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Features of Effective K-1 Early Numeracy Interventions

An Implementation Guide

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This report summarizes findings from the Early Math Meta-Analysis, a pre-registered meta-analysis of early numeracy interventions for children with and without learning difficulties (https://osf.io/ra3n8/overview). Analyses were drawn from 112 PreK-Grade 1 studies published from 2006 to 2025, including more than 21,000 students.

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Purpose of Guide

The purpose of this guide is to help teachers, instructional coaches, and district leaders understand the features of effective early numeracy intervention programs. This guide can also be used to inform the selection of early numeracy interventions and strengthening multi-tiered systems of support (MTSS) implementation in mathematics.

What are Early Numeracy Interventions?

1. They extend beyond typical core (i.e., Tier 1) mathematics instruction.

Interventions are typically delivered **in addition to** Tier 1 instruction. In some cases, interventions may be delivered in a whole-class setting. Compared to standard core instruction, they include features such as **increased instructional time** (e.g., how often the intervention is delivered, the length of lessons, or the total number of weeks of instruction), a **decreased group size**, and/or a **focus on remediating difficulties in math**.

2. They target early numeracy skills.

Early numeracy skills include math skills taught in K-1, focused on the **number, relations, and operations** domains.[1,2,3] These domains are interrelated and essential for building students' knowledge of foundational number concepts.

Early numeracy does not include concepts such as geometry, measurement, or data analysis.

Tables 1-3 describe specific early numeracy skills under each of these domains.

Overview of Early Numeracy Mathematical Domains and Skills

Table 1. Number Domain

Skill	Description
Rote counting	Counting out loud, forward or backward
Counting with correspondence	Counting objects by matching each object with a number word
Cardinality	Understanding that the last number counted represents the total in the group
Subitizing	Seeing a group of objects and automatically "knowing" how many are in the group
Numeral identification and writing	Naming and writing numerals

Table 2. Relations Domain

Skill	Description
Comparison	Comparing sets or numerals to determine which is greater or lesser
Sequencing numbers	Putting numbers in order

Table 3. Operations Domain

Skill	Description
Composing/Decomposing	Putting numbers together or breaking them apart (e.g., 17 = 10 + 7)
Equivalence	Understanding the equal sign
Addition/Subtraction	Understanding and solving simple addition/subtraction problems
Place Value	Understanding the base-ten system

Why is Intervention in Grades K-1 Important?

Children enter kindergarten with widely divergent early mathematics skills.[4] Gaps in math knowledge tend to grow as content becomes more complex.[5,6] However, early numeracy intervention narrows these achievement and opportunity gaps.[7,8] These findings signal the need for effective interventions that target foundational skills in the earliest years of school.

Why are Early Numeracy Skills Important?

Developing foundational early numeracy knowledge is essential for building overall mathematics proficiency.[1,2] Early numeracy skills are necessary for accessing other mathematical domains (e.g., measurement, geometry) and more advanced concepts in the later grade levels. Students must develop an understanding of what numbers represent, their relative size or magnitude, and how to flexibly manipulate them to solve real-world problems.

Where the Evidence Comes From

The guidance included in this document is from a **meta-analysis**. A meta-analysis **combines results across multiple studies to understand the effectiveness of a practice or approach**. Because meta-analyses synthesize the evidence from a broader pool of studies, they provide more information about what works, for whom, and under what conditions compared to a single study.

Who was included?

- More than 21,000 students
- Students were predominantly Hispanic (25.0%), White (24.2%), and Black (20.1%)*
- 30.5% from low SES backgrounds*
- 14.8% multilingual learners*
- 6.0% students with disabilities*

* DEMOGRAPHIC DATA ARE DRAWN FROM U.S. STUDIES ONLY.

Study Requirements

- Focused on students in PreK, Kindergarten, or Grade 1
- Included at least 4 intervention sessions across 2 weeks of instruction
- Focused on early numeracy concepts
- Took place in school-based settings
- Included at least one math outcome measure
- Used an experimental or quasi-experimental design

The current meta-analysis included 112 studies published from 2006 to 2025, conducted across 23 countries.

Key Takeaways

Early numeracy interventions in kindergarten and Grade 1 lead to **meaningful student growth in mathematics.**

Early numeracy interventions are effective for **students from low socioeconomic backgrounds** and for **students at high risk for difficulty in mathematics** (i.e., those scoring below the 25th percentile on mathematics screening measures).

Effective interventions typically occur in **brief, frequent sessions**, target multiple **foundational numeracy skills**, use the **concrete–representational–abstract (CRA) instructional sequence**, and use **explicit and systematic instruction** to support student learning.

Implications for Teachers

1. Focus on **foundational early numeracy skills**.

Early numeracy interventions lead to **strong, educationally meaningful effects on student outcomes**. On average, students increased by 18 percentile points in kindergarten, and 12 percentile points in Grade 1.

Effective early numeracy interventions target foundational skills within the **number, relations, and operations** domains, including:

- Counting and one-to-one correspondence
- Identifying and comparing numbers or quantities
- Using number lines and visual models
- Addition and subtraction

2. Use the **concrete-representational-abstract (CRA) instructional sequence** and **explicit, systematic instruction**.

Interventions that use CRA show stronger improvements in student math learning compared to interventions that do not. Students increased by 22 percentile points from interventions that used CRA, compared to 14 percentile points from interventions without CRA.

In CRA instruction, students first use **concrete models** (manipulatives), then transition to **representational models**, and finally to **abstract symbols** and equations. If students struggle to understand abstract symbols, teachers can return to concrete or representational models to solidify understanding.

- Concrete models (e.g., base-ten blocks, counters)
- Representational models (e.g., number lines, hundreds charts, or diagrams)
- Abstract symbols (e.g., 3, 105, +, – , =).

Interventions that used **explicit and systematic instruction** were also effective. On average, students increased by about 16 percentile points from interventions that used explicit and/or systematic instruction.

3. Deliver intervention in **short, frequent sessions**.

Early numeracy interventions are typically delivered in **25-minute lessons, 3 times per week, for about 9 weeks.** Even **brief interventions** (2–8 weeks) can lead to meaningful improvements in student outcomes.

4. Deliver intervention in **small groups or one-to-one settings** to provide targeted support and frequent opportunities for practice.

Early numeracy interventions are most often taught in small group or one-to-one settings. Review screening and assessment data to form appropriate instructional groupings.

5. Monitor student progress using targeted assessments that measure both **calculation** and **broad math skills**.

Early numeracy interventions have especially strong impacts on student calculation and broad math skills.

Calculation skills include:

- Performing single- and multi-digit addition and subtraction accurately
- Emphasizing procedural fluency with arithmetic operations

Broad math skills include:

- Understanding the meaning of numbers and quantities
- Reasoning about mathematical relationships
- Applying math to real world problem-solving contexts

To evaluate students' response to early numeracy intervention, use pre-intervention, post-intervention, and progress monitoring assessments that include calculation and broad math items.

Implications for District and State Leaders

1. Implement **district-wide screening and progress monitoring** in kindergarten and Grade 1.

District-wide screening and progress monitoring in K-1 can help identify students with math difficulties early on and ensure timely access to intervention. **Early numeracy interventions show strong effects on student learning** (g = .40, p < .001), with average gains of 18 percentile points in kindergarten, and 12 percentile points in Grade 1.

Early numeracy interventions are also effective for **students from low socioeconomic backgrounds** (g = .51) and for **students scoring below the 25th percentile** on mathematics screening measures (g = .53), with average gains of 20 percentile points across both categories.

District leaders can support district-wide screening and progress monitoring by:

- Ensuring that staffing structures allow for MTSS teams to oversee screening and progress monitoring within school buildings
- Encouraging MTSS teams to review student math screening data at least three times per year to guide the formation of intervention groups
- Reviewing district-wide procedures for screening and progress monitoring annually
- Reviewing fidelity of implementation data on building-level screening and intervention delivery

2. Schedule **protected intervention blocks** for early numeracy intervention.

Provide protected time for early numeracy intervention, typically about **25 minutes per session, 3 times per week, in small group settings.**

If district resources are constrained, **shorter-term interventions (2–8 weeks)** still lead to meaningful improvements in student outcomes (g = .40, p < .001).

District leaders can support protected early numeracy intervention blocks by:

- Providing professional learning on the importance of early numeracy skills in K-1
- Guiding development of the master schedule to include a protected early numeracy intervention block of approximately 25 minutes, 2-3 days per week
- Balancing recommendations for intervention duration with school resources
- Ensuring that staffing structures allow for intervention to occur in small groups

3. Support the use of the **concrete-representational-abstract (CRA) instructional sequence** and **explicit, systematic instruction**.

Intervention programs that used CRA led to stronger improvements in student math learning (g = 0.59) compared to interventions without CRA (g = 0.37). On average, students increased about 22 percentile points from interventions that used CRA, compared to 14 percentile points from interventions that did not.

Interventions that used **explicit and systematic instruction** also resulted in meaningful improvements in math outcomes (*g* = .40), resulting in a 16 percentile-point improvement.

District leaders can support CRA implementation and explicit, systematic instruction by:

- Providing teacher professional learning on CRA instruction and the importance of systematic, explicit instruction for struggling learners
- Ensuring classrooms contain appropriate math manipulatives and visual representations
- Reviewing selected intervention programs to ensure they incorporate the CRA framework and an explicit and systematic instructional framework

4. **Provide strategic coaching** to support implementation.

Interventions that included **follow-up coaching** (*g* = 0.44) had a greater effect than interventions that did not include follow-up coaching (*g* = 0.39), though this difference was not statistically significant. Coaching supports instructional quality, teacher learning, and implementation fidelity. District leaders may consider coaching as one **strategy to support high-quality implementation**.

District leaders can support the use of strategic coaching by:

- Reviewing existing district-level resources for instructional coaches to determine areas of need
- Providing tools, resources, and professional learning for instructional coaches to work more efficiently
- Providing guidance for instructional coaches to prioritize classrooms with the greatest level of need

Implementation Checklist

Schools can use the checklist below to determine whether their early numeracy intervention approach aligns with research-based practices.

Screening and Progress Monitoring

- ❑ Students in kindergarten and Grade 1 are screened to identify early mathematics difficulties.
- ❑ Student progress is monitored during the intervention period.
- ❑ Pre- and post-intervention assessments include calculation and broader numeracy items.

Intervention Structure

- ❑ Intervention is delivered in small groups or one-to-one settings.
- ❑ Sessions occur about three times per week.
- ❑ Each session lasts approximately 25 minutes.
- ❑ Intervention groups are scheduled for several weeks (e.g., 3–9 weeks) before reviewing student progress.

Intervention Content

- ❑ Intervention targets foundational early numeracy skills in the number, relations, and operations domains.
- ❑ Students practice skills such as counting, one-to-one correspondence, number comparison, number identification, and early addition and subtraction.
- ❑ Multiple related skills are integrated within intervention sessions to strengthen overall number sense.

Instructional Practices

- ❑ Instruction uses the concrete–representational–abstract (CRA) sequence. Students first use manipulatives, then transition to visual models, and finally to abstract symbols and equations.
- ❑ Teachers adjust instruction by returning to concrete or visual supports if students struggle with abstract concepts.
- ❑ Interventions use explicit and systematic instruction.

System Supports

- ❑ Teachers have access to manipulatives and visual math models (e.g., counters, cubes, base-ten blocks, number lines).
- ❑ Professional learning is available to support effective implementation of intervention strategies such as CRA and explicit instruction.
- ❑ Schools provide dedicated time in the schedule for early numeracy intervention.

Meta-Analysis Findings

What is an effect size?

- An effect size provides information about the strength or magnitude of the effect of an intervention on student outcomes, compared to a condition without the intervention.[9, 10] It is a standardized measure that allows for comparison of intervention effectiveness across studies.
- Typically, results with a p-value less than 0.05 are considered statistically significant, meaning that there is less than a 5% chance that the results (e.g., differences between groups) are due to chance.
- An effect size can be understood as a percentage of a standard deviation. An effect size of 0.30 means that student outcomes increased by 30% of a standard deviation. Effect sizes can be positive, negative, and greater than or less than 1.0.

Early numeracy interventions provide large, educationally meaningful, and statistically significant improvements in children's math skills.

- The overall average effect of early numeracy interventions was $g = 0.40$ ($p < .001$, 95% CI [0.33, 0.47]).
- **The average effect of $g = 0.40$ is considered to be a large effect for educational interventions.**[11] It is equivalent to a What Works Clearinghouse improvement index of 16 percentile points.

The improvement index is a transformation of an intervention's effect size into a percentile-based metric intended to aid interpretation of practical significance. It represents the expected change in percentile rank for an average student in the comparison group if that student had participated in the intervention.

- Table 4 illustrates how an improvement of 16 percentile points would influence a student's math scores from pre- to post-intervention.

Table 4. Examples of 16 Percentile Point Improvement from Pre- to Post-Intervention

Child	Pre Intervention Percentile	Average Post Intervention Percentile
Child A	10th percentile	26th percentile
Child B	50th percentile	66th percentile
Child C	75th percentile	91st percentile

The effect of both kindergarten and Grade 1 early numeracy interventions was large and educationally meaningful. Kindergarten interventions led to greater effects on student learning, though this difference was not statistically significant.

- The average effect of **kindergarten interventions** was $g = 0.47$ ($p < .001$, 95% CI [0.34, 0.61]). On average, students increased by 18 percentile points in kindergarten.

- The average effect of **Grade 1 interventions** was $g = 0.31$ ($p < .001$, 95% CI [0.34, 0.61]). On average, students increased by 12 percentile points in Grade 1.

Early numeracy interventions were effective for students from low socioeconomic backgrounds and for students at high risk for difficulty in mathematics.

- The average effect of early numeracy intervention for students from **low socioeconomic backgrounds** was $g = 0.51$. On average, students from low socioeconomic backgrounds increased by 20 percentile points.
- The average effect of early numeracy intervention for **students scoring below the 25th percentile on mathematics screening measures** was $g = 0.53$. On average, students scoring below the 25th percentile increased by 20 percentile points.

Early numeracy interventions were especially effective in improving students' calculation and broad math skills.

- The average effect of early numeracy interventions on students' **calculation** skills was $g = 0.52$. On average, a student increased by 20 percentile points on calculation measures after receiving intervention.
- The average effect of early numeracy interventions on students' comprehensive, or **broad math skills** was $g = 0.42$. On average, a student increased by 16 percentile points on comprehensive math measures after receiving intervention.

Early numeracy interventions that used the concrete-representational-abstract framework (CRA) framework were on average, more effective than interventions that did not.

- **Interventions that included CRA were more effective** ($g = 0.59$) compared to interventions that did not report the use of CRA ($g = 0.37$; $F(1,571) = 3.81$, $^*p = .052$)
  - **Note*. *p*-value was marginally significant
- On average, a student increased by 22 percentile points from interventions that used CRA, compared to 14 percentile points from interventions that did not report using CRA.

Early numeracy interventions were effective with and without follow-up coaching. While not statistically significant, coaching may lead to slightly larger student math gains.

- Interventions that included **follow-up coaching** ($g = 0.44$) had a greater effect than interventions that did not include follow-up coaching ($g = 0.39$), though this difference was not statistically significant.
- Interventions implemented for **2-8 weeks** ($g = 0.40$) were as effective as interventions implemented for **9 or more weeks** ($g = 0.40$; $F(2,570) = 0.001$, $p = .994$).

Features of Early Numeracy Interventions Included in Meta-Analysis

Intervention Dosage:

On average, early numeracy interventions lasted for roughly **9 weeks**, were taught about **3 times per week**, with lessons lasting about **25 minutes**. The average total instructional time across all studies was about **10 hours**.

Table 5. Average Intervention Dosage across Studies

Intervention dosage	*M*	Range
Length of intervention	9 weeks	1 – 45 weeks
Sessions per week	3 per week	1 – 5 per week
Session length	25 min	6 – 120 min
Total sessions	23 sessions	4 – 92 sessions
Total instructional time	10 hours	50 min – 48 hours

Group Size:

Interventions were most commonly delivered in **one-to-one** (44%) and **small group** (44%) settings, followed by **mixed groupings** (7%) and **whole class settings** (4%).

Table 6. Percentage of Interventions Delivered by Group Size

Instructional group size	% Groups
One-to-one	44%
Small group	44%
Whole class	4%
Mixed groupings	7%
Not reported	2%

Math Content:

Interventions most commonly included a focus on **number skills** (89%), followed by **relations skills** (88%) and **operations skills** (72%). Interventions also included a variety of subskills within each of those domains. A majority of interventions included practice with numeral identification (71%), addition or subtraction (64%), correspondence (62%), number line skills (57%), and numeral or quantity comparison (53%).

Table 7. Percentage of Interventions Focused on Each Early Numeracy Domain

Numeracy Domains	% Groups
Number skills	89%
Relations skills	88%
Operations skills	72%

Table 8. Percentage of Interventions that Targeted Each Early Numeracy Skills

Early Mathematics Content	% Groups
Numeral identification	71%
Addition or subtraction	64%
Correspondence	62%
Number line skills	57%
Numeral or quantity comparison	53%
Cardinality	51%
Counting	49%
Counting on	44%
Composing and/or decomposing	37%
Quantity identification, subitizing	32%
Story problems	25%
Place value	24%
Numeral writing	18%
Equivalence	17%
Fact fluency	17%
Math vocabulary	15%
Skip counting	11%
Ordinal numbers	8%

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