REL Appalachia Ask A REL Response

Early Childhood, Math
May 2021

Question:

What are interventions or components of interventions that promote early numeracy skills for students performing below grade-level benchmarks?

Response:

Thank you for your request to our REL Reference Desk regarding evidence-based information about interventions or components of interventions that promote early numeracy skills for students performing below grade-level benchmarks. 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 interventions focused on early numeracy. We focused on identifying resources that specifically addressed the effects of various interventions on early numeracy skills for students performing below grade-level benchmarks. 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

Bryant, D. P., Bryant, B. R., Roberts, G., Vaughn, S., Pfannenstiel, K. H., Porterfield, J., & Gersten, R. (2011). Early numeracy intervention program for first-grade students with mathematics difficulties. *Exceptional Children, 78*(1), 7–23. https://eric.ed.gov/?id=ED577119

From the abstract: "The purpose of this study was to determine the effects of an early numeracy preventative Tier 2 intervention on the mathematics performance of first-grade

students with mathematics difficulties. Researchers used a pretest-posttest control group design with randomized assignment of 139 students to the Tier 2 treatment condition and 65 students to the comparison condition. Systematic instruction, visual representations of mathematical concepts, purposeful and meaningful practice opportunities, and frequent progress monitoring were used to develop understanding in early numeracy skills and concepts. Researchers used progress-monitoring measures and a standardized assessment measure to test the effects of the intervention. Findings showed that students in the treatment group outperformed students in the comparison group on the progress-monitoring measures of mathematics performance and the measures that focused on whole-number computation. There were no differences between groups on the problem-solving measures."

Bryant, D. P., Bryant, B. R., Sorelle-Miner, D. A., Falcomata, T. S., & Nozari, M. (2018). Tier 3 intensified intervention for second grade students with severe mathematics difficulties. *Archives of Psychology, 2*(11), 1–24. https://archivesofpsychology.org/index.php/aop/article/view/86/163

From the abstract: "A multiple baseline design was employed to examine the effects of an intensive mathematics intervention, which focused on early numeracy concepts and skills. Thirty-three second grade students participated in the study. Students attended five different schools in one school district and received the intervention in a total of 12 groups from mathematics interventionists. The intervention occurred for about 30 min per session, 5 days a week for 8 weeks with a maintenance phase two weeks later and generalization testing four weeks later. The intervention consisted of explicit instruction, strategies, and mathematics practices. Visual analyses of the data showed improvement for the majority of the groups. Effect size calculations showed no evidence of overlapping data between baseline and intervention for nine out of twelve groups. Maintenance data revealed positive results and five students had a posttest score at or above the 25th percentile on the generalization measure. We discuss implications for practice with limitations and future research."

Clarke, B., Doabler, C. T., Kosty, D., Kurtz Nelson, E., Smolkowski, K., Fien, H., & Turtura, J. (2017). Testing the efficacy of a kindergarten mathematics intervention by small group size. *AERA Open, 3*(2), 1–16. https://eric.ed.gov/?id=EJ1194151

From the abstract: "This study used a randomized controlled trial design to investigate the ROOTS curriculum, a 50-lesson kindergarten mathematics intervention. Ten ROOTS-eligible students per classroom (n = 60) were randomly assigned to one of three conditions: a ROOTS five-student group, a ROOTS two-student group, and a no-treatment control group. Two primary research questions were investigated as part of this study: What was the overall impact of the treatment (the ROOTS intervention) as compared with the control (business as usual)? Was there a differential impact on student outcomes between the two treatment conditions (two- vs. five-student group)? Initial analyses for the first research question indicated a significant impact on three outcomes and positive but nonsignificant impacts on three additional measures. Results for the second research question, comparing the two- and five-student groups, indicated negligible and nonsignificant differences. Implications for practice are discussed."

Doabler, C. T., Clarke, B., Kosty, D., Turtura, J. E., Firestone, A. R., Smolkowski, K., Jungjohann, K., Brafford, T. L., Nelson, N. J., Sutherland, M., Fien, H., & Maddox, S. A. (2019). Efficacy of a first-grade mathematics intervention on measurement and data analysis. *Exceptional Children*, *86*(1), 77–94. Abstract retrieved from https://eric.ed.gov/?id=EJ1229461; full text available at https://www.researchgate.net/publication/334446954_Efficacy_of_a_First-Grade_Mathematics_Intervention_on_Measurement_and_Data_Analysis

From the abstract: "Well-designed mathematics instruction focused on concepts and problem-solving skills associated with measurement and data analysis can build a foundational understanding for more advanced mathematics. This study investigated the efficacy of the Precision Mathematics Level 1 (PM-L1) intervention, a Tier 2 print- and technology-based mathematics intervention designed to increase first-grade students' conceptual understanding and problem-solving skills around the areas of measurement and data analysis. Employing a randomized controlled trial, 96 first-grade students at risk for mathematics difficulties were randomly assigned within classrooms to either a treatment (PM-L1) or a control (business-as-usual) condition. A statistically significant positive effect was found on one of five outcome measures, with the other four showing positive but nonsignificant results. Results also suggested preliminary evidence of differential response based on students' number sense and early literacy risk status. Implications for using mathematics interventions focused on measurement and data analysis to build comprehensive, multitiered service delivery models in mathematics are discussed."

Mattera, S. K., Jacob, R., & Morris, P. A. (2018). *Strengthening children's math skills with enhanced instruction: The impacts of Making Pre-K Count and High 5s on kindergarten outcomes.* MDRC. https://eric.ed.gov/?id=ED581579

From the abstract: "Early math skills are a strong predictor of later achievement for young children, not only in math, but in other domains as well. Exhibiting strong math skills in elementary school is predictive of later high school completion and college attendance. To that end, the Making Pre-K Count and High 5s studies set out to rigorously assess whether providing high-quality math instruction, aligned across prekindergarten (pre-K) and kindergarten, could lead to long-term gains across a variety of domains for students growing up in low-income communities in New York City. In Making Pre-K Count, pre-K programs were randomly assigned to receive an evidence-based early math curriculum (Building Blocks) and associated professional development or to a pre-K-as-usual control condition. Pre-K in New York City changed rapidly during the study, with teachers overall conducting substantially more math than had previously been documented—a factor that may have played a role in the lack of impacts from Making Pre-K Count on children's math learning at the end of the pre-K year. In the High 5s study, students who had been in Making Pre-K Count program classrooms in pre-K were individually randomly assigned within schools in the kindergarten year to supplemental small-group math clubs, which took place outside of regular instructional time, or to a business-as-usual kindergarten experience. A companion report describes the High 5s program in more detail. This report focuses on the effects in kindergarten of the two math programs. Key findings of the report were: (1) Making Pre-K Count: At the end of kindergarten, there was a small, positive, but not consistently

statistically significant effect for the Making Pre-K Count program on one of two measures of math skills, a measure that is more sensitive to children's skill levels than the more global test used in pre-K and kindergarten. Making Pre-K Count led to positive impacts on children's attitudes toward math at the end of kindergarten and to about two months' greater growth in kindergartners' working memory skills. (2) Making Pre-K Count plus High 5s kindergarten supplement: Two years of aligned, enhanced math experiences led to positive impacts on the more sensitive measure of children's math skills, both above and beyond Making Pre-K Count alone (equivalent to 2.5 months' growth) and compared with no math enrichment in pre-K and kindergarten (equivalent to 4.2 months' growth); effects were positive but not statistically significant on the more global measure. The effect of two years of enhanced math translates into closing more than a quarter of the achievement gap between low-income children and their higher-income peers at the end of kindergarten. Children who were offered two years of math enrichment also had more positive attitudes toward math than children with no enrichment. These findings suggest that early enriched math instruction, particularly when aligned across years, can have a positive effect on children's math skills, math attitudes, and working memory. The amount of math already in place was associated with the magnitude of the estimated effects of these programs. In addition, the sensitivity of the math measures used in the study may have played a role in how well each assessed math skills. The studies will continue to follow children into third grade to better understand the long-term effects of these early math programs."

Mononen, R., Aunio, P., Koponen, T., & Aro, M. (2014). A review of early numeracy interventions for children at risk in mathematics. *International Journal of Early Childhood Special Education, 6*(1), 25–54. https://helda.helsinki.fi/bitstream/handle/10138/232676/20150930191208_intjecse.pdf?s

From the abstract: "This study reviewed early numeracy interventions for four-to seven-year-old children at risk for mathematics difficulties. The search yielded 19 peer-reviewed studies with pre-and post-treatment control designs. The interventions were categorised as either core or supplemental instruction. The study analysed the effectiveness and identified the pedagogical components of the interventions: setting, duration, numeracy content used for intervention training and progress measurement, conductor and professional developmental support offered, and instructional design features. The interventions showed, to various degrees, the promising effect of improving the early numeracy skills of at-risk children. Results indicated that different types of instructional design features, including explicit instruction, computer-assisted instruction (CAI), game playing, or the use of concrete-representational-abstract levels in representations of math concepts, led to improvements in mathematics performance. The paper discusses the implications for practise and suggestions for future research."

Additional Ask A REL Responses to Consult

Ask A REL Northwest at Education Northwest. (2019). *What does the research say about effective elementary math interventions for students who are not meeting standards?* https://ies.ed.gov/ncee/edlabs/regions/northwest/askarel/math-interventions.asp

Additional Organizations to Consult

Development and Research in Early Math Education (DREME) Network: https://dreme.stanford.edu/

From the website: "The DREME Network was created in 2014 to advance the field of early mathematics learning research and improve young children's opportunities to develop math skills. The Network focuses on math learning from birth through age eight years, with an emphasis on the preschool years. Network members and affiliates collaborate to conduct basic and applied research, develop innovative tools that address high-priority early math topics, and inform and motivate other researchers, educators, policymakers, and the public."

- Early math resources for teacher educators: http://prek-math-te.stanford.edu/

Early Math Counts: https://earlymathcounts.org/

From the website: "In 2012, the University of Illinois at Chicago College of Education launched the Math at Home (now Early Math Counts) website with a grant from the CME Group Foundation to give early childhood educators in Illinois the knowledge and skills they need to boost children's mastery of early math. The CME Group Foundation provided additional funding in 2016 to support the development of Early Math Counts—a free, online professional development program for early childhood educators across the nation."

- Early math resources: https://earlymathcounts.org/resources/

Erikson Institute, Early Math Collaborative: https://earlymath.erikson.edu/

From the website: "In 2007 Erikson Institute launched the Early Math Collaborative to increase the quality of early math education. We do this in three key ways:

1. Professional development of teachers, facilitators/trainers, and administrators.
2. Conducting research to generate new knowledge about approaches to teacher education, teacher development, and the most effective methods of mathematics instruction for young children.
3. Being a source of information on foundational mathematics—what it is, how it develops in children, and how best to teach it."

Methods:

Keywords and Search Strings

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

- (numeracy OR "early numeracy" OR "early math") AND ("early elementary" OR "early grade") AND (intervention OR program) AND (low-performing OR "below grade level" OR "at risk")

Databases

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 10 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 May 3, 2021. 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.