Links to Learning Adaptive Math Assessment (LLAMA)

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LLAMA Team

University of Washington
Kristen Missall, PhD
Local Partners: Developmental Preschool, Public Preschool, Head Start, Private Preschool

Lehigh University
Robin Hojnoski, PhD
Local Partners: Head Start, Public Preschool

Purdue University
David Purpura, PhD
Local Partners: Head Start, Private Preschool

University of California-Davis
Anthony Albano, PhD
Local Partners: Private Preschool

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Early Math Development is Important

Early math skills are essential to short- and long-term achievement with performance gaps emerging in preschool (Watts et al., 2014).

Preschoolers with identified delays and disabilities tend to show slower growth over time in early math learning (Hojnoski et al., 2018; Lambert et al., 2014).

Early math instruction is urgent.

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Assessing Early Math

Targeted instruction based on knowledge of learner needs can support early math development for all learners.

Few multidimensional mathematics assessments are readily available to PreK educators that inform instruction and have included all children in the research and development process (National Research Council, 2009).

Most published early math assessments are diagnostic and not designed for instructional planning (Carta & Miller-Young, 2018), also lengthy admin, high cost, limited math domain coverage, and questionable use with young children with disabilities.

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Links to Learning Adaptive Math Assessment (LLAMA)

LLAMA, a tablet-based preK math assessment inclusive of items from numeracy, shape and space (geometry), pre-algebraic thinking, and measurement domains addresses these concerns to support educators' data-based decision making for universal screening and instructional planning for all students.

Developed in inclusive classrooms, LLAMA is centered on providing information about math development for all preschoolers to support instruction.

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LLAMA Development: Participants

Across 4 years, more than 700 preschoolers from 4 states have participated in LLAMA development.

Children diverse in language, race, ethnicity, disability, and socioeconomic status and enrolled in a range of preschool settings.

Families and teachers of enrolled children, and experts in early education and mathematics also participated.

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LLAMA Development

Data from literature validated by teachers and experts showed 4 clear constructs/domains and learning pathways PreK math.

Learning pathways translated to ordered developmental task models for item development/subtests.

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Numbers & Operations (n = 81)

- Counting
- Cardinality
- Comparing quantities
- Numeral knowledge
- Subitizing
- Early addition & subtraction

Shape & Space (n = 74)

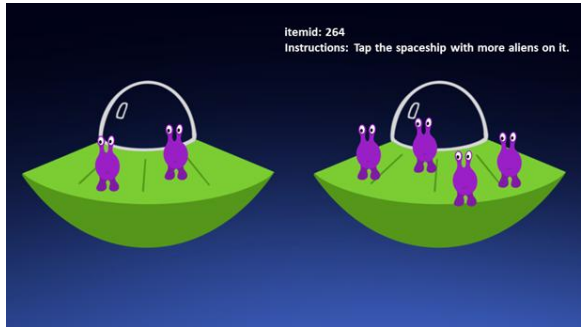
- Shape identification
- Shape composition & decomposition
- Shape rotation
- 2D & 3D mental rotation
- Spatial language

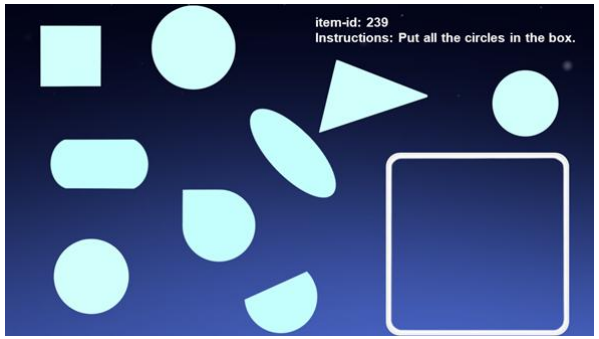
Measurement (n = 31)

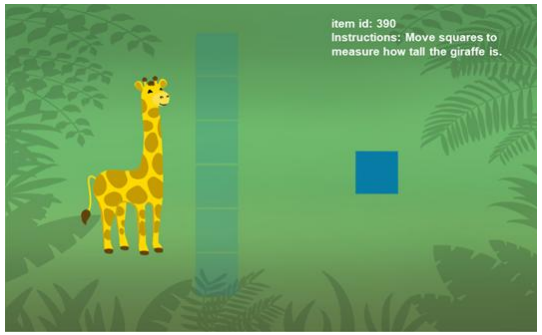
- Height & Width
- Directly comparing objects
- Indirectly comparing objects
- Ordering
- Concept of units
- Capacity/volume
- Weight

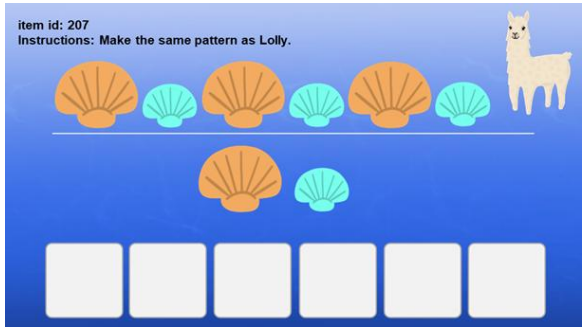
Pre-Algebraic Thinking (n = 38)

- Sorting
- With patterns:
  - recognizing
  - copying
  - completing/ filling-in
  - extending
  - describing
  - generating









LLAMA Assessment Format

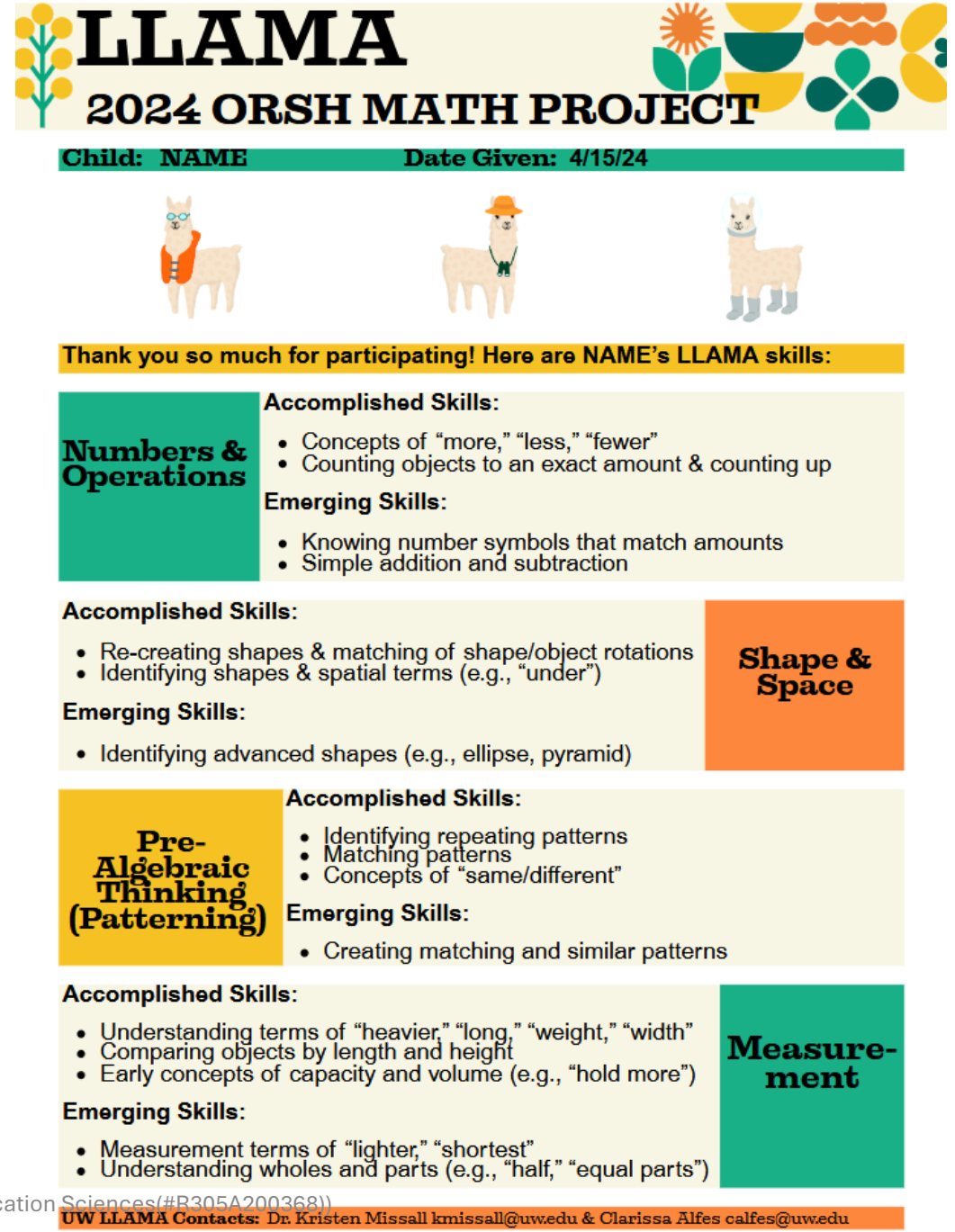
In addition to items in 4 math domains, we created a parasocial character – Lolly -- that follows children along their item adventures.

Items appear in 3 “adventure” contexts: Space, Ocean, and Jungle

Items delivered via app on a touch tablet with automated directions

- Includes training tasks for: touch, drag, rotate, etc.
- Taught to tap an “arrow button” for the next item
- Lolly “brain breaks”
- Items delivered via CAT and takes about 15 min.

Research Partnership: Feedback Loop



LLAMA

2024 ORSH MATH PROJECT

Child: NAME **Date Given: 4/15/24**

Thank you so much for participating! Here are NAME's LLAMA skills:

Numbers & Operations

Accomplished Skills:
- Concepts of "more," "less," "fewer"
- Counting objects to an exact amount & counting up

Emerging Skills:
- Knowing number symbols that match amounts
- Simple addition and subtraction

Shape & Space

Accomplished Skills:
- Re-creating shapes & matching of shape/object rotations
- Identifying shapes & spatial terms (e.g., "under")

Emerging Skills:
- Identifying advanced shapes (e.g., ellipse, pyramid)

Pre-Algebraic Thinking (Patterning)

Accomplished Skills:
- Identifying repeating patterns
- Matching patterns
- Concepts of "same/different"

Emerging Skills:
- Creating matching and similar patterns

Measure-ment

Accomplished Skills:
- Understanding terms of "heavier," "long," "weight," "width"
- Comparing objects by length and height
- Early concepts of capacity and volume (e.g., "hold more")

Emerging Skills:
- Measurement terms of "lighter," "shortest"
- Understanding wholes and parts (e.g., "half," "equal parts")

UW LLAMA Contacts: Dr. Kristen Missall kmissall@uw.edu & Clarissa Alfes calfes@uw.edu

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Psychometric Sneak-Peak

- Inter-item and inter-scale correlations
  - NO α = .94; SS α = .85; MM α = .80; PA α = .80
  - Subscale intercorrelations, *r* = .84 - .92
- Through item analysis and calibration, 175 of 200 items determined to be functional with good discrimination; this is a very high retention rate!
- We tested item administration in different formats (pre-CAT): by domain, with pre-set numbers of items by domain (blocked), and with mixed items (interleaved).
  - Analyses supported administration of interleaved items across domains, which justifies CAT and provides evidence that mixed items won't affect performance.
  - Approach has potential to increase engagement and task persistence.

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Conclusions

- LLAMA offers preschool math assessment beyond numeracy.
- Per preschoolers, experts, and educators LLAMA is:
  - Representative of math areas and pathways that are important.
  - Able to inform instruction given that items are arranged in developmental task models.
  - Engaging and as brief as possible (and this will improve as a CAT).
  - Feasible for schools – both as a tablet-based assessment and as a math assessment.
  - Developmentally appropriate with evidence of technical adequacy for diverse preschoolers.

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Next Steps

- ✓ Test LLAMA with another 300 children to finalize item reliabilities for CAT-based administration.
- ✓ Evaluate criterion validity (concurrent and discriminant) with 90 children.
- ✓ Finalize LLAMA app and teacher dashboard for learning about student skills related to learning pathways (i.e., which skills in each math domain are developed, emerging, not yet developed).
- ✓ Run a final teacher focus group centered on their independent administration and use of LLAMA and the teacher dashboard.
- ✓ Support school partners with PD.

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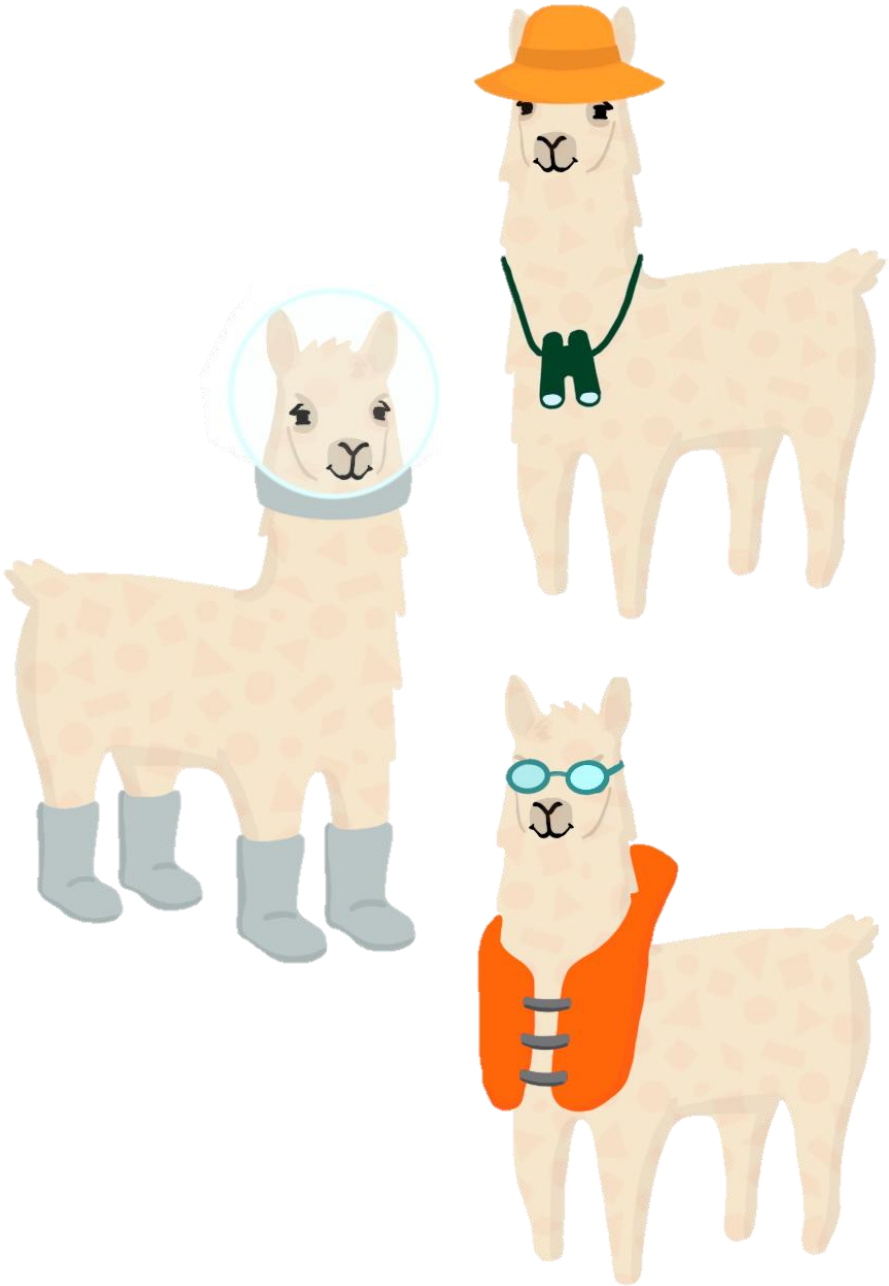
Thank you!



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