



PROMOTING MATH OUTSIDE OF SCHOOL

Findings from a new study show the benefits
of math games and activities outside of
school for children's school readiness

Gena Nelson and Colleagues, 2023



UNIVERSITY OF
OREGON

HEDCO Institute

THIS REPORT SUMMARIZES FINDINGS FROM: "A META-ANALYSIS AND QUALITY REVIEW OF MATHEMATICS INTERVENTIONS CONDUCTED IN INFORMAL LEARNING ENVIRONMENTS WITH CAREGIVERS AND CHILDREN"

Gena Nelson - University of Oregon

Hannah Carter - Boise State University

Peter Boedeker - Baylor College of Medicine

Emma Knowles - Boise State University

Claire Buckmiller - Boise State University

Jessica Eames - Boise State University

Funding for Nelson and colleagues research was supported by grant #2000292/2313440 funded by National Science Foundation in the Division of Research on Learning in Formal and Informal Settings.

<https://doi.org/10.3102/00346543231156182>

Review of Educational Research

DOI: 10.3102/00346543231 156182

Article reuse guidelines: sagepub.com/journals-permissions

© 2023 AERA. <https://journals.sagepub.com/home/rer>

The HEDCO Institute for Evidence-Based Educational Practice

College of Education | University of Oregon

Designed by: Joe Golfen, Elizabeth Day, and Lisa Shimmel, HEDCO
Institute for Evidence-Based Educational Practice

Recommended citation: Day, E., Golfen, J., & Shimmel, L. (2023).

Promoting math outside of school. HEDCO Institute for Evidence-Based Educational Practice. hedcoinstitute.uoregon.edu/promoting-math-outside-school <https://doi.org/10.17605/OSF.IO/7RC4F>

WHY IS IT IMPORTANT FOR EDUCATORS TO SUPPORT CAREGIVERS WITH MATH ACTIVITIES?

Caregivers who play math games and activities with children outside of school support their children's school readiness.

Across 25 studies including over 3,500 children, math games and activities outside of school time were significantly linked to children's math skills and school readiness.

Findings estimate there is an 84% chance that a math intervention offered outside of school will improve children's math skills. This assumes the families, children, and math interventions at your school are similar to those in this review.

Math interventions in informal learning environments require very few resources, can be low cost, and take little time to implement. This means they may be more accessible to a broad range of families compared to in-school interventions.

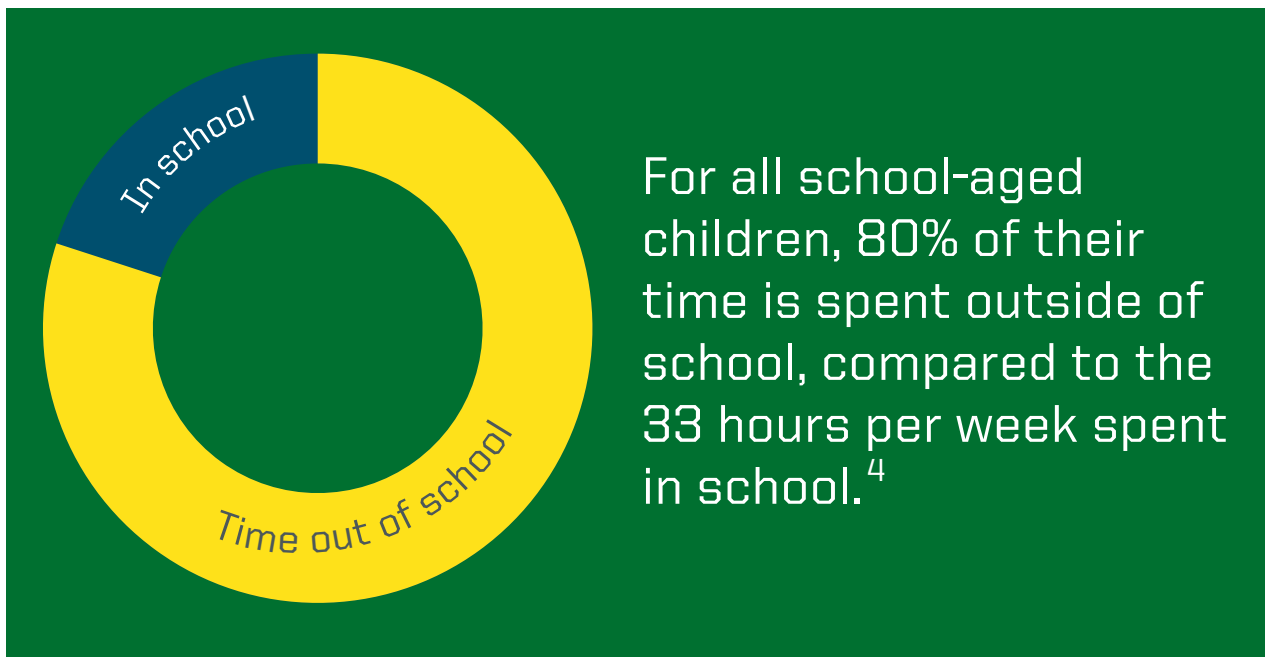


THE IMPORTANCE OF EARLY MATH SKILLS

Early math development is associated with later math achievement in school,¹ as well as various other early-developing skills, such as literacy.²



Children's proficiency with identifying numerals, counting, and recognizing patterns were the most consistent and significant predictors of later reading and math achievement across elementary school.³



ENCOURAGE CAREGIVERS TO TALK ABOUT MATH

Informal learning environments are spaces outside of school where learning takes place, such as homes, sports facilities, and exhibits at libraries and museums. From birth to 8 years old,⁵ children spend more time in informal learning environments than formal learning environments, such as school classrooms.

Math activities in informal learning environments are linked to math knowledge and fluency⁶ and may play an important role in decreasing achievement differences related to socioeconomic status.⁷

A close-up photograph of a young child with a joyful expression, showing their teeth. The child is holding a white card with a large, red number '1' on it. The background is softly blurred, showing green foliage.

SUPPORTING CAREGIVERS WITH MATH LANGUAGE

CAREGIVER TRAINING

Interventions that take place in the home and include an initial training session for caregivers with follow-up support (e.g., additional training sessions, in-home coaching, text message support) may be particularly beneficial for supporting children.

Examples of caregiver training:

- 30-minute presentation at an early childhood center caregiver night
- a brief phone call explaining the intervention materials and procedures
- three at-home visits for the caregiver to practice activities with coaching support

Examples of follow-up support:

- text message reminders three times per week
- phone calls once per week, and
- three classes involving a lesson and time for caregiver questions

TIPS AND IDEAS FOR CAREGIVERS

The following section offers ideas of concrete activities and tips you can provide to caregivers as needed.

STORYBOOKS¹⁴

Support caregivers with the following tips:

- Incorporate math into reading by describing the illustrations using math language or specific numbers.
- Ask questions that encourage your child to use math language or count.
- Go through books before reading with your child and think about ways to incorporate math. This might take off some of the pressure of trying to think of things in the moment. Teachers will often write notes to themselves on post-its and stick them in the book as reminders for certain questions or observations.



STORYBOOKS



Specific Math Terms

- A couple
- A lot
- Above
- Add
- Big, bigger, biggest
- Enough
- Few, fewer, fewest
- Inside
- Less, least
- Many
- Minus
- More, most
- Outside
- Same
- Several
- Small, smaller, smallest
- Take away
- Tall, taller, tallest
- Under
- Wide, wider, widest

General Math Discussions

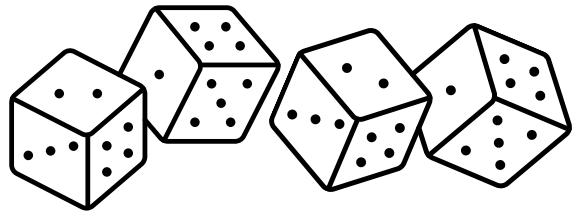
- Shape characteristics
- Patterns
- Informal measuring
- Spatial relations/locations

Math Concepts

- Compare amounts and sizes of pictures
- Count objects
- Describe pictures using the terms above (There are so many cats, The boy has several toys but his friend only has a few)
- Ask your child to tell you about the picture and prompt with math questions (How many? Who has more?)



GAMES¹⁵



Tips:

- Check your local library for board games or card games.
- Look for games that allow children to count past 10 and include shapes as well as numbers, for example, Chutes and Ladders and the Great Race.
- Look for card games that incorporate matching or comparing amounts.
- Create your own games with dice.
- Include things like comparing amounts and adding or subtracting numbers.



Example dice game:

1. Each player rolls 1-2 dice, identifies the number rolled, and then counts out that amount of colored counters (or pennies, pom poms, whatever is available around the house) from a pile in the center of the table.
2. At the end of one round, each player compares how many counters they have won (be sure to talk about things like “more than”, “less than”, and “the same as”).
3. Repeat 2-3 rounds and the person with the most counters wins!

COOKING AND MEALTIME¹⁶



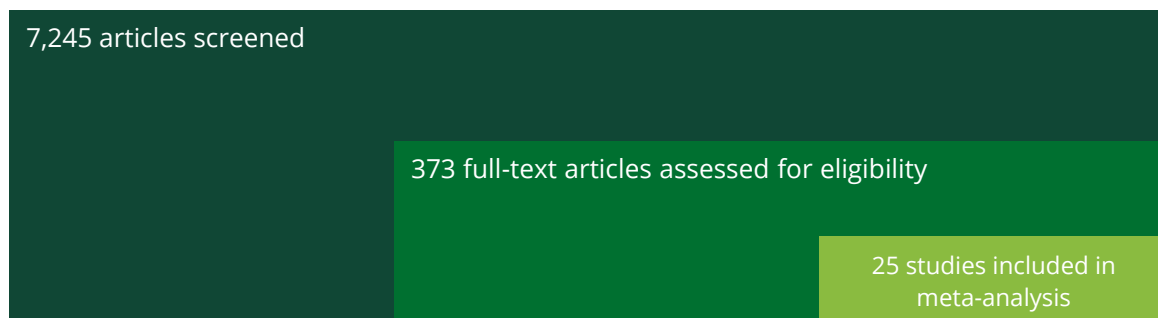
Tips:

- Ask your children to write out the grocery list. While older children can use letters and numbers – for example, “2 cereal boxes, 10 bananas,” younger children might be encouraged to draw pictures of the items their caregivers want to buy or to use a combination of letters, numbers, and pictures.
- Talk about spatial awareness when you’re at the grocery store (and anywhere!), for example, “Let’s walk from aisle 4 to aisle 7” or “Is the pasta above or below the pasta sauce?”
- Include your children in reading recipes and gathering and measuring ingredients. Ask your child questions such as: Can you get five apples from the fridge? I added 4 cups of milk plus one more – how many are there in total? How many plates and forks do we need today?
- For more ideas, visit: familymath.stanford.edu/activity/tips-for-cooking-with-math-2/



STUDY DETAILS

The goal of this systematic review with meta-analyses was to understand the effects of math interventions offered in informal learning environments.



DESCRIPTIVES

There were 3,697 total child participants with an average age of 4.77 years, ranging from 1.58 years to 8.5 years.

18 of the 25 studies reported information about participants' race or ethnicity. Using race and ethnicity categories that are commonly applied to studies conducted in the United States, students were predominantly Hispanic (39.11%), Black (33.10%), and White (21.42%).

For non-U.S. studies, the majority of students (94.95%) were identified as Asian.

RESULTS

The overall effect was statistically significant.

$g = 0.26$, 95% CI [0.07, 0.45], $t(19.3) = 2.92$, $p = 0.009$

The average effect of 0.26 is equivalent to a What Works Clearinghouse [improvement index](#) of approximately 10.3 percentile points.

CITATIONS

1. Geary, D. C., van Marle, K., Chu, F. W., Rouder, J., Hoard, M. K., & Nugent, L. (2018). Early conceptual understanding of cardinality predicts superior school-entry number system knowledge. *Psychological Science*, 29(2), 191-205. <https://doi.org/10.1177/0956797617729817>

- Kiss, A. J., Nelson, G., & Christ, T. J. (2019). Predicting third-grade mathematics achievement: A longitudinal investigation of the role of early numeracy skills. *Learning Disability Quarterly*, 42(3), 161-174. <https://doi.org/10.1177%2F0731948718823083>

2. Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, 43(6), 1428- 1446.

- Purpura, D. J., Litkowski, E. C., & Knapik, V. (2019). Mathematics and reading develop together in young children: Practical and policy considerations. *Policy Insights from the Brain and Behavioral Sciences*, 6(1), 12- 20. <https://doi.org/10.1177/2372732218815923>

3. Claessens, A., & Engel, M. (2013). How important is where you start? Early mathematics knowledge and later school success. *Teachers College Record*, 115(6), 1- 29. <https://psycnet.apa.org/record/2013-18273-005>

4. National Center for Education Statistics (NCES), U.S. Department of Education. (2007- 2008). *Schools and Stajing Survey* (SASS). https://nces.ed.gov/surveys/sass/tables/sass0708_035_sls.asp

5. Hofferth, S. L., & Sandberg, J. F. (2001). How American children spend their time. *Journal of Marriage and Family*, 63(2) , 295-308. <https://doi.org/10.1111/j.1741-3737.2001.00295.x>

6. LeFevre, J. A., Skwarchuk, S. L., Smith-Chant, B. L., Fast, L., Kamawar, D., & Bisanz, J. (2009). Home numeracy experiences and children's math performance in the early school years. *Canadian Journal of Behavioural Science*, 41 (2), 55-66. <http://dx.doi.org/10.1037/a0014532>

7. Galindo, C., & Sonnenschein, S. (20 15). Decreasing the SES math achievement gap: Initial math proficiency and home learning environments. *Contemporary Educational Psychology*, 43, 25- 38. <https://doi.org/10.1016/j.cedpsych.2015.08.003>

8. Niklas, F., Cohrssen, C., & Tayler, C. (2016). Improving preschoolers' numerical abilities by enhancing the home numeracy environment. *Early Education and Development*, 27(3), 372-383. <https://doi.org/10.1080/10409289.2015.1076676>

9. Flynn, L. (2021). Game based intervention to develop early childhood mathematical understanding and decrease gaps related to socioeconomic status [Unpublished doctoral dissertation, Boise State University].

10. Dulay, K. M., Cheung, S. K., Reyes, P., & McBride, K. (2019). Effects of parent coaching on Filipino children's numeracy, language and literacy skills. *Journal of Educational Psychology*, 111(4), 641-662. <http://dx.doi.org/10.1037/edu0000315>

11. Leyva, D., Weiland, C., Shapiro, A., Yeomans-Maldonado, G., & Febles, A. (2021). A strengths-based, culturally responsive family intervention improves Latino kindergarteners' vocabulary and approaches to learning. *Child Development*. Advance online publication. <https://doi.org/10.1111/cdev.13698>

CITATIONS

12. Libertus, M. E., Darko, O., Feigenson, L., & Halberda, J. (2020). Effects of visual training of approximate number sense and school math ability. *Frontiers in Psychology*, 11, Article 2085. <https://doi.org/10.3389/fpsyg.2020.02085>
13. Blanch, M. J. (2002). The role of parents as formal math instructors of prekindergarten children (Publication No. 1409335) [Master's thesis, Utah State University]. Proquest Dissertations and Theses Global.
14. Napoli, A. R. (2023). Personal Communication.
15. Niklas, F., Cohrssen, C., & Tayler, C. (2016). Improving preschoolers' numerical abilities by enhancing the home numeracy environment. *Early Education and Development*, 27(3), 372-383.
16. Leyva, D. (2021). How getting kids to make grocery lists and set the table can improve their vocabulary and willingness to learn. *The 74*. <https://www.the74million.org/article/how-getting-kids-to-make-grocery-lists-and-set-the-table-can-improve-their-vocabulary-and-willingness-to-learn/>