REL Appalachia Ask A REL Response

Educator Effectiveness, Math, Teacher Preparation
December 2018

Question:

What are the effects of sustained teacher professional development in elementary mathematics on teacher confidence and mathematics content knowledge?

Response:

Thank you for your request to our REL Reference Desk regarding evidence-based information about sustained teacher professional development in elementary mathematics. Ask A REL is a collaborative reference desk service provided by the 10 Regional Educational Laboratories (RELs) that, by design, functions much in the same way as a technical reference library. Ask A REL provides references, referrals, and brief responses in the form of citations in response to questions about available education research.

Following an established REL Appalachia research protocol, we searched for peer-reviewed articles and other research reports on sustained teacher professional development in elementary mathematics. We focused on identifying resources that specifically addressed the effects of sustained teacher professional development in elementary mathematics on teacher confidence and mathematics content knowledge. The sources included ERIC and other federally funded databases and organizations, research institutions, academic research databases, and general Internet search engines. For more details, please see the methods section at the end of this document.

The research team did not evaluate the quality of the resources provided in this response; we offer them only for your reference. Also, the search included the most commonly used research databases and search engines to produce the references presented here, but the references are not necessarily comprehensive, and other relevant references and resources may exist. References are listed in alphabetical order, not necessarily in order of relevance.

References

Althauser, K. (2015). Job-embedded professional development: Its impact on teacher self-efficacy and student performance. *Teacher Development, 19*(2), 210–225. Abstract retrieved from https://eric.ed.gov/?id=EJ1057741

From the abstract: "A quantitative approach was used to investigate the impact of a district-wide, job-embedded mathematics professional development program on elementary teachers' general and personal efficacy. This investigation was based on the principles of mathematics professional development, efficacy theory, and student achievement. It was designed to determine the impact on teachers' personal and general mathematics teaching efficacy as well as the relationship between teachers' personal and general efficacy in teaching mathematics and students' socioeconomic status with students' achievement in mathematics. Teachers' general and personal efficacies were measured using a paired-t analysis on the Math Teaching Efficacy Beliefs Instrument. Student achievement as measured by the state mathematics content test was regressed over the measures of teachers' general efficacy, teachers' personal efficacy, and socioeconomic status. Results indicate teachers' general efficacy and student socioeconomic status predicted student achievement in mathematics, supporting the conclusion that job-embedded, sustained professional development may lead to improved student achievement in mathematics."

Bruce, C. D., Esmonde, I., Ross, J., Dookie, L., & Beatty, R. (2010). The effects of sustained classroom-embedded teacher professional learning on teacher efficacy and related student achievement. *Teaching and Teacher Education: An International Journal of Research and Studies*, *26*(8), 1598–1608. Abstract retrieved from https://eric.ed.gov/?id=EJ897518; full text available at http://www.tmerc.ca/pub/Bruce_etal_TATE2010.pdf

From the abstract: "This paper reports on the impact of a classroom-embedded professional learning (PL) program for mathematics teaching in two contrasting districts in Canada, and investigates the relationship between teacher efficacy and student achievement. Before the PL, District A had lower teacher efficacy and student achievement than District B, but after the PL, this situation was reversed. Qualitative analysis revealed that the two districts reported learning very different things from the PL opportunity. The complexities of context, prior learning experiences, goal setting, and persistence of participants all factored into what and how teachers learned."

Garet, M. S., Heppen, J. B., Walters, K., Parkinson, J., Smith, T. M, Song, M., … Borman, G. D. (2016). *Focusing on mathematical knowledge: The impact of content-intensive teacher professional development* (NCEE 2016-4010). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. Retrieved from https://eric.ed.gov/?id=ED569154

From the abstract: "This report examines the impact of content-intensive Professional Development (PD) on teachers' math content knowledge, their instructional practice, and their students' achievement. The study's PD had three components, totaling 93 hours. The core of the PD was 'Intel Math,' an intensive 80-hour workshop delivered in summer 2013 that focused on deepening teachers' knowledge of grades K–8 mathematics. Two additional PD components totaling 13 hours were delivered during the 2013–14 school year: the 'Mathematics Learning Community,' a series of five 2-hour collaborative meetings focused on analyzing student work; and 'Video Feedback Cycles,' a series of three one-on-one coaching sessions where teachers' lessons were observed and critiqued. The purpose of

these two components was to reinforce the math content in Intel Math and help teachers apply the content to improve their instruction. Grade 4 teachers from 94 schools in six districts and five states participated in the study and were randomly assigned within schools to either a treatment group that received the study PD or a control group that did not receive the study PD. The key findings on the impact of the study PD on teacher knowledge, practice, and student achievement include: (1) The PD had a positive impact on teacher knowledge; (2) The PD had a positive impact on some aspects of instructional practice, particularly 'Richness of Mathematics;' and (3) Despite the PD's generally positive impact on teacher outcomes, the PD did not have a positive impact on student achievement. … This may be partially explained by the finding that the math content knowledge and dimensions of instructional practice targeted by the study PD were generally not correlated with student math achievement. The one exception was 'Errors and Imprecision,' on which the study PD did not have a statistically significantly impact. Thus, future research might focus on identifying PD that will improve this aspect of practice. Future research might also seek to identify other aspects of knowledge and practice to target with PD that are more strongly related to improved student achievement."

Garet, M. S., Wayne, A. J., Stancavage, F., Taylor, J., Eaton, M., Walters, K., … Doolittle, F. (2011). *Middle School Mathematics Professional Development Impact Study: Findings after the second year of implementation.* Washington, DC: U.S. Department of Education, Institute of Educational Sciences, National Center for Education Evaluation and Regional Assistance. Retrieved from https://eric.ed.gov/?id=ED519922

From the report: "This is the second and final report of the Middle School Mathematics Professional Development Impact Study, which examines the impact of providing a professional development (PD) program in rational number topics to seventh-grade mathematics teachers. An interim report (Garet et al. 2010) described the findings after one year of PD. The current report documents the impact after providing a second year of PD in a subset of the original participating districts and includes supplemental analyses that use data from both years of the study. The study produced the following core second-year results: (1) The study's PD program was implemented as intended, but teacher turnover limited the average dosage received; (2) At the end of the second year of implementation, the PD program did not have a statistically significant impact on teacher knowledge; and (3) At the end of the second year of implementation, the PD program did not have a statistically significant impact on average student achievement in rational numbers. Appended are: (1) Details of the Study Samples; (2) Details of Data Collection and Analytical Approaches; (3) Supplemental Information on the Design and Implementation of the PD Program; (4) Supporting Tables and Figures for Impact Analyses; and (5) Exploratory Analyses: Approaches and Additional Results."

Gersten, R., Taylor, M. J., Keys, T. D., Rolfhus, E., & Newman-Conchar, R. (2014). *Summary of research on the effectiveness of math professional development approaches.* Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Education Laboratory Southeast. Retrieved from https://eric.ed.gov/?id=ED544681

From the report: "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 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). 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."

Goldsmith, L. T., Doerr, H. M., & Lewis, C. C. (2014). Mathematics teachers' learning: A conceptual framework and synthesis of research. *Journal of Math Teacher Education*, *17*(1), 5–36. Abstract retrieved from https://eric.ed.gov/?id=EJ1038177; full text available at https://www.researchgate.net/publication/257583694_Mathematics_teachers'_learning_A_conceptual_framework_and_synthesis_of_research

From the abstract: "How do practicing mathematics teachers continue to develop the knowledge and habits of mind that enable them to teach well and to improve their teaching over time? The question of how (and what) teachers learn lies at the crux of any effort to provide high-quality mathematics teaching for all students. This article reviews 106 articles written between 1985 and 2008 related to the professional learning of practicing teachers of mathematics. We offer a synthesis of this research, guided by Clarke and Hollingsworth's dynamic model of teacher growth. Their model emphasizes the recursive nature of teachers' learning and suggests that growth in one aspect of teachers' knowledge and practice may promote subsequent growth in other areas. We report the results in six major areas of teacher learning, identify several crosscutting themes in the literature, and make recommendations for future research aimed at understanding teachers' professional learning."

Kutaka, T. S., Ren, L., Smith, W. M., Beattie, H. L., Edwards, C. P., Green, J., L., … Lewis, W. J. (2018). Examining change in K–3 teachers' mathematical knowledge, attitudes, and beliefs: The case of Primarily Math. *Journal of Mathematics Teacher Education*, *21*(2), 147–177. Abstract retrieved from https://eric.ed.gov/?id=EJ1172258

From the abstract: "This study examines the impact of the Primarily Math Elementary Mathematics Specialist program on K–3 teachers' mathematical content knowledge for teaching, attitudes toward learning mathematics, and beliefs about mathematics teaching

and learning. Three cohorts of teachers participating in the program were compared to a similar group of non-participating teachers. Teacher outcomes were measured longitudinally across 5 years. Participating teachers showed changes in their knowledge, attitudes, and beliefs in line with program goals immediately after completion of coursework. Moreover, these changes were sustained in subsequent years, following program completion. Relative to the comparison group, participants demonstrated greater gains in knowledge as well as greater improvements in attitudes and beliefs. Implications of these results for professional development design, implementation, and evaluation are discussed."

Yoon, K. S., Duncan, T. Lee, S W.., Scarloss, B., & Shapley, K. L. (2007). *Reviewing the evidence on how teacher professional development affects student achievement.* Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Education Laboratory Southwest. Retrieved from https://eric.ed.gov/?id=ED498548

*From the report: "*The Regional Educational Laboratory - Southwest (REL Southwest) conducted a systematic and comprehensive review of the research-based evidence on the effects of professional development (PD) on growth in student achievement in three core academic subjects (reading/ELA, mathematics, and science). The primary goal of this study was to address the question, What is the impact of teacher participation in professional development on student achievement? Nine studies emerged as meeting What Works Clearinghouse (WWC) evidence standards, from more than 1,300 manuscripts identified as potentially relevant. Although the number of studies that met evidence standards was small, the average overall effect size of 0.54 was observed when examined within the three content areas included in the review. The consistency of this effect size indicates that across all forms and content of PD, providing training to elementary school teachers does have a moderate effect on their students' achievement. However, because the average number of contact hours averaged almost 49 hours across the nine studies, the total contact hours must be substantial to get such an effect size. Because of the limited number of studies and the variability in the PD that was represented among the nine studies we examined, we were unable to make any conclusions about the effectiveness of specific PD programs or about the effectiveness of PD by form, content, or intensity. The following are appended: (1) Methodology; (2) Protocol for the review of research-based evidence on the effects of professional development on student achievement; (3) Key terms and definitions related to professional development; (4) List of keywords used in electronic searches; and (5) Relevant studies, listed by coding results."

Additional Organizations to Consult

National Council of Teachers of Mathematics: https://www.nctm.org/Conferences-and-Professional-Development/Professional-Development-Resources/

From the website: "Founded in 1920, the National Council of Teachers of Mathematics (NCTM) is the world's largest mathematics education organization, with 60,000 members and more than 230 Affiliates throughout the United States and Canada … The National Council of Teachers of Mathematics advocates for high-quality mathematics teaching and learning for each and every student.

Strategic framework:

- Teaching and Learning: NCTM provides guidance and resources for the implementation of research-informed and high-quality teaching that supports the learning of each and every student in equitable environments.
- Access, Equity and Empowerment: NCTM advances a culture of equity where each and every person has access to high-quality teaching empowered by the opportunities mathematics affords.
- Building Member Value: NCTM provides community and resources to engage and listen to members in order to improve the teaching and learning of mathematics.
- Advocacy: NCTM engages in advocacy to focus, raise awareness, and influence decision makers and the public on issues concerning high-quality mathematics teaching and learning."

Methods

Keywords and Search Strings

The following keywords and search strings were used to search the reference databases and other sources:

- teacher AND math* AND elementary AND ("professional development" OR "professional learning" OR "in-service") AND ("content knowledge" OR confidence OR efficacy OR beliefs OR "pedagogical content knowledge" OR PCK) AND (impact OR effect)

Databases and Resources

We searched ERIC, a free online library of more than 1.6 million citations of education research sponsored by the Institute of Education Sciences (IES), for relevant resources. Additionally, we searched the academic database ProQuest, Google Scholar, and the commercial search engine Google.

Reference Search and Selection Criteria

In reviewing resources, Reference Desk researchers consider—among other things—these four factors:

- Date of the publication: Searches cover information available within the last ten years, except in the case of nationally known seminal resources.
- Reference sources: IES, nationally funded, and certain other vetted sources known for strict attention to research protocols receive highest priority. Applicable resources must be publicly available online and in English.
- Methodology: The following methodological priorities/considerations guide the review and selection of the references: (a) study types—randomized controlled trials, quasi experiments, surveys, descriptive data analyses, literature reviews, policy briefs, etc., generally in this order; (b) target population, samples (representativeness of the target population, sample size, volunteered or randomly selected), study duration, etc.; (c) limitations, generalizability of the findings and conclusions, etc.

- Existing knowledge base: Vetted resources (e.g., peer-reviewed research journals) are the primary focus, but the research base is occasionally slim or nonexistent. In those cases, the best resources available may include, for example, reports, white papers, guides, reviews in non-peer-reviewed journals, newspaper articles, interviews with content specialists, and organization websites.

Resources included in this document were last accessed on November 26, 2018. URLs, descriptions, and content included here were current at that time.

This memorandum is one in a series of quick-turnaround responses to specific questions posed by education stakeholders in the Appalachia region (Kentucky, Tennessee, Virginia, and West Virginia), which is served by the Regional Educational Laboratory Appalachia (REL AP) at SRI International. This Ask A REL response was developed by REL AP under Contract ED-IES-17-C-0004 from the U.S. Department of Education, Institute of Education Sciences, administered by SRI International. The content does not necessarily reflect the views or policies of IES or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. government.