills Level 7 Computation | No |
| | | | | | Iowa Test of Basic Skills Level 7 Problem Solving | No |
| | | | | | Problem solving subtest: simple addition/ subtraction word problem | No |
| | | | | | Problem solving subtest: complex addition/ subtraction word problem | No |
| | | | | | Problem solving subtest: advanced word problem | No |
| | | | | | Problem solving interview (a measure of students' strategy use) | No |
| | | | | | Number facts interview (a measure of students' strategy use) | No |
| Jacobs, V., Franke, M., Carpenter, T., Levi, L., & Battey, D. (2007). Professional development focused on children's algebraic reasoning in elementary school. *Journal for Research in Mathematics Education, 38*(3), 258–288. | Randomized controlled trial | 180 teachers and 606 students in grades 1–5 from 19 schools in one district | A 4.5-hour Saturday introductory meeting with teachers from across the district; 1.5-hour after-school workshops approximately once a month eight times over the year; additionally, a half-day per week of onsite coaching. | Business as usual; teachers in the control condition received professional development the year after the study. | Equality subtest (grade 1) | Yes |
| | | | | | Equality subtest (grades 2/3) | Yes |
| | | | | | Equality subtest (grades 4/5) | Yes |
| | | | | | Computation subtest (grade 1) | No |
| | | | | | Computation subtest (grades 2/3)[a] | No |
| | | | | | Computation subtest (grades 4/5)[a] | No |
| | | | | | Solving equations subtest (grades 2/3)[a] | No |
| | | | | | Solving equations subtest (grades 4/5)[a] | No |

**Note:** Student-level effect sizes were not calculated because the authors reported only classroom-level data and were not able to provide additional data when requested.

**a.** Authors reported results as nonsignificant but did not report effect sizes or relevant data for calculating effect sizes at the level of assignment (school level) using What Works Clearinghouse standards (version 2.1). However, because the authors used liberal means of calculating statistical significance, none of the effects would be statistically significant using the school as the unit of analysis.

**Source:** Authors' literature review (see appendix A).

**Table C4. America's Choice: no discernible effects on students' acquisition of math**

| Full citation | Research design | Analysis sample | Actual implementation | Nature of the counterfactual | Student outcome measures | Effect size (Hedges's *g*) | Statistically significant at $p < .05$? |
|---|---|---|---|---|---|---|---|
| Garet, M., Wayne, A., Stancavage, F., Taylor, J., Walters, K., Song, M., et al. (2010). *Middle school mathematics professional development impact study: Findings after the first year of implementation* (NCEE 2010–4009). Washington, DC: U.S. Department of Education, Institute for Education Sciences, National Center for Education Evaluation and Regional Assistance. | Randomized controlled trial | *Year 1:* 99 teachers and 2,385 grade 7 students from 40 schools in 12 districts | Three-day summer institute, five one-day seminars during the school year, and 10 days of intensive in-school coaching. The in-school coaching sessions occurred immediately after each seminar and were scheduled (to the extent possible) to align with periods in which rational number topics were being covered in the districts' grade 7 math curriculum. The total intended dosage of professional development (including institutes, seminars, and coaching) in rational number topics was 68 hours. | Business as usual; grade 7 teachers in control schools received professional development offered by the district or state. | *Year 1:* Northwest Evaluation Association total score—a test of student knowledge of rational number topics | 0.02 | No |
| Garet, M., Wayne, A., Stancavage, F., Taylor, J., Eaton, M., Walters, K., et al. (2011). *Middle school mathematics professional development impact study: Findings after the second year of implementation* (NCEE 2011–4024). Washington, DC: U.S. Department of Education, Institute for Education Sciences, National Center for Education Evaluation and Regional Assistance. | | *Year 2:* 155 teachers and 3,971 grade 7 students from 40 schools in 6 districts | | | *Year 2:* Northwest Evaluation Association total score—a test of student knowledge of rational number topics | 0.03 | No |

**Source:** Authors' literature review (see appendix A).

**Table C5. Pearson Achievement Solutions: no discernible effects on students' acquisition of math**

| Full citation | Research design | Analysis sample | Actual implementation | Nature of the counterfactual | Student outcome measures | Effect size (Hedges's *g*) | Statistically significant at $p < .05$? |
|---|---|---|---|---|---|---|---|
| Garet, M., Wayne, A., Stancavage, F., Taylor, J., Walters, K., Song, M., et al. (2010). *Middle school mathematics professional development impact study: Findings after the first year of implementation* (NCEE 2010–4009). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. | Randomized controlled trial | *Year 1:* 89 teachers and 1,826 grade 7 students from 37 schools in 12 districts | Three-day summer institute, five one-day seminars during the school year, and 10 days of intensive in-school coaching. The in-school coaching sessions occurred immediately after each seminar and were scheduled (to the extent possible) to align with periods in which rational number topics were being covered in the districts' grade 7 math curricula. The total intended dosage of professional development (including institutes, seminars, and coaching) in rational number topics was 68 hours. | Business as usual; grade 7 teachers in control schools received professional development offered by the district or state. | *Year 1:* Northwest Evaluation Association total score—a test of student knowledge of rational number topics | 0.05 | No |
| Garet, M., Wayne, A., Stancavage, F., Taylor, J., Eaton, M., Walters, K., et al. (2011). *Middle school mathematics professional development impact study: Findings after the second year of implementation* (NCEE 2011–4024). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. | | *Year 2:* 123 teachers and 2,689 grade 7 students from 36 schools in 6 districts | | | *Year 2:* Northwest Evaluation Association total score—a test of student knowledge of rational number topics | 0.03 | No |

**Source:** Authors' literature review (see appendix A).

## Notes

1. Effectiveness studies determine whether there is a causal relationship between the approach and the outcomes; in this case, effectiveness studies examine whether mathematics professional development approaches cause improvements in student mathematics proficiency.
2. These studies focused only on students in grades 1–8.
3. There are many professional development programs and approaches beyond the five presented here, and not all five have positive findings. These five are highlighted because the research evidence for these approaches is of the highest quality in terms of determining the professional development approach's effect. For this WWC-style review, the review team determined that these five studies met WWC evidence standards (version 2.1) with or without reservations. Effect on student achievement is just one piece of evidence to consider when deciding whether to adopt an approach.
4. Earlier case study research suggests that focusing on concrete materials that are also used in the classroom is a hallmark of effective professional development (Garet, Porter, Desimone, Birman, & Yoon, 2001; Gersten, Chard, & Baker, 2000; Huberman & Miles, 1984).
5. This finding differs from those reported in Yoon et al. (2007), which evaluated studies of professional development from 1986 to 2006 using standards similar to but less extensive in some dimensions of research quality than an earlier version of the WWC standards (personal communication with Kwang Suk Yoon).
6. Yoon et al. (2007) evaluated studies of professional development from 1986 to 2006, using standards similar to, but less extensive in some dimensions of research quality than, an earlier version of the WWC standards (personal communication with Kwang Suk Yoon).

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The National Center for Education Evaluation and Regional Assistance (NCEE) conducts unbiased large-scale evaluations of education programs and practices supported by federal funds; provides research-based technical assistance to educators and policymakers; and supports the synthesis and the widespread dissemination of the results of research and evaluation throughout the United States.

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Gersten, R., Taylor, M. J., Keys, T. D., Rolfhus, E., & Newman-Gonchar, R. (2014). *Summary of research on the effectiveness of math professional development approaches.* (REL 2014–010). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southeast. Retrieved from http://ies.ed.gov/ncee/edlabs.

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